Final Report

Evaluation of Snow Disposal into Near Shore Marine Environments

Contract 18-9001-12

Prepared for

Alaska Department of Environmental Conservation

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Acronyms and Abbreviations

ACC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADOT	Alaska Department of Transportation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
BMP	Best Management Practice
BOD	biochemical oxygen demand
BOD_5	5-day biochemical oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylene
CBD	Central Business District
CBJ	City and Borough of Juneau
DEP	Department of Environmental Protection
DOT	Department of Transportation
EPA	Environmental Protection Agency
°F	degrees Fahrenheit
FWPC	Federal Water Pollution Control Act
μg/L	micrograms per liter
μm	microns
MFL	Million fibers per liter
mg/L	milligrams per liter
ml	milliliter
MOA	Municipality of Anchorage
MPRSA	Marine Protection, Research, and Sanctuaries Act
MS/MSD	matrix spike or matrix spike duplicate
ND	non-detect
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System

ORP	oxidation reduction potential
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyl
pH	Hydrogen (ion) concentration
PQL	Practical quantitation limit
QAPP	Quality Assurance Project Plan
TAH	Total aromatic hydrocarbons
TKN	Total Kjeldahl Nitrogen
USACE	U.S. Army Corps of Engineers
TDS	Total Dissolved Solids
TSS	Total Suspended Solids

Executive Summary

This report presents the results of the evaluation of snow disposal into near shore environments for both Anchorage and Juneau, Alaska. The report was prepared by CH2M HILL under Contract 18-9001-12 for the Alaska Department of Environmental Conservation (ADEC).

The overall goals of this evaluation included:

- Defining the potential pollutants that may be found in snow removed from streets in Anchorage and Juneau, Alaska.
- Providing technical data for pollutants actually found in snow collected from streets in Anchorage and Juneau, as well as background information on the receiving waters.
- Determining the impact the pollutants may have on receiving waters if disposed of in a marine environment.
- Providing information on snow removal practices in other communities.
- Determining if disposal of collected snow into a marine environment is environmentally and publicly acceptable.

Snow sample data results indicated an exceedance of regulatory standards for TAH/TAqH, some metals, and visual sheen of oil and grease.

Several communities across the northern hemisphere that currently, or have historically, disposed of snow into marine environments are identified in this report. The practice is generally limited to use under emergency snow fall conditions only.

Permitting disposal of collected snow in a marine environment would be based on its classification as a point source or non-point source of pollution. Arguments presented by the Alaska Department of Transportation (ADOT) validate either classification. EPA Region 10 considers snow dumping a minor discharge but a point source. Point source disposal would require a permit. Anchorage could include disposal in its Municipal Separate Storm Sewer System (MS4) permit. For other Alaskan communities that do not have an MS4 permit, a Permit by Rule or General Permit could be issued by the State of Alaska.

Before ADEC considers implementing a marine snow disposal program, site specific mixing zone analysis should be conducted and benchmark limits should be calculated.

SECTION 1

Introduction

Alaska municipalities face unique challenges disposing of more than 100 inches of snow that falls on many maritime cities. Many of Alaska's larger cities have been developed on relatively narrow strips of land between coastal mountain ranges and marine waters. As these land-limited cities continue to grow, vacant land that was once used to store snow has been developed into residential and commercial properties. As a result, many Alaskan cities are currently disposing of snow into the marine environment or have expressed a desire to do so. Concerns have been raised about disposing snow into near-shore marine waters.

Fresh snow in Alaska is typically clean. However, as snow accumulates on the roadways, pollutants may concentrate in the snow. Pollutants that may deposit onto fallen snow include salt, sand, gravel, suspended solids, dissolved solids, oil, grease, antifreeze, heavy metals, and other trace elements from vehicle traffic and automobile engine emissions. Snow collected from roadways often contains incidental trash, broken pavement, and other road debris. Some pollutants become diluted as the snow melts. Other pollutants can accumulate in the area where the snow is dumped, or downstream from areas where snow is dumped, and meltwater can accumulate.

The goal of this study is to determine if the practice of disposing plowed snow into marine waters is environmentally and publicly acceptable. Snow removal practices in northern communities were summarized along with a list of deicers generally used. Other communities were also surveyed to determine public acceptance of past or present snow disposal practices. Once the possible constituents were determined, a sampling plan was instituted to measure the concentration of selected pollutants present in snow in the intersections and streets of the downtown corridors of Anchorage and Juneau. The results of this sampling are summarized along with a discussion of existing regulations and how they might apply to disposing of collected, urban snow in a marine environment.

SECTION 2

Snow Removal Practices and Deicing Activities in Test Cities of Anchorage and Juneau

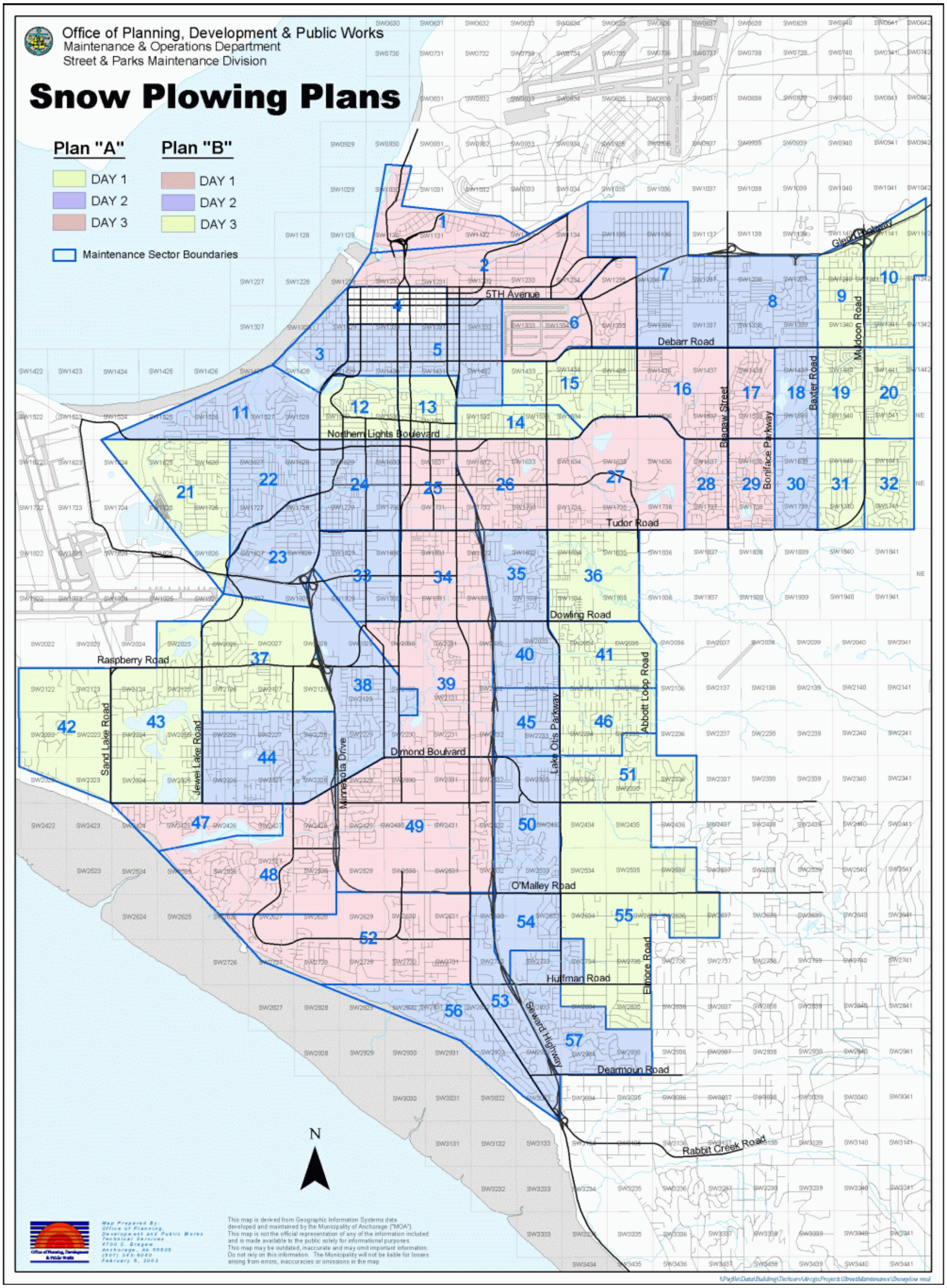
In an effort to determine the potential pollutants that could accumulate in snow on city streets, road deicing activities and snow removal practices for Anchorage and Juneau were studied.

Anchorage

Average annual snowfall for the Anchorage area is 70 inches. The Municipality of Anchorage (MOA) attempts to remove snow from its roadways within 72 hours. Exhibit 2-1 illustrates the snow plowing plans for the Anchorage bowl. The MOA alternates between Plan A and Plan B for each snowfall event.

The MOA is responsible for approximately 1,250 lane miles of roadway. This area does not include highways and "major feeder roads" such as Minnesota Drive, Tudor Road, Dimond Boulevard, and Northern Lights Boulevard. These roads are maintained by the Alaska Department of Transportation (ADOT). (MOA, Winter Maintenance, 2005).

EXHIBIT 2-1
Anchorage Snow Plowing Map, Plans A & B
(Courtesy of Anchorage Maintenance and Operations)



The deicer primarily used by the MOA is potassium acetate, diluted to 25 percent before application. The deicer also contains 2 percent corrosion inhibitor and trace metals. The MOA also uses this solution as an anti-icer (applied just before a storm) and before the distribution of sand, to help imbed the sand particles into the ice and snow. The MOA deicer application is principally limited to the intersections in the Central Business District (CBD), which is bounded by 3rd and 9th Avenues and L and Karluk Streets. This practice was instituted to reduce sand application after complaints that the area was extremely dirty by springtime. Sand is still applied to parking areas and walkways and contributes grit to the CBD. Deicer is also used in areas in the MOA described as select snow route intersections, sharp-radius vertical curves, and sharp-radius horizontal curves on major thoroughfares and freeways.). (MOA Watershed Management Program, 1998) The MOA also uses magnesium chloride but on a limited basis. Potassium acetate has a wider temperature range for application and is therefore preferred. (Dan Southard, MOA Street Maintenance, 2005)

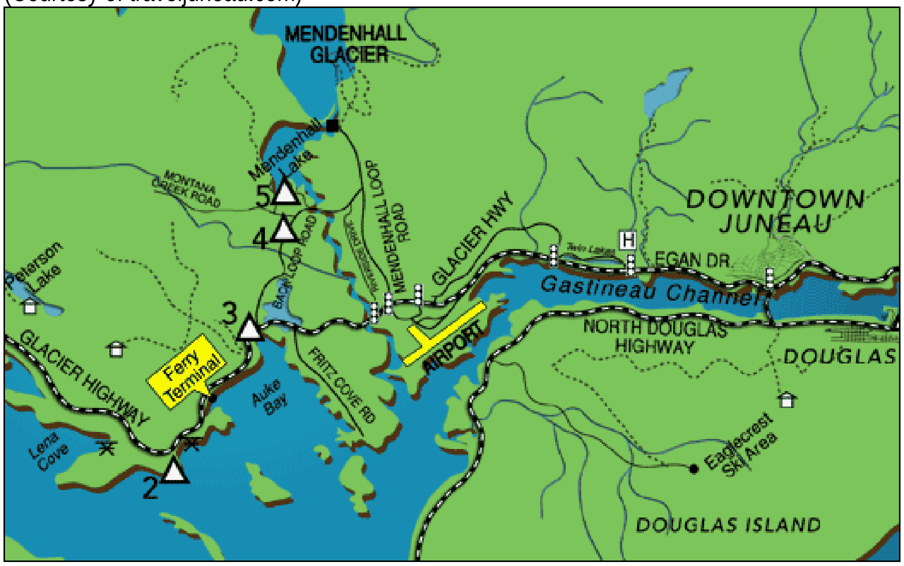
Approximately 275,000 gallons of deicer were used in the CBD in 1997-1998 and 12,000 gallons of deicer were used to pre-wet the sand applied throughout town. During the winter season, 3,000 to 7,000 tons of sand are applied in the Anchorage area. The sand is mixed with 3 percent sodium chloride to prevent freezing during storage, totaling about 300 tons annually. (Dan Southard, MOA Street Maintenance, 2005)

ADOT uses magnesium chloride with corrosion inhibitors on the roads it maintains in Anchorage and Juneau. The magnesium chloride is diluted to approximately 29 percent before application. ADOT puts deicer down before a snow event. During a winter season, ADOT uses roughly 60,000 gallons of deicer and 3000 cubic yards of sand. (Patz, 2005)

Juneau

Juneau receives about 100 inches of snow annually. However, warmer temperatures preclude the need for a large snow haul or for snow storage facilities like those needed in Anchorage. Snow removal in Juneau is shared by the City and Borough of Juneau (CBJ) and ADOT. The CBJ handles the downtown area while ADOT plows Egan Drive and the residential areas to the north (“the Valley”) and Douglas. A map of the Juneau area is shown as Exhibit 2-2.

EXHIBIT 2-2
Juneau Area Map
(Courtesy of traveljuneau.com)



Snow is removed from the downtown area depending on the amount of snow accumulation. For a snowfall of approximately 4 inches or less, snow is plowed to the side of the road and allowed to accumulate until a larger snowfall has taken place. For a single, large snowfall event, snow haul begins immediately after initial plowing has been completed. Therefore, snow removal time for the downtown area varies from 2 to 3 days to 1.5 weeks. Snow removed by the CBJ from the downtown area is dumped on the tidal flats in Gastineau Channel. The tidal action removes the snow within 6 hours. There is no evidence of debris or pollution from the ocean dumping due to tidal action.

ADOT hauls very little snow from the streets of Juneau. Snow plowed to the side of the road along Egan Drive may drain into Gastineau Channel. In the Valley, ADOT collects and hauls snow to a city snow storage facility located in the Valley. ADOT manages the snow removal in the Douglas residential area. After a snow event, ADOT typically pushes the snow to the side of the streets until a sufficient amount of snow has accumulated to warrant hauling. ADOT typically hauls snow that has accumulated in parking areas and along the roads in Douglas two to three times during a winter season. ADOT disposes of the snow at a snow storage site in Douglas. The storage area in Douglas is close to the water and snow melt runoff may be flowing directly into the ocean.

The CBJ uses magnesium chloride to deice Juneau roads; it is not used as an anti-icer. The type used is CG-90, which is 10 percent magnesium chloride and also contains corrosion inhibitors. Approximately 200 to 300 tons of CG-90 are used per year. The CBJ also uses pea/rock gravel (less than 1/8-inch stones) to sand the roads. Typical winter season use of gravel averages 1500 to 3000 tons. (Scott, 2005)

SECTION 3

Public Acceptance and Experience in Other Communities

Most northern communities incorporate snow disposal into city planning. Typically snow is disposed of at one or more snow dump sites. However, some communities have restricted land area and others, under extreme snow conditions, have more snow than can be accommodated by the snow dumps. Under these conditions, communities may look to disposing of snow into nearby waterbodies.

It is evident that marine snow dumping is under increased scrutiny. What once was a widespread practice has been discontinued in many communities. One of the greatest barriers is general public acceptance. Environmental groups have targeted snow dumping practices in European countries as a contributing source of pollution in marine harbors. Snow dumping into freshwater is almost universally prohibited due to the serious impact that deicer salts can have on freshwater aquatic life.

Some communities make exceptions to the ban on disposing snow in water bodies. Under extreme snowfall conditions, when snow disposal sites have reached capacity, some communities have utilized waterbody snow disposal as part of their snow management practice. This is typically approved by state or local regulatory agencies on a case-by-case basis. In cases where snow has been disposed of in marine waters, little data has been collected to determine the impact the snow has had on the water quality of the receiving water.

For this evaluation, communities were selected on the basis of available information and similar winter conditions.

Valdez, Alaska

Approximately 27 miles of road are cleared in the City of Valdez. The average snowfall per year is 350 inches. No deicer is used in Valdez. After a snow event, sand is applied to the streets. Prior to application, the sand is mixed with approximately 3 percent calcium chloride to keep the sand from freezing. Roughly 300 to 600 cubic yards of sand are used per season. Around eight thousand pounds of sand are generally mixed in preparation for coming snowfall.

The City of Valdez does not haul snow or push it around more than once. Snow is pushed to storage areas within the closest proximity to snow removal. Many snow storage sites have French drains or drain into the stormwater collection system. The areas closest to the water, such as North Harbor and Spent Road, are plowed and snow is piled in the harbor area. The snow pile runoff flows directly to the ocean. A spring cleanup is performed in all areas to get rid of any debris that might have collected over the winter (Roetman, 2005).

Whittier, Alaska

Whittier, Alaska allows the plowed snow to melt into the ocean but does not dump directly into it. The City of Whittier has a tidal pool where the dumped snow stays until the tide melts it away. Any trash or debris stays in the tidal pool to be cleaned up in the spring as part of the city-wide cleanup. Whittier has not received any public outcry against the practice because there is not much noticeable trash in the snow. The population in Whittier in the winter is only about 180 people and there is an understanding that there is not anywhere to store snow in the City (Blonski, 2005).

Maine, Massachusetts, and Virginia

Many cities and states in the United States prohibit dumping snow into water bodies, although the Clean Water Act does not specifically forbid it (Interactive Environment, 2004). Most cities use water bodies only in an emergency situation.

In the State of Maine, municipalities used to dump into the ocean. However, in the early 1990s, state environmental regulators ended the practice and now municipalities must dump their snow on land. A town can, however, apply for a waste discharge license for snow that is transported to and dumped into tidewater. As of November 2002, 7 municipalities and 1 business had such a license. A license is not needed for discharge of snow from areas abutting water bodies such as bridges, docks, parking lots, wharves, or roadways (Maine Department of Environmental Protection [DEP], Permits and Standards, 2002). No snow disposal licenses are issued for freshwater snow dumping in the State of Maine (Maine Department of Transportation [DOT], 2002).

The Massachusetts Bureau of Resource Protection Snow Disposal Guidance document (March, 2001) states that dumping of snow is to be avoided "into any waterbody, including rivers, the ocean, reservoirs, ponds, or wetlands." Urban snow is most often trucked to suburban "snow farms." When land sites have been exhausted, however, one may dispose of snow near waterbodies, provided a 50-foot vegetated buffer protects the waterbody. "Under extraordinary conditions," the DEP may allow snow dumping in waterbodies on a case-by-case basis.

Boston, Massachusetts stopped dumping in the ocean harbor at least 10, and perhaps even as much as 15 or 20 years ago (Casazza, 2005). The choice was made as a pre-emptive action to avoid polluting the bay. Boston received some criticism for the decision because the alternatives (trucking the snow) were more expensive. Now, however, Boston has just completed a multi-million dollar clean-up of the harbor and would not consider dumping city snow into it. According to Joe Casazza, Boston's Commissioner of Public Works, no urban area should dump its street snow in waterways because of debris and contaminants. To prove his point when the harbor dumping was stopped, he had a truckload of snow dumped into the loch system, where the water level rises and falls for the shipyards. Once the snow melted there were "all kinds of debris" left behind such as shopping carts, hubcaps, and other "gory stuff."

The Commonwealth of Virginia does not restrict snow dumping in rivers but most cities avoid it anyway. Examples of small area exceptions do exist, such as the City of Fredericksburg, which does allow snow plowed from the parking lot at the city dock to be piled near the boat ramp and allowed to drain into the Rappahannock River. All of the downtown snow is trucked across the river to a landfill.

Canada

Canadian water quality regulations do not allow any visible "deleterious substances" in areas "frequented by fish." According to Environment Canada, there is no specific ban on ocean dumping but it is considered on a case-by-case basis. Formerly, towns on Prince Edward Island dumped snow into the ocean; however wharf owners have stopped this practice due to damage to piers from trucks backing up to the wharf. British Columbia has paid millions in remediation costs for soil and groundwater contamination due to road salts and is taking steps to minimize that impact. Some communities have automatic deicing systems which only disburse chemicals when there is a need. Canada is considering other technologies such as remote sensors and infrared pavement temperature monitors. Studies instigated by insurance companies and performed on high traffic and accident areas have helped to defer costs.

Canada uses more than 5 million metric tons (5.5 million U.S. standard tons) of road salt per year (Winnipeg Civic Environment Committee, 2002). Using the winter of 1997-98 as an example, Winnipeg, Manitoba received approximately 230,000 cubic yards of snow and used 27,000 tons of salt on the roads. Winnipeg also mixed 110,000 tons of sand with 5 percent sodium chloride. The Province of Manitoba used 77,000 tons of sodium chloride and 7,700 tons of calcium chloride on the roads. In the same winter, 103,000 tons of road salt were applied in British Columbia.

The City of Toronto, Ontario has 18 public snow dumps, many of which drain directly to rivers in the area. Public awareness of the practice has grown with increased scrutiny by environmentalists who want to stop any polluting of the Don River, a major river through Toronto. Many snow dumps and their lingering debris also remained highly visible after the winter of 1999, the worst on record with 44 inches of snow accumulation from back-to-back storms. The storm created the need for 3 weeks of around the clock snow removal and assistance from Canada's Army. Yet after such an extreme storm, lake dumping was still rejected because of environmental concerns. Toronto even piloted a snow melting machine, which can dissolve over 300 tons of snow an hour. The snow melting machine alternative has not been further studied due to concern with the melt water disposal into Lake Ontario.

Current snow removal guidelines for Toronto state that snow should be removed from expressways within 3 days, from other feeder areas with limited or no storage capacity within 2 weeks, and from other laneways in 3 weeks. The City of Toronto is now looking into proposals for a central disposal site and the use of filters and settling ponds at snow disposal sites to protect the surrounding watersheds.

Oslo, Norway

Oslo, Norway is situated on the banks of Oslo Fjord. Its history dates back 1000 years and is now home to approximately 500,000 people. Oslo Fjord has a naturally low water exchange and high levels of sediments. The fjord has received years of pollution from untreated sewage, industrial wastes, urea deicer runoff from the airport, buried barrels of oil and heavy metals, and snow removed from roadways. As a result, the fjord has contaminated sediments and tainted seafood. In 1996, the Environmental Foundation Bellona instituted several measures to slow the pollution of the fjord. Included in these measures is the ban on marine dumping of cleared street snow. The reason cited for the ban was the presence of pollutants in the snow including trash, sand, gravel, salts, oil, heavy metals, polynuclear aromatic hydrocarbon (PAH), and polychlorinated biphenyls (PCBs). Sampling data and analysis results are not available at this time but may be available to the public in the future.

Helsinki, Finland

Helsinki, the capital of Finland, has occupied its current location since 1640. The population in 2000 was 1.2 million. In the 1998-1999 winter season, Helsinki had eight snow dumping sites, two of which were directly into the sea. Helsinki also uses waste heat from wastewater treatment to melt snow at two of the sites. Helsinki takes annual snow samples and water samples at the end of the spring thaw. As of 1999, no environmentally harmful substances were found. Trash collected with the snow was simply considered an aesthetic nuisance and booms were installed at waterfront dump sites to keep the trash from floating out to sea. (Helsinki Department of Public Works, 1999)

Calcium chloride is used both as a deicer and as an anti-icer on Helsinki's roads. Using calcium chloride allows the city to use 30 to 40 percent less salt compared to when sodium chloride had been used in the past. (Helsinki DPW, 1999) Street dust is a noted problem in Helsinki. The city now uses a pre-mixed calcium chloride solution, diluted to 15 percent, to moisten the streets and bind the dust. The same solution diluted to 5 percent is sometimes mixed with the sand before it is applied. This option was successful in keeping the streets dust-free "for weeks," according to the Helsinki 1999 Environmental Report.

Deicer Summary

EXHIBIT 3-1
Northern Community Deicer Usage
(Including the percent land use and area of each drainage, and respective receiving waters)

			Land Uses (Percent)		
Location	**Compound**	**Dilution**	**Other ingredients**	**Usage**	**Amount**
Anchorage	potassium acetate	25%	2% corrosion inhibitor and trace metals.	Deicer, anti-icer, and before distribution of sand	NA
Juneau	magnesium chloride, CG-90	10%	corrosion inhibitors	deicer	200-300 tons per year
Juneau	magnesium chloride	29%	corrosion inhibitors	Anti-icer, deicer	60,000 gallons per winter season
Canada	Road salt	NA			5.5 tons per year
Winnipeg, Manitoba, Canada	sodium chloride	NA	NA	Anti-icer, deicer	Approx. 30,000 tons in 97-98
Winnipeg,	sodium chloride	5%		Mix with sand	Approx. 122,000

EXHIBIT 3-1
Northern Community Deicer Usage
(Including the percent land use and area of each drainage, and respective receiving waters)

Land Uses (Percent)				
Manitoba, Canada				tons of sand (6,100 tons $NaCl_2$)
Province of, Manitoba, Canada	sodium chloride	NA	Anti-icer, deicer	Approx. 85,000 tons in 97-98
Province of, Manitoba, Canada	calcium chloride	NA	Anti-icer, deicer	Approx. 8,500 tons in 97-98
Province of, British Columbia, Canada	Road salt	NA	NA	Approx 114,000 tons in 97-98
Helsinki, Finland	calcium chloride	15%	Anti-icer, deicer, moisten streets and bind dust	NA
Helsinki, Finland	calcium chloride	5%	Mix with sand prior to application	NA

NA = information not available.

SECTION 4

Compliance with Regulations and Standards

The following is a discussion of existing state and federal regulations and how regulations might apply to marine disposal of snow from city streets. A comparison of results and existing limits is included in Section 5, Monitoring Program and Data Results.

When determining compliance with existing regulations, permitting officials would need to classify waste snow as a point source or a non-point source of pollution. A point source has a distinct definition and a discreet source and must be regulated through permits. Non-point source pollution occurs over a wide area from rainfall or snowmelt moving over and through the ground. The discharge of stormwater in larger cities is regulated by the National Pollutant Discharge Elimination System (NPDES) program Municipal Separate Storm Sewer System (MS4) permit.

Point sources include solid waste, which is defined as "drilling wastes, household garbage, refuse, sludge, construction or demolition wastes, industrial solid waste, asbestos, and other discarded, abandoned, or unwanted solid or semi-solid material, whether or not subject to decomposition, originating from any source" (Alaska Coastal Project Questionnaire, 2004). Debris collected with snow would count as residue under this definition. Snow collected from city streets can contain metals, oils and greases, salts, chemicals from tire and engine wear, as well as miscellaneous trash and debris. Since snow is an "atmospheric deposition" and melting snow would also collect and carry many of the same contaminants, collected snow can also be defined as stormwater. As the only coastal city in Alaska with an NPDES permit in place, Anchorage could include snow disposal in its MS4 permit. The determination of the type of pollution (non-point versus point source) is left for further discussion.

State Regulations

The water quality standards are set in states to maintain the health of their waterbodies. Permits use those standards to set limits on effluent and also provide for some flexibility, in monitored situations, from the standards. If mixing zones or zones of deposit are established, state standards must be met at the edge and outside of the zone.

Alaska Water Quality Standards, 18 AAC 70

Regulated snow disposal would have to meet the Water Quality Standards for Marine Water Uses as set forth in the Alaska Water Quality Standards, 18 Alaska Administrative Code (AAC) 70 (as amended through June 26, 2003). The Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances provides the numeric criteria on which the Alaska Water Quality Standards are based.

The Alaska Water Quality Standards protect the marine water supply such that it is "fishable and swimmable" (Environmental Protection Agency [EPA], 2000). Specific references to petroleum hydrocarbons, oils and grease, residues, and turbidity are made in the Water Quality Standards for Marine Water Uses. Generally, these may not cause a film, sheen, or discoloration on the surface or floor of the waterbody or adjoining shorelines; reduce the depth of the compensation point for photosynthetic activity by more than 10 percent; and make the water unfit or unsafe for use.

Existing state water quality regulations for those constituents expected in city snow can be found in Exhibit 4-1.

EXHIBIT 4-1
Summary of Water Quality Criteria for Parameters Selected for Monitoring in Snow Samples and Marine Receiving Waters

Possible Pollutant	Marine Acute Criterion (µg/L)	Marine Chronic Criterion (µg/L)
Biological Oxygen Demand (BOD)		
Chemical Oxygen Demand (COD)		
Total Kjeldahl Nitrogen (TKN)		
Glycols/Antifreeze		
Total suspended Solids (TSS)		
Total Dissolved Solids (TDS)		
Oil and grease		
Metals		
Arsenic (As)	69 (one-hour average) [2] dissolved [6]	36 (four-day average) [3] Dissolved[7]
Barium (Ba)		
Cadmium [8] (Cd)	40 (24-hour average) [9] dissolved	8.8 (four-day average) [3] dissolved
Chromium (Cr) (Chromium VI) [10]	1100 (one-hour average) [2] dissolved [11]	50 (four-day average) [3] Dissolved [12]
Lead (Pb)	210 (one-hour average) [2] dissolved [13]	8.1 (four-day average) [3] dissolved [14]
Magnesium (Mg)		
Mercury (Hg) [15]	1.8 (one-hour average) [2] dissolved [16]	0.94 (four-day average) [3] Dissolved [17]
Potassium (K)		
Selenium [18] (Se)	290 (one-hour average) [2] dissolved [19]	71 (four-day average) [3] dissolved [20]
Zinc (Zn)	90 (one-hour average) [2] dissolved [21]	81 (four-day average) [3] Dissolved [22]
Asbestos		
TAH & PAH (TAqH)		
Debris		

[2]Acute criteria are based on the average concentration of chemical pollutants during a one-hour period. One hour was chosen because it is a substantially shorter period than the length of most acute toxicity tests. Acute and chronic criteria are used together to develop water quality-based effluent limits.

[3]Chronic criteria are based on the average concentration of chemical pollutants during a four-day period. A four-day averaging period was chosen because it is substantially shorter than most chronic toxicity tests. Chronic criteria are typically stricter than the acute criteria and are therefore used to protect ambient waters.

[4]The aquatic life criteria for free cyanide shall be measured as weak acid dissociable (WAD) cyanide or equivalent approved EPA methods.

[8] The limited data suggest that the acute toxicity of cadmium is salinity-dependent; therefore the 24-hour average concentration might be under protective at low salinities and overprotective at high salinities.

[9]The 24-hour average is to be applied as an average concentration and not as a criterion to be met instantaneously at any point in the surface water.

[10] Data suggest that the acute toxicity of chromium VI is salinity-dependent; therefore the one-hour average concentration might be under protective at low salinities.

[15] The recommended criteria were derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, the criteria will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, these criteria do not account for uptake via the food chain because sufficient data were not available when the criteria were derived.

[18] If selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the concentration of selenium exceeds 5 g/l in saltwater (EPA, 1987, Ambient Water Quality Criteria For Selenium-1987, EPA 440/5-87-008, p. 35)

Mixing zones may be required if it is determined that Alaska Water Quality Standards will be exceeded. According to the EPA, mixing zones are generally not issued without a permit. Alaska at this time does not allow mixing zones for stormwater but does for industries. When proposing a mixing zone, it is necessary to consider the habitat and aquatic life, water flow, water quantity, natural currents, and the quantity and quality of the wastewater that is being discharged. Mixing zones are discussed at length in the Alaska Water Quality Standards.

An important calculation to make when considering ocean disposal of snow from city streets is the area and time required for snow dilution once it is dumped. To determine whether water quality standards would be met, a method of calculation should be used to determine the geometry and characteristics of the snow dumping and a decision should be made as to what dilution zone would result in avoiding water quality violations. Then, policy judgment would be made to determine whether that zone is small enough to affect life in the area. Chronic criteria must be met at the edge of the established mixing zone and dumped snow must not cause lethality to organisms passing within the mixing zone.

ADEC could issue a Permit-by-Rule at a later date, although EPA Region 10 has not seen this done before under NPDES. (Misha Vacok, 2005.) Another option for the state would be to issue a General Permit. This would be a permit that becomes a set of rules and Best Management Practices (BMPs) to follow so that no formal application for disposal is needed. Enforcement of the permit would start with the local jurisdiction and/or the state. EPA could then also add those inspections on to their current NPDES duties and complete inspections only when necessary or if complaints were received. If marine snow dumping were to come into practice, the municipalities and state DOT would be expected to establish BMPs for themselves and then oversee private companies.

Alaska Coastal Zone Consistency Review

Ocean dumping of snow will necessarily undergo an Alaska Coastal Zone Consistency Review to determine compliance with the Alaska Coastal Management Plan. States with such coastal management programs are now also required to create Coastal Nonpoint Pollution Control Programs. These programs focus on controlling polluted runoff and protecting "pristine areas and coastal waters" from "increases in pollution from new or expanding sources" (Coastal Zone Management Program, 2006). Management of these developing programs was assigned to the National Oceanic and Atmospheric Administration (NOAA) and the EPA.

The ADEC, Alaska Department of Fish & Game (ADF&G), and Alaska Department of Natural Resources (ADNR) use the Alaska Coastal Project Questionnaire to coordinate control of marine waters by multiple agencies. In addition to the standards already discussed to be met by ADEC, care should be taken to determine whose land abuts the disposal area.

Department of Fish and Game. If it is determined that the snow dumping would occur in a designated State Game Refuge, Critical Habitat Area, or State Game Sanctuary, an ADF&G approval would be necessary. (Alaska Coastal Project Questionnaire, 2004)

Department of Natural Resources. Approval by ADNR would be necessary for any dumping within a unit of the Alaska Park System or for anything placed in a stream, river, or lake. This would also include "streams entering or flowing through tidelands, above the level of mean lower low tide." Approval would be necessary for the introduction of "silt, gravel, rock, petroleum products, debris, brush, trees, chemicals, or other organic or inorganic material, including waste of any type, into water." (Alaska Coastal Project Questionnaire, 2004)

Federal Regulations

At the federal level, ocean dumping has been handled in a number of ways and through a number of agencies. Snow dumping is not specifically prohibited in the US Code, Title 33, Chapter 27 – Ocean Dumping, Section 1411 – Prohibited Acts.

Marine Protection, Research, and Sanctuaries Act

Title I of the Marine Protection, Research, and Sanctuaries Act (MPRSA) is most often referred to as the Ocean Dumping Act. It contains permit and enforcement provisions for ocean dumping. Prior to the creation of this act in 1972, the ocean had been used for the disposal of many types of waste including sewage, sludge, and industrial wastes. Four federal agencies have responsibilities under the Ocean Dumping Act. The EPA regulates ocean disposal of all substances except dredged spoils, which are regulated by the U.S. Army Corps of Engineers (USACE). The NOAA is responsible for long-range research on the effects of human-induced changes to the marine environment. The U.S. Coast Guard maintains surveillance of ocean dumping.

The MPRSA bans all ocean dumping of material, except by permit. As discussed previously, "material" is considered a point source of pollution. Conversely, if the snow can be classified as simple stormwater, permitting would be handled through NPDES regulations because the Federal Water Pollution Control Act (FWPCA) supersedes the MPRSA (Carlson et al, 2003).

The MPRSA now contains language that requires permits to conform to long-term management plans for designated dump sites, to ensure that permitted activities are consistent with expected uses of the site. Items regulated under such permits include the type and amount of material to be disposed, the location of the dump site, the length of time the permit is valid, and special provisions for surveillance. (Copeland, 1999)

EPA

The Environmental Protection Agency publishes water quality standards under the Clean Water Act (CWA). States can then adopt those standards or modify them to create more stringent criteria for site-specific conditions and designated uses. The EPA maintains an oversight role and ensures that the state implements its program in accordance with existing regulations.

EPA permits may be issued after it is determined that such dumping will not "degrade or endanger human health, welfare, the marine environment, ecological systems, or economic potentialities." (Copeland, 1999) As a permitting authority, the EPA would consider many factors before issuing a permit for marine disposal of waste snow. Criteria considered for ocean dumping include:

- Environmental impact of the dumping
- Need for the dumping
- Effect of the dumping on esthetic, recreational, or economic values
- Adverse effects of the dumping on other uses of the ocean

NPDES Permitting. In a draft memo from the EPA in 1996, it was suggested that the discharge of snow collected from city streets into U.S. waters would require an NPDES permit (Draft EPA Snow Dumping Policy, M. Plehn). The EPA would thus encourage cities with existing NPDES permits to incorporate any possible snow dumping activities into their permit. Acceptable guidelines for dumping snow into U.S. waters (in the draft memo) included:

- Open water
- Non-sensitive environmental areas
- Water with enough flow to prevent ice-dam formation
- Dumping at sites that would avoid damage to shoreline from trucks and front-end loaders
- Dumping only the least contaminated snow

All of the U.S. waters mentioned in the draft memo are fresh water. More investigation of the presence of contaminants in collected urban street snow should be provided to the EPA for permitting decisions.

In the past, short-term emergency dumping has been handled by the permitting authority at their discretion of enforcement. In response to the draft memo, some regions argued that such an environment discretion policy is best, since it emphasizes the "emergency only" nature of allowed dumping. Also, the limited nature of possible emergency snow dumping in municipalities without existing NPDES permits does not warrant the expansion of municipalities' permitting programs. These same regions recommended requiring a 404 permit (USACE Dredge/Fill Permit) as opposed to an NPDES permit.

Point Source Permitting. An EPA Region 10 representative considers snow dumping a minor discharge but a point source. As such, it would require a permit but it is possible to permit as an individual discharge. (Vakoc, 2005.) Individual permit applications could mean an extreme increase in paperwork for the EPA, making it very difficult to process and approve each one. In the State of Alaska, only Anchorage and Fairbanks have city NPDES permits. Therefore most coastal cities could not include a marine snow disposal clause in an existing permit. As discussed under state regulations, the state could issue a Permit-by-Rule or General Permit instead.

If it is determined that plowed snow and everything collected with it qualifies as a point source of pollution, the permit writer must determine what limit of harmful substances will protect aquatic organisms and human health. This includes "an analysis of how much of the waterbody is subject to the exceedance of criteria, for how long, and how frequently "(EPA, Technical Support Document for Water Quality-based Toxics Control, 1991).

U.S. Army Corps of Engineers

Any work "in, over, or under navigable waters of the United States, or which affects the course, location, condition or capacity of such waters" requires approval from the U.S. Army Corps of Engineers (USACE, 2006). Under authority of amendment 404 to the Federal Water Pollution Control Act, a 404 Permit is required for dredged or fill material to be disposed in navigable waters. A typical example is placement of spoils from excavation. Most do not put snow in this category. However, if the urban snow contains high concentrations of sediment which could affect navigable waters and wetlands, a 404 Permit may be required (Carlson et al, 2003).

SECTION 5

Monitoring Program and Data Results

To provide a background of information for permitting officials of the actual debris and pollutants that could be potentially disposed of in Alaska's coastal waters, sampling of plowed snow was conducted along five streets and at five intersections in both Anchorage and Juneau. Receiving water contaminant levels were also measured to provide baseline data for comparison.

Sampling was conducted as presented in the sampling plan and Quality Assurance Project Plan (QAPP), and included in Appendix A. The sampling was conducted between March 2005 and May 2006. See Exhibits 5-1 and 5-2 for sampling event dates and locations.

EXHIBIT 5-1
Sampling Locations in Anchorage

Type of sample	Type of location	Sampling dates	Location
Snow	Intersection	3/28/05	3rd Avenue/A Street
		11/23/05	4th Avenue/E Street
			5th Avenue/Cordova Street
			6th Avenue/Gambell Street
			6th Avenue/C Street
Snow	Street		On 4th Avenue, between Gambell Street and Eagle Street
			On 4th Avenue, between C Street and D Street
			On 5th Avenue, between H Street and I Street
			On 7th Avenue, between Barrow Street and A Street
			On 7th Avenue, between G Street and H Street
Water	Open receiving water	4/13/05	North Star dock
		5/2/06	

EXHIBIT 5-2
Sampling Locations in Juneau

Type of sample	Type of location	Sampling dates	Location
Snow	Intersection	1/24/06	Ferry Street/South Franklin Street
		3/9/06	Front Street/Seward Street
			Egan Drive/Willoughby Avenue
			Willoughby Avenue / Whittier Street
			F Street/12th Street
Snow	Street		On Glacier Avenue between 9th Street and 10th Street
			On Main Street between Front Street and Egan Drive
			On 4th Street between Main Street and Seward Street
			On 2nd Street between Seward Street and Franklin Street
			On Calhoun Street between Goldbelt Street and 8th Street
Water	Open receiving water	4/24/06, 4/26/06	Gastineau Channel below Douglas Drive

Pollutant parameters were chosen based on both their potential presence in collected snow and on their potential harmful impact on the environment. Some contaminants, such as magnesium, sand, and gravel were expected as a direct result of winter street maintenance. Many other sources of contamination are present in cities. Cars contribute contaminants from fuel and other fluids, to metals and other toxins present in the exhaust, to asbestos from wearing brakes. Fuel contamination can also come from public transportation systems and gas stations. Rationale for pollutants measured is included in Exhibit 5-3, along with a brief summary of findings.

EXHIBIT 5-3
Summary of Parameters Selected for Monitoring in Snow Samples and Marine Receiving Waters

Parameter Tested	Rationale	Acceptable Range or Limit in AK Water Quality Standards	Sample Location/Type	Detected (y/n), or range
Asbestos	Found in brakes and a variety of building materials. Asbestos fibers collected with snow could become concentrated where melt runoff evaporates or in receiving water bodies		Anchorage Snow	ND
			Anchorage Receiving Water	0-1
			Juneau Snow	0-1
			Juneau Receiving Water	ND
BTEX	Aromatic hydrocarbons naturally present in crude oil and gasoline	Toluene<17mg/L, See report for discussion	Anchorage Snow	Yes-(1 detection for 1,2 dichlorobenzene)

EXHIBIT 5-3
Summary of Parameters Selected for Monitoring in Snow Samples and Marine Receiving Waters

Parameter Tested	**Rationale**	**Acceptable Range or Limit in AK Water Quality Standards**	**Sample Location/Type**	**Detected (y/n), or range**
	and an indicators of petroleum-based pollution. Required by ADEC wastewater disposal permit.		Anchorage Receiving Water	ND
			Juneau Snow	Toluene, Total Xylenes
			Juneau Receiving Water	ND
Biological Oxygen Demand (BOD_5)	Reflects the amount of oxygen that would be required by microorganisms to degrade organic material in the water. Deicing materials are primary contributors to BOD_5.		Anchorage Snow	30-517 mg/L
			Anchorage Receiving Water	ND-4 mg/L
			Juneau Snow	ND-24.3 mg/L
			Juneau Receiving Water	ND
Chemical Oxygen Demand (COD)	Reflects the amount of oxygen that would be required by for chemical oxidation of organic material in the water. COD can be correlated with BOD_5, but it is less expensive and can be more quickly analyzed.		Anchorage Snow	112-1010 mg/L
			Anchorage Receiving Water	450-808
			Juneau Snow	74-1510
			Juneau Receiving Water	806
Debris	Visual assessment of garbage, sand, and organic material collected along with snow. Evaluate number and type of any miscellaneous items which could represent a water quality violation	may not make the water unfit or unsafe for use	Anchorage Snow	Yes
			Anchorage Receiving Water	No
			Juneau Snow	Yes
			Juneau Receiving Water	No
DO	Required for aquatic life; levels effected by glycols and other pollutants.	4 – 17 mg/L	Anchorage Snow	NA
			Anchorage Receiving Water	13.34-13.45 mg/L
			Juneau Snow	NA/NS
			Juneau Receiving Water	11
Glycols	Used in de-ice and anti-ice fluids, including antifreeze in cars and substances used for street application. Can cause elevated BOD_5.	Not regulated	Anchorage Snow	ND
			Anchorage Receiving Water	ND-9.8 mg/L
			Juneau Snow	ND
			Juneau Receiving Water	ND

EXHIBIT 5-3
Summary of Parameters Selected for Monitoring in Snow Samples and Marine Receiving Waters

Parameter Tested	Rationale	Acceptable Range or Limit in AK Water Quality Standards	Sample Location/Type	Detected (y/n), or range
Metals	Heavy metals are generated from vehicle engines, body wear, and emissions Evaluate the potential of heavy metals contamination to receiving water Metals tested include: As, Ba, Cd, Cr, K, Mg, Pb, Se, Zn, and Hg		Anchorage Snow	Yes-Ba, Cd, Cr, K, Mg, Pb, Zn
			Anchorage Receiving Water	Ba, Cr, K, Mg, Zn
			Juneau Snow	Ba, Cr, Hg, K, Pb, Mg, Zn
			Juneau Receiving Water	Ba, K, Mg
Arsenic (As)		69 (µg/L) (1-hour average)		
		36 (µg/L) (4-day average) [3]		
Barium (Ba)				
Cadmium (Cd)		40(µg/L) (24-hour average)		
		8.8 (µg/L) (4-day average) [3]		
Chromium (Cr)		1100(µg/L) (1-hour average)		
(Chromium VI)		50(µg/L) (4-day average) [3]		
Lead (Pb)		210(µg/L) (1-hour average)		
		8.1 (µg/L) (4-day average) [3]		
Magnesium (Mg)				
Mercury (Hg)		1.8 (µg/L) (1-hour average)		
		0.94 (µg/L) (4-day average) [3]		
Potassium (K)				
Selenium (Se)		290 (µg/L) (1-hour average)		
		71 (µg/L) (4-day average) [3]		

EXHIBIT 5-3
Summary of Parameters Selected for Monitoring in Snow Samples and Marine Receiving Waters

Parameter Tested	Rationale	Acceptable Range or Limit in AK Water Quality Standards	Sample Location/Type	Detected (y/n), or range
Zinc (Zn)		90 (μg/L) (1-hour average) 81 (μg/L) (4-day average) [3]		
Oil and grease	Visual indication of pollutants such as gasoline.	May not cause a film, sheen, or discoloration on the surface or floor of the waterbody or adjoining shorelines	Anchorage Snow	Yes
			Anchorage Receiving Water	No
			Juneau Snow	Yes
			Juneau Receiving Water	NS
TAH & PAH (TAqH)	Evaluate the potential of petroleum contamination to receiving water	TAH < 10 μg/L TAqH < 15 μg/L	Anchorage Snow	ND
			Anchorage Receiving Water	ND
			Juneau Snow	ND
			Juneau Receiving Water	ND
Total Kjeldahl Nitrogen (TKN)	Primary forms of nitrogen, an essential nutrient for algal growth. Needed for some water quality models to assess nutrient budgets, and mass loading estimates.		Anchorage Snow	ND-6.68 mg/L
			Anchorage Receiving Water	ND
			Juneau Snow	ND-7.46 mg/L
			Juneau Receiving Water	ND
Total suspended Solids (TSS)	Evaluate the impact on turbidity of the receiving water. Measure of particles of given size in water		Anchorage Snow	ND-1750 mg/L
			Anchorage Receiving Water	1050-1930 mg/L
			Juneau Snow	432-3000 mg/L
			Juneau Receiving Water	30 mg/L
Total Dissolved Solids (TDS)	Evaluate the impact on turbidity of the receiving water		Anchorage Snow	166-5300 mg/L
			Anchorage Receiving Water	20300-20700 mg/L
			Juneau Snow	49.4-4980 mg/L
			Juneau Receiving Water	30300 mg/L

Numbers presented are from the Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances, as amended through May 15, 2003. See standards for further details and comments.
NA = Not Applicable
ND = Non Detect
NS = Not Sampled

Asbestos

The only agreed upon standard for waterborne asbestos is for drinking water. The standard used by ADEC and the EPA is less than 7 million fibers per liter (MFL). Levels are measured in structures or fibers longer than 10 microns (μm). Small fibers may be carried long distances by water currents before settling. Though recent studies have begun to show some connection between gastrointestinal cancers and the ingestion of asbestos fibers through drinking water, the EPA does not expect asbestos to accumulate in aquatic life. Asbestos is also a naturally occurring substance whose presence is expected in surface and ground water.

Asbestos would not be a prohibitive factor in snow disposal. The data found no asbestos in the Anchorage snow sample but it was found in the receiving water at one measurement of 1 MFL. The Juneau snow samples had one hit for 1 MFL while there was none present in the marine sample. The sensitivity was 5.60 – 5.72 MFL.

Biochemical Oxygen Demand (5-day)

The 5-day biochemical oxygen demand (BOD_5) is not regulated by the Alaska Water Quality Standards. However, the BOD_5 concentrations in the collected snow were considerably higher than in the receiving waters. The highest levels were found in the Anchorage snow samples. The range for these samples was between 30 and 517 mg/L, with 17 of the 22 samples producing results over 100 mg/L. The average measurement for BOD_5 in Anchorage was 198 mg/L for the 5 road samples and 241 mg/L for the intersections. BOD_5 results for the Juneau snow samples were considerably lower, with results ranging from non-detect (ND) to 24.3 mg/L, with just over half of the results below 11 mg/L. The averages for Juneau roads and intersections were 10.76 and 13.23, respectively. The receiving waters had still lower concentrations, with the Juneau receiving water sample showing ND, and 1 of the 2 Anchorage samples ND and the other reporting 4 mg/L.

Since the receiving water concentrations were so much lower, these high readings for the collected snow indicate a level of contamination that could be of concern in a marine dumping scenario. Glycols can contribute to high BOD_5 and are commonly used in de-icing fluid and antifreeze but the sampling results for this study show non-detects for glycol in both Anchorage and Juneau. High Total Kjeldahl Nitrogen (TKN) results indicate that ammonia could also have been a potential contributor.

For airport facilities that use more than 100,000 gallons average annual glycol-based deicing/anti-icing chemicals and/or 100 tons average annual urea, the Multi-Sector General Permit (MSGP) benchmark limit for BOD_5 is 30 mg/L.

Chemical Oxygen Demand

The results for COD were high for both snow and receiving water samples. Because the receiving water COD levels were higher for both Anchorage and Juneau, this parameter would not be a prohibitive factor for potential marine disposal. However, the benchmark limit for airport facilities described above is 120 mg/L, which was exceeded in both Anchorage and Juneau snow samples.

EXHIBIT 5-4
COD Results for Anchorage and Juneau Tests

	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)
Anchorage Snow Road	74.5	758	466.9
Anchorage Snow Intersection	112	1,230	545.7
Anchorage Receiving Water	450	808	655.3
Juneau Snow Road	568	1390	877
Juneau Snow Intersection	74	1510	567
Juneau Receiving Water	806	806	806

Debris

Estimated percent debris was recorded at the time of sampling as part of the field notes. In addition, debris collected in the sample was documented as a percentage of the sample volume. Dried sediment remaining from the collected snow was run through sieves to determine the percentage of large debris and gravel caught on the number 5 screen; the sand and some of the smaller organics caught on the 35 screen; and the fines caught on the 230 screen. Debris was observed in snow samples from both Anchorage and Juneau. No debris was noted in the receiving water samples for either location.

Little excess trash was evident during the Juneau snow sampling aside from some organics and a few mentions of wrappers and cigarette butts. Snow collected was estimated to be from five to forty percent gravel and sand. No trash or gravel was noted while taking the Anchorage snow samples. The highest percentage of the remains after sieving was gravel and larger debris. Other items included in the results were pine needles, bits of plants, sticks, bark, Styrofoam, plastic, cigarette butts, paint chips, soda wrappers and caps, feathers, and a fish skin.

A brief comparison of intersection and road locations in both cities indicated higher amounts of debris collected with the snow at road locations than at intersections, with roads in Juneau having considerably higher results. Trash and other residues did not differ significantly from intersection to road. (See Exhibit 5-5)

EXHIBIT 5-5
Total Weight of Debris Found at Intersection vs. Road Locations in Juneau and Anchorage

	Minimum Weight of Debris (g)	Maximum Weight of Debris (g)	Average Weight of Debris (g)
Anchorage Snow Road	1.9	264.3	70.4
Anchorage Snow Intersection	5.6	233.2	66.3
Juneau Snow Road	303.1	2815.4	1181.9
Juneau Snow Intersection	114.9	493.2	316.92

A private snow pile near C Street and Northern Lights was photographed during the period of breakup in March 2006. See Exhibits 5-6 and 5-7 for an example of the nature of debris that can collect in snow piles. Appendix F shows photos of the snow pile thawing over a period of several weeks during the spring and the trash and sediment that emerged.

EXHIBIT 5-6
Parking Lot Collected Snow 3/15/06

EXHIBIT 5-7
Parking Lot Collected Snow 4/14/06

Dissolved Oxygen

Given that dissolved oxygen is temperature and pressure sensitive, readings taken from the snow sample meltwater are not indicative of natural conditions. The receiving water results for both Juneau and Anchorage (around 11 and 13 mg/L, respectively) indicate healthy levels of dissolved oxygen, however.

Glycols

Glycols are not regulated by the Alaska Water Quality standards but they do affect the BOD_5. Glycols were not found at all in Juneau or in the Anchorage snow samples, but were present once in the Anchorage marine samples at 9.8 mg/L.

Metals

Metal levels in the snow samples were over state limits for chromium, lead, and zinc in both Anchorage and Juneau. Interestingly, the zinc levels measured at the shore for the Anchorage marine environment were also over the state levels of aquatic life criteria for marine waters, even higher than the levels measured in the snow samples. Mercury levels in the Juneau snow samples violated both the acute and chronic criteria for marine life.

Although not regulated, it is worthwhile to note the potassium and magnesium levels in relation to deicer usage. Magnesium levels measured in marine environments in Juneau and Anchorage were much higher than the levels measured in the snow samples. Marine potassium levels had higher averages than the snow samples but levels present in the snow samples had higher maximums.

EXHIBIT 5-8
Metal Results for Anchorage and Juneau Tests

	Anchorage Snow (mg/L)			Anchorage Marine (mg/L)			Juneau Snow (mg/L)			Juneau Marine (mg/L)			State Limit (mg/L)	
	Min	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Acute**	**Chronic**
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.069	0.036
Barium	0.11	0.81	0.26	0.16	0.19	0.17	0.13	1.10	0.60	0.013	0.015	0.014	Not Limited	Not Limited
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.040	0.0088
Chromium	0.014	0.110	0.038	0.034	0.380	0.123	0.023	0.210	0.110	ND	ND	ND	1.100	0.050
Lead	ND	0.58	0.06	ND	ND	ND	ND	0.65	0.21	ND	ND	ND	0.210	0.0081
Magnesium	4.10	170	22.82	710	750	730	4.9	350	78	1,100	1,100	1,100	Not Limited	Not Limited
Potassium	38	520	234	220	250	238	1.7	750	71	380	400	390	Not Limited	Not Limited
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.290	0.071
Zinc	0.073	0.710	0.238	0.078	0.100	0.086	0.095	1.00	0.430	ND	ND	ND	0.090	0.081
Mercury	ND	ND	ND	ND	ND	ND	ND	1.5	0.115	ND	ND	ND	0.0018	0.00094

Highlighted and underlined cells (_____) indicate parameters that exceed state standards.

Oil and Grease

A visual sheen was observed on all of the snow samples collected in Juneau, approximately half of the total snow samples collected in Anchorage, and none of the receiving water samples from Anchorage. An Oil and Grease parameter was not recorded for the Juneau receiving water sample.

All but one of the Anchorage snow samples collected on March 28, 2005 were recorded as having a visual sheen, but those collected on November 23, 2005 did not. This difference could be due to weather conditions. Temperatures fluctuated from the 20 degrees Fahrenheit (°F) range into the 40°F range in the days leading to the March sampling, and stayed well below freezing (10°F to 20°F) leading up to the November sampling. The melt/freeze conditions may have caused gasoline and oil to collect on road puddles which were then splashed into the collected snow by passing cars. Juneau temperatures prior to both sampling events were similar to those of the Anchorage March sampling, with highs above freezing during the day and below freezing at night.

TAqH (TAH and PAH)

Aromatic hydrocarbons are naturally present in crude oil and gasoline and are indicators of petroleum-based pollution. Total aqueous hydrocarbons (TAqH) is a measure of both the total aromatic hydrocarbons (TAH) and of the polynuclear aromatic petroleum hydrocarbons (PAH) present in the water. TAH is often measured as BTEX for the levels of benzene, toluene, ethylbenzene, and total xylenes (sum of m,p and o xylenes). In this study, however, chlorobenzene, 1-3, 1-4 and 1-2 di-chlorobenzenes were also analyzed.

Very few BTEX or chlorobenzenes were detected in the snow. None were detected in the marine samples. PAH were not detected in any of the samples. The Alaska Water Quality Standards for Marine Water Uses limits TAqH to 0.015 mg/L and TAH to 0.010 mg/L. Three parameters would appear to exceed those limits, except when compared individually to the limits set in the Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances.

A single detection of 1 mg/L of 1,2-dichlorobenzene was found in the March Anchorage snow sample, the same as the reporting limit for that parameter. The limit for the human consumption of aquatic organisms is 17 mg/L. Toluene was detected in all of the Juneau snow samples, measuring an average of 2.0 mg/L with a single detection of 8.6 mg/L. Xylenes were detected twice in the Juneau snow samples at levels below the EPA drinking water standard. There is no standard for consumption of organisms because xylenes are not expected to accumulate in aquatic organisms.

Total Kjeldahl Nitrogen

The Total Kjeldahl Nitrogen (TKN) test evaluates the presence of the primary forms of nitrogen, an important nutrient for plant growth. TKN is not regulated for marine waters in Alaska. Results were generally around 7mg/L or below for snow samples, with the exception of the November 28, 2005 snow sample from the Anchorage intersection at 4th and E, which had an outlier value of 18.3. TKN was not detected in any of the marine samples.

Total Suspended Solids and Total Dissolved Solids

TSS and TDS are measures of two size classes of particulates suspended in the water column which can contribute to turbidity. Both parameters generally had high results for both snow meltwater and the receiving waters, indicating high turbidity. The lowest results were for the Juneau receiving waters, which had only 30 mg/L. (See Exhibit 5-9) The MSGP limit for airports for TSS is 100 mg/L, which was exceeded in both the Anchorage and Juneau snow samples.

EXHIBIT 5-9
TSS and TDS Results for Anchorage and Juneau Tests

	Minimum TSS (mg/L)	Maximum TSS (mg/L)	Average TSS (mg/L)	Minimum TDS (mg/L)	Maximum TDS (mg/L)	Average TDS (mg/L)
Anchorage Snow Road	140	1120	381	166	5300	1814
Anchorage Snow Intersection	114	1750	569	178	1640	828.4
Anchorage Receiving Water	1050	1930	1398	20,300	20,700	20450
Juneau Snow Road	618	3000	1920	80.6	4980	1827
Juneau Snow Intersection	250	2980	1284	49.4	3750	1397
Juneau Receiving Water	30	30	30	30,300	30,300	30,300

Weather

See Exhibit 5-10 for weather observations at the sampling areas in the days surrounding the sampling events.

EXHIBIT 5-10
Weather Data for Anchorage and Juneau

		Observed Temperatures °F		Observed Precipitation (inches)		
	Day	Low	High	Precip	Snow	Snow on ground
	26	30	42	0.04	0.8	2
Anchorage Snow Sampling March 28, 2005	27	27	32	0.17	2.3	2
	28	25	35	0.23	4.8	5
	29	23	35	T	T	5
	30	19	33	0	0	4
	21	16	26	T	T	2
	22	18	27	T	T	2
Anchorage Snow Sampling November 23,2005	23	18	24	0.32	4.4	6
	24	14	18	0.08	5.1	10
	25	8	16	0.01	0.8	9

		Observed Temperatures °F		Observed Precipitation (inches)		
Anchorage Marine Sampling April 13, 2005	11	27	52	0	0	0
	12	27	48	0	0	0
	13	27	48	0	0	0
	14	26	51	0	0	0
	15	28	48	0	0	0
Anchorage Marine Sampling May 2, 2005	30	31	53	0	0	0
	1	29	52	0	0	0
	2	36	47	T	0	0
	3	33	53	0.17	0	0
	4	37	54	0.01	0	0
Juneau Snow Sampling January 24. 2006	22	29	41	0.09	0.4	T
	23	27	31	0.05	0.8	1
	24	23	29	0.53	12.4	2
	25	13	23	0.07	1.5	11
	26	15	26	0.02	0.8	9
Juneau Snow Sampling March 11, 2006	7	33	37	0.31	T	T
	8	28	38	0.43	0.9	T
	9	22	38	0.02	0.7	1
	10	16	32	0	0	T
	11	14	30	0	0	T
Juneau Marine Sampling April 24 & 26, 2006	22	38	43	0.74	0	0
	23	40	43	0.23	0	0
	24	36	43	0.38	0	0
	25	32	47	0.02	T	0
	26	29	49	0.02	0	0
	27	37	47	0.3	0	0
	28	34	45	0.1	T	0

Source: National Weather Service Forecast Office, Anchorage, Alaska

SECTION 6

Conclusion and Recommendations

Nearly all interviews and research revealed public concern regarding the trash entrained in collected snow. Actual trash collected with the snow was not excessive but there were non-perishables, as well as the presence of sediment.

Seventy-five percent of the snow samples also had an oily sheen present, violating Alaska standards. Chromium, lead, and mercury were also detected in the snow above established limits which would prohibit dumping into the ocean. TAH and TAqH levels were above the limits set forth in the Alaska Water Quality Standards for Marine Water Uses. Though not regulated, BOD_5 levels in the snow samples were considerably higher than the receiving waters.

There are no regulatory limits for magnesium or potassium. Deicer chemical concentrations measured in the snow samples in Anchorage and Juneau did not exceed the magnesium or potassium concentrations measured in the marine samples.

Due to the potential presence of trash and debris in snow collected from the roadways, it is not recommended that the ADEC allow snow disposal directly into marine waters. To lessen the impact of trash and debris on receiving waters, the disposal of snow near marine waters or screening of snow may be considered as part of best management practice. Reference should be made to Synthesis of Best Mangement Practices for Snow Storage Areas for additional information on best management practices. Similarly, stockpiling of snow may equalize pollutant concentrations found in the collected snow.

Prior to adopting a marine snow disposal program, ADEC should determine a mixing zone at each snow disposal location. Mixing zones are to be site specific, based on water currents, influence of nearby streams, allowable size of mixing zone, and pollutants present in the snow. A maximum allowable benchmark for potential pollutants should be established. It is not realistic to monitor the pollutants present in each batch of snow that would be disposed. Therefore, a reasonable potential to exceed water quality standards should be determined based on monitoring data to determine acceptability of the marine snow disposal practice.

SECTION 7
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Appendix A
Sampling Plan andQAPP

The objectives of the sampling plan are to determine what impact snow disposal from representatives sites in Anchorage and Juneau would have on marine receiving waters. The sites targeted in this study are roadsides and intersections in downtown Anchorage and Juneau. After sufficient snow accumulation, which may occur within hours of heavy snowfall or after several days of light snowfall, snow is plowed to the side of the road. It is later collected into a dump truck and hauled off. The Alaska Department of Environmental Conservation (ADEC) has been asked by citizens to look into the feasibility of disposing of hauled snow into marine waters. Under this sampling plan, snow that has been plowed to the side of the road will be sampled to determine the concentration of pollutants that might be found in hauled snow. In addition, marine receiving water will also be sampled to establish background water quality.

The sampling plan addresses monitoring locations, sample parameters, sampling and analytical methodologies, and sampling schedule. The ADEC Quality Assurance Project Plan (QAPP) is used as a guideline for collecting, documenting, handling, and transporting samples and using correct sampling and analytical methodologies. The ADEC QAPP is included in Attachment A.

2.1 Parameter Selection

Parameters for the snow monitoring program have been selected based on the potential for their presence in the snow samples and potential negative impact to the environment. The same parameters will also be monitored in the marine receiving waters to determine background concentrations. The identified parameters satisfy a number of purposes and data needs. Table 2-1 presents the rationale for sampling each of the parameters as well as the analytical method, the volume required by the laboratory, the preservation method, and the maximum hold time prior to being analyzed. MS/MSDs will be provided by the laboratory and will be taken from their batch samples.

TABLE 2-1
Snow and Receiving Water Sampling Parameters

Parameter	Rationale	Method	Volume	Preservative	Holding Time
BOD	Reflects the amount of oxygen required for chemical oxidation of organic material in water BOD is affected by glycol content	SM5210B	300 mL	None	48 Hours
COD	Reflects the amount of oxygen required for chemical oxidation of organic material in water BOD is affected by glycol content	SM5220C	200 mL	H_2SO_4	28 Days
TKN	Evaluate the impact of ammonia on the receiving water	SM4500-N B	500 mL	H_2SO_4	28 Days
Glycols/ Antifreeze	Influence the BOD and COD	ASTM D-3695	100 mL	None	14 Days
TSS	Evaluate the impact on turbidity of the receiving water	SM2540D	1000 mL	None	7 Days
TDS	Evaluate the impact on turbidity of the receiving water	SM2540C	250 mL	None	7 Days
Oil and grease	Evaluate the potential of petroleum contamination to receiving water	Visual (sheen Yes/No)	N/A	N/A	N/A
Heavy metals	Heavy metals are generated from vehicle engines, body wear, and emissions Evaluate the potential of heavy metals contamination to receiving water Metals tested include: As, Ba, Cd, Cr, K, Mg, Pb, Se, Zn, and Hg	RCRA metals: ICP 6010 Mercury: CVAA 245.1	500 mL	HNO_3	RCRA 7: 90 days Hg: 28 Days
Asbestos	Asbestos is generated from car brakes and tires Evaluate the potential of asbestos contamination to receiving water	100.1 TEM	1 L amber	None	48 Hours
TAH (TAqH)	Evaluate the potential of petroleum contamination to receiving water	602	Two 40 mL	HCl	14 Days
PAH (TAqH)	Evaluate the potential of petroleum contamination to receiving water	625	1000 mL	None	7 Days
Debris	Evaluate number and type of any miscellaneous items which could represent a water quality violation	Visual count	N/A	N/A	N/A

2.2 Monitoring Locations

Snow monitoring will take place in the central business district (CBD) of downtown Anchorage and in the downtown area of Juneau, Alaska. Snow samples will be collected on five streets and five intersections in both cities.

Water samples of marine receiving waters will be collected at locations where snow could potentially be disposed in the future. These areas are identified as the North Star dock in Anchorage and below Douglas Bridge in Juneau. There has been some limited snow disposal at the North Star dock in the past. Disposal of snow into Gastineau Channel from under the Douglas Bridge is currently practiced by the City and Borough of Juneau (CBJ).

Under snow sampling, streets and intersections are differentiated because the Municipality of Anchorage (MOA) applies anti-icing to the intersections prior to an anticipated snow event. The purpose of the anti-icing is to prevent snow from sticking to the pavement and leading to ice build-up in the intersections. As it snows, the MOA plows the snow; once all of the snow is cleared and the storm is over, deicer is applied. The MOA follows this same procedure whether the operations take place on a weekday or weekend. In both communities sand and deicer are applied at intersections for improved vehicular stop/start traction. Therefore, snow collected from intersections may have a higher pollutant concentration than snow collected from alongside the roads.

2.2.1 Anchorage.

Table 2-2 and Figure 2-1 identify the snow and water sampling locations in Anchorage.

TABLE 2-2
Sampling Locations in Anchorage

Type of sample	Type of location	Number of locations	Location
Snow	Intersection	5	3rd Avenue / A Street
			4th Avenue / E Street
			5th Avenue / Cordova Street
			6th Avenue / Gambell Street
			6th Avenue / C Street
Snow	Street	5	On 4th Avenue, between Gambell Street and Eagle Street
			On 4th Avenue, between C Street and D Street
			On 5th Avenue, between H Street and I Street
			On 7th Avenue, between Barrow Street and A Street
			On 7th Avenue, between G Street and H Street
Water	Open receiving water	1	North Star dock

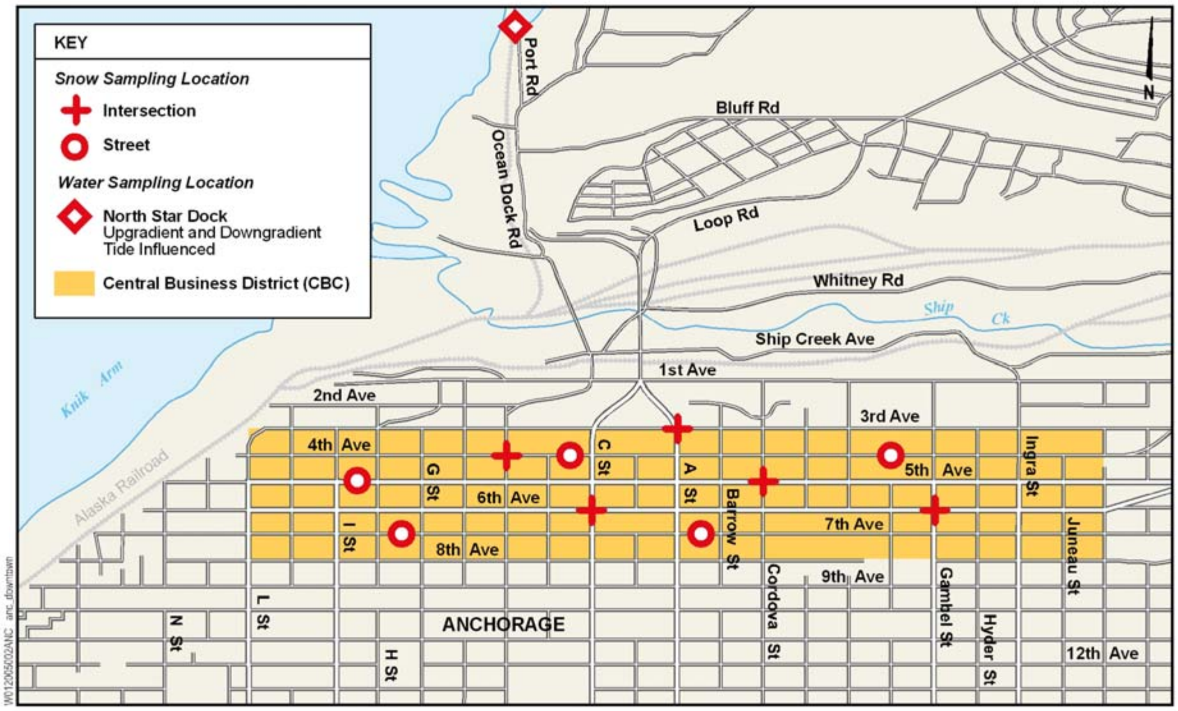

Figure 2-1: Anchorage Sampling Locations

2.2.2 Juneau. Table 2-3 and Figure 2-2 identify the snow and water sampling locations in Juneau.

TABLE 2-3
Sampling Locations in Juneau

Type of sample	Type of location	Number of location	Location
Snow	Intersection	5	Ferry Street / South Franklin Street
			Front Street / Seward Street
			Egan Drive/Willoughby Avenue
			Willoughby Avenue / Whittier Street
			F Street / 12th Street
Snow	Street	5	On Glacier Avenue between 9th Street and 10th Street
			On Main Street between Front Street and Egan Drive
			On 4th Street between Main Street and Seward Street
			On 2nd Street between Seward Street and Franklin Street
			On Calhoun Street between Goldbelt Street and 8th Street
Water	Open receiving water	1	Gastineau Channel below Douglas Drive

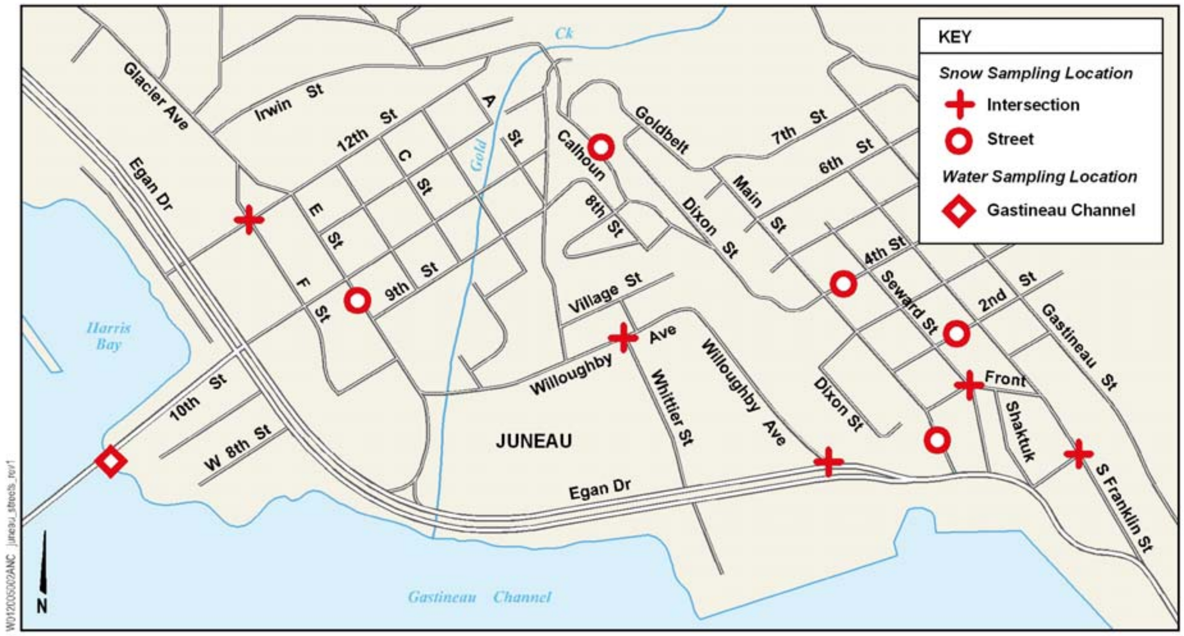

Figure 2-2: Juneau Sampling Locations

2.3 Sampling Methodology

The sampling methodology has been developed for two types of sample sites:

- Fresh snow stockpiled adjacent to roadways and intersections before being removed
- Marine receiving waters

Additional data to be collected include precipitation data for the period prior to sampling and after the previous snow removal event. The duration between the sampling date and the previous snow removal event will also be documented.

Photographs will be taken of all sampling locations. In addition, sampling locations will be documented with a recreational grade GPS unit.

Quality Assurance/Quality Control (QA/QC) measures are described in the QAPP for field sampling techniques (Attachment A). The sampling discussed in the QAPP will be conducted by CH2M HILL staff. Additionally, the matrix spike or matrix spike duplicate (MS/MSD) outlined in the QAPP will be taken from the laboratory's batch sample for each parameter required. These parameters include: Total Aqueous Aromatic Hydrocarbons (TAqH); alcohols and glycols; Total Suspended Solids (TSS); 5-day Biochemical Oxygen Demand (BOD-5); Total Dissolved Solids (TDS); Chemical Oxygen Demand (COD); nitrogen (organic), Macro-Kjeldahl Method (TKN); mercury; heavy metals; and asbestos in receiving water. One duplicate sample will be taken for each parameter for each snow sample event and for each marine water sample event in Anchorage and likewise in Juneau. The project goal is to take samples from two storm events in Anchorage and two storm events in Juneau.

2.3.1 Snow Sample Collection. Samples will be collected from each of the pre-determined locations (Section 2.2). The general approach will be to conduct the sampling effort in conjunction with the snow removal effort of the MOA in Anchorage and the CBJ in Juneau.

The CH2M HILL field team will collect snow composite samples immediately after fresh snow has been plowed and stockpiled adjacent to roadways and before being removed. The team will use a plastic snow shovel which will be decontaminated with Alconox® and rinsed with deionized water between sample sites. Snow will be collected in a manner that simulates municipal snow removal efforts by scraping down to the street surface to the extent feasible.

The discreet samples will be placed and compacted in a 5-gallon bucket, sealed with a lid, and allowed to melt at room temperature. The lids will be placed on the buckets during the melting process to minimize volatilization. After snow has been collected, buckets will be monitored three times per day: first thing in the morning, mid-day, and evening. It is anticipated that the snow will melt in approximately two to three days. Samples will be collected as soon as snowmelt is complete to minimize degradation of the sample parameters. Hold times begin as soon as the sample has been collected and sample preservative added to the sample bottle.

The melting time, room temperature, final volume of meltwater in the bucket, and weight of the sample will be recorded. The sample buckets will be visually inspected for the presence of a colored sheen that would indicate the occurrence of oil and grease in the sample. The melted snow will then be mixed in the bucket before being transferred to the sampling containers. High volume parameters will be taken as grab samples. Volatile parameters such as PAH and TAH sample sets will be siphoned from the bucket to the sample bottles through a plastic tube which will also be cleansed with Alconox® and rinsed with deionized water between buckets. The resulting composite samples will be analyzed for the parameters listed in Table 2-1 at Analytica Alaska Incorporated (Analytica).

The remaining bucket water will be sieved using geotechnical screens to differentiate between fine (<0.075 millimeters [mm]), sand (0.075 - 4.75 mm), and gravel (>4.75 mm). The retained materials will be dried and weighed. Other debris will be separated out and weighed after a week of drying at room temperature.

The percentage of debris in the snow bank will be based on ocular estimations. Estimated percent debris will be recorded at the time of sampling as part of the field notes. In addition, debris collected in the sample will be documented as a percentage of the sample volume. Debris will be classified based on composition: paper, plastics, metal, rubber, or wood debris.

To better understand the nature of debris that accumulates in parking lot snow piles, a private snow pile near C Street and Northern Lights Boulevard will be visually inspected, field noted, and photographed weekly throughout March 2005. Debris remaining in the parking lot after the spring thaw will also be photographed and documented.

2.3.2 Water Sample Collection. A sample will be collected from each of the identified marine water locations (Section 2.2). The general approach will be to conduct the sampling effort a week after any snow disposal to regional marine receiving waters has taken place. The results of the water samples will be used as baseline data and the goal is to avoid any influence by snow disposal activity, as this is not an ambient monitoring program.

Field parameters (pH, conductivity, turbidity, Dissolved Oxygen, Temperature, ORP, salinity) will be collected using a Horiba U-22. The CH2M HILL field team will collect grab samples during high tide. The samples will be submitted to Analytica for analysis of the parameters listed in Table 2-1.

The sampling effort will include coordination with both MOA and CBJ to avoid any influence of snow disposal into the marine environment.

2.4 Schedule

It is anticipated that sampling will be conducted as two sampling rounds between mid-February and end-of-March. Snow samples will be collected within 24-hours of a snow storm or, in those instances where the City does not plow the snow immediately, concurrent with the City's snow operations. Water samples will be collected minimally a week after any snow disposal to marine receiving waters to minimize snow disposal influence on background water quality. Currently, there is no sign of snow within six hours of marine snow disposal in Juneau. The goal of this project is not to monitor ambient water quality, that is, not to sample water under the influence of snow disposal.

In order to avoid missing the hold times for analysis, every effort will be made to coordinate with the laboratory to conform to their analysis times. Samples will be turned into Analytica before 11 AM on Wednesday in Anchorage and before 5 PM on Wednesday in Juneau to meet hold times for those parameters which need to be shipped outside Alaska for analysis.

Appendix B
Data Tables

Appendix C
Field Notes

Appendix D
Lab Results

Appendix E
Photos of Sampling Locations

Appendix F
Photos of Parking Lot Snow Pile over Time