February 1, 2011

EVALUATION OF THE EFFECTS OF DISCHARGE PERMIT REAUTHORIZATION ON ENDANGERED SPECIES

FINAL DRAFT

WB072009001ANC

submitted to
Anchorage Water and Wastewater Utility

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John M. Asplund Water Pollution Control Facility
NPDES Permit Reauthorization
Biological Evaluation

February 1, 2011

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Acronyms and Abbreviations

µg/L	micrograms per liter
AWWU	Anchorage Water and Wastewater Utility
BE	Biological Evaluation
CFR	Code of Federal Regulation
CI	Cook Inlet
CID	critical initial dilution
cm/sec	centimeters per second
CPUE	catch per unit effort
CWA	Clean Water Act
DO	dissolved oxygen
DPS	distinct population segment
EC20	effects concentration 20
EFDC	Environmental Fluid Dynamics Code
EPA	U.S. Environmental Protection Agency
EPOC	emerging parameter of concern
ESA	Endangered Species Act
ft/sec	feet per second
HQ	hazard quotient
km^2	square kilometer
m/sec	meters per second
mgd	million gallons per day
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyls
PCE	primary constituent element
POC	parameters of concern
ppt	parts per thousand
TRV	toxicity reference value

TSS	total suspended solids
TUc	chronic toxic unit
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
WET	whole effluent toxicity
WPCF	Water Pollution Control Facility
ZID	zone of initial dilution

Executive Summary

Background

This Biological Evaluation (BE) has been prepared to support the U.S. Environmental Protection Agency (EPA) consultation requirements under Section 7 of the Endangered Species Act, and as a requirement of Section 301(h) of the Clean Water Act (the Act) for renewal of the John M. Asplund Water Pollution Control Facility (WPCF) discharge permit. Reauthorization of the 301(h)-modified National Pollutant Discharge Elimination System (NPDES) permit for the WPCF is currently under review by Region 10 of the EPA.

The Anchorage Water and Wastewater Utility (AWWU) applied for and received its initial permit with 301(h) modifications in 1985, which was administratively extended and subsequently renewed in 2000. AWWU's current application for renewal is now under review by EPA. As a part of its renewal and decision process, EPA must obtain federal agency certifications that a proposed action authorize a modification of the NPDES permit under Section 301 (h) of the Act (permit reauthorization) will not adversely affect threatened or endangered species or their critical habitats, as listed by the National Marine Fisheries Service (NMFS), in the area of the WPCF outfall.

NMFS, on April 22, 2008, designated the beluga whale in Cook Inlet as an endangered species. Designation of a Critical Habitat Area for the beluga whale has been proposed by NMFS and is currently proceeding through a public review process. No other threatened or endangered species or their habitats exist in the area of the Asplund WPCF discharge.

This BE will be used in whole or in part by EPA, in consultation with NMFS, to determine whether a permit reauthorization is likely to affect the continued existence of the Cook Inlet beluga whale population.

Biological Evaluation Approach

The constituents evaluated as parameters of concern (POC) in this BE are categorized as either "regulated" (those that are currently controlled by federal and state regulations) or "unregulated" (those whose characteristics create an emerging potential for concern, but that are not yet subject to federal or state regulations). The BE approach is based on coupling hydrodynamic modeling with food web modeling.

Hydrodynamic Modeling

Nearfield and farfield hydrodynamic modeling were used to understand the dilution, transport, and fate of Asplund WPCF constituents dissolved in the water or adsorbed/adhering to suspended solids. Considering the objectives of the BE, the model UDKHDEN was used to calculate the initial dilution of the plume as it exits at the Asplund WPCF diffuser. To supplement the nearfield initial dilution modeling, a farfield hydrodynamic model of Upper Cook Inlet was developed using the Environmental Fluid Dynamics Code (EFDC) model.

The EFDC model was selected as the most appropriate farfield model to address the farfield mixing, fate, and transport of the POCs discharged from the Asplund WPCF into Cook Inlet, once initial dilution is complete. It is a three-dimensional model covering Upper Cook Inlet south to the Forelands, including both Knik Arm and Turnagain Arm. The EFDC model results provide a really integrated concentrations of measured regulated or inferred unregulated POCs discharged into Cook Inlet by the Asplund WPCF.

Both models are in the public domain, have been widely applied in similar applications, and are supported and endorsed by EPA for making environmental permitting decisions. The model results were used to help assess both direct and indirect effects of pollutants from the Asplund WPCF discharge on the beluga whale, its food sources, and associated habitats.

Food Web Modeling

Food web modeling was based primarily on published literature and information provided by federal resource management agencies, state environmental and resource agencies, AWWU, and EPA. However, AWWU completed in 2010 sampling and analyzing WPCF influent and effluent to determine the presence/absence/concentrations of unregulated POCs. This provided facility-specific information to better assess the effects of the Asplund WPCF discharge on the beluga whale.[1]

Food-web modeling was used to estimate the potential for bioaccumulation (biomagnification) of effluent-related POCs and exposure of the beluga whale to these constituents. The potential for bioaccumulation was calculated using the following two different approaches, depending on sources of available data:

1. Fish tissue residue data of beluga whale prey species collected from Cook Inlet were used to directly estimate the potential dietary exposure to effluent-related POCs. This approach is referred to as the “Fish Tissue Approach.”
2. A second, more conservative, approach modeled the potential uptake of POCs from the discharge into whale prey species using literature-derived bioconcentration factors (BCF) to estimate the potential dietary exposure of the beluga whale to effluent-related POCs. This approach is referred to as the “BCF Approach.”

The data used for food web modeling includes the following:

- Concentrations of regulated POCs directly measured in the Asplund WPCF effluent as required by the current NPDES permit
- Inferred presence/concentrations of unregulated POC based on literature sources
- Actual measured concentrations of regulated and unregulated POCs in the Asplund WPCF effluent, measured during the 2010 sampling and analysis program.

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[1] These unregulated POCs include pharmaceuticals and personal care products, endocrine disruptors, and flame retardants. The sampling and analysis of WPCF influent and effluent for unregulated POCs is projected to be complete in July 2010. The data obtained will be used to update the analysis of effects presented in Section 3 of this BE.

The empirically based Fish Tissue Approach was considered the more realistic approach, yet is still conservative considering that the source of POCs in beluga whale prey fish tissue (primarily salmon) is not solely from WPCF effluent because adult salmon are only seasonally present, with little feeding occurring in Upper Cook Inlet. The BCF Approach was performed to test a worst-case scenario for bioaccumulation of POCs potentially present in Asplund WPCF effluent. This BE conservatively used the maximum fish tissue concentrations reported by either the Alaska Department of Environmental Conservation (for salmon) or AWWU (for Pacific cod) for metals, pesticides, polychlorinated biphenyls, volatile organic compounds, semi-volatile organic compounds, dioxins, and polybrominated diphenyl ethers.

For the BCF Approach, in addition to the actual measured concentrations of unregulated POCs, an extensive search of available literature sources was conducted to identify levels of unregulated POCs reported in municipal wastwater treatment system in North America. It should be noted that many of these studies reported in the literature focus on unregulated POC concentrations in the final effluent from secondary treatment plants and in receiving waters. Because the Asplund WPCF effluent represents primary-treated wastewater, this BE used reported concentrations in municipal wastewater influents.

Literature sources used include EPA's "Nine Plant Study," studies conducted in Canada by local agencies and studies reported by the Water Environment Research Foundation.

The Fish Tissue and BCF approaches were supplemented by a consideration of the potential for the Asplund WPCF discharge to adversely affect populations of beluga whale prey species. In doing so, the same starting effluent concentrations (either measured as part of monthly monitoring program or the 2010 sampling and analysis of effluent POCs or inferred were used.. Projected receiving water concentrations were then compared with aquatic toxicological endpoint concentrations to determine whether there were likely population level effects that could affect the density of prey species in the Asplund WPCF discharge area. These results are presented in Appendix A and B, using a Hazard Quotient (HQ) index; the ratio of the receiving water concentration divided by the toxicological endpoint concentration. A quotient below 1.0 being indicative of no affect on the target population of prey species.

Concentrations used for analysis of affects were those calculated for edge of the zone of initial dilution (ZID) and beyond; Turnagain Arm, Knik Arm and Upper CI. The potential for affects on CI beluga whale from concentrations within the ZID was taken into account through a consideration of exposure resulting from; (a) frequency and travel time of beluga whales through the ZID, (b) availability and feeding within the ZID and (c) other habitat functions such as resting or calving. The CI beluga whale travel time through the ZID is calculated to be less than 25 minutes and less than 2% of time annually, assuming all CI belugas use Turnagain Arm. CI beluga whales will pass Point Woronzof as a transit corridor only and appear to have no site fidelity to this area for feeding.. The bottom within the ZID is scoured by high tidal velocities and provides little food source.

The 25 minutes of exposure calculated for this study assumes the ZID area is fully occupied by the discharged plume. However, the plume occupies a very small portion of the total ZID at any given time under Critical Initial Dilution (CID) conditions. This limited area of exposure to plume further limits time of exposure to whales traversing the ZID or prey species uptake of effluent constituents.

Due to the limited travel time exposure, limited food source, frequency in the ZID, the resulting whale and prey species exposure within the ZID is not likely to adversely affect the beluga whale.

The results of AWWU's whole effluent toxicity (WET) testing of sensitive marine organisms also provide supporting evidence to assist in reaching a conclusion that the discharge is not likely to adversely affect the beluga whale.

Results

Hydrodynamic Modeling Results

The results of modeling with the UKHDEN hydrodynamic model results used in the most recent NPDES permit were also used in this BE to define initial dilution. For farfield fate and transport modeling, the EFDC model was developed and successfully calibrated against a number of key variables such as salinity, temperature, water levels, current patterns, and current velocity. Once calibrated, the model was used to simulate the fate and transport of dissolved constituents and suspended solids in the WPCF discharge.

The model area includes Knik Arm, Turnagain Arm, and the area of Upper Cook Inlet south to the Forelands. This geographic area includes the entire proposed Cook Inlet beluga whale Critical Habitat Area 1 and a large portion of Critical Habitat Area 2.

Three key scenarios were assessed using the model. One scenario assumed no degradation over time of the constituents discharged and the other scenarios assumed degradation over time of dissolved constituents for two representative decay rates. Seasonal patterns of discharge circulation and transport were calculated for each of these scenarios. A complete description of the EFDC model and results is given in Appendix F of this report.

The model predicts concentration of effluent discharged from the WPCF outfall as it is circulated and transported by the tidal energy and inflow of fresh water into Upper Cook Inlet. Using measured or inferred effluent concentrations of discharged POCs, the model results were used to calculate the concentration of effluent-derived constituents discharged into Upper Cook Inlet. These concentrations were used in the toxicological evaluation presented in Appendices A and B and discussed below.

The model also simulates sedimentation of natural and effluent-derived sediments. Effluent-derived sediments accumulate only in very limited areas on the mudflat fringes. The fraction of effluent-derived sediments in the water column and in the sediment deposits is negligible compared to natural sediment concentrations (i.e., less than six orders of magnitude smaller).

Because of the extreme tidal energy in the study area, the concentration of the WPCF discharge is reduced significantly within the zone of initial dilution (ZID) and continues to reduce rapidly as it moves away from the ZID. Vertical mixing of the discharge is complete throughout the inlet.

Figure ES-1 shows the transport and circulation of Asplund WPCF discharge in Upper Cook Inlet, assuming no degradation (the “worst case”) in a summertime condition. Over the annual cycle modeled, areally integrated effluent dilutions range from approximately 1,250:1 to more than 10,000:1 for the “no degradation” scenario.

Food Web Modeling and Toxicology Results

The following two primary lines of evidence were evaluated:

1. Projected receiving water concentrations in Cook Inlet were compared with literature-based aquatic toxicological effects concentrations.
2. WET test results were evaluated to identify whether direct toxicity has been observed following exposure of fish or invertebrates to Asplund WPCF wastewater.

Food web modeling, using the hydrodynamic modeling results as input to define concentration factors, was used to evaluate whether the WPCF discharge could adversely affect the beluga whale through consumption of prey species that may have accumulated wastewater-related chemicals through the food chain. Appendix A contains a complete description of the evaluation used to determine the effects on beluga whale prey species.

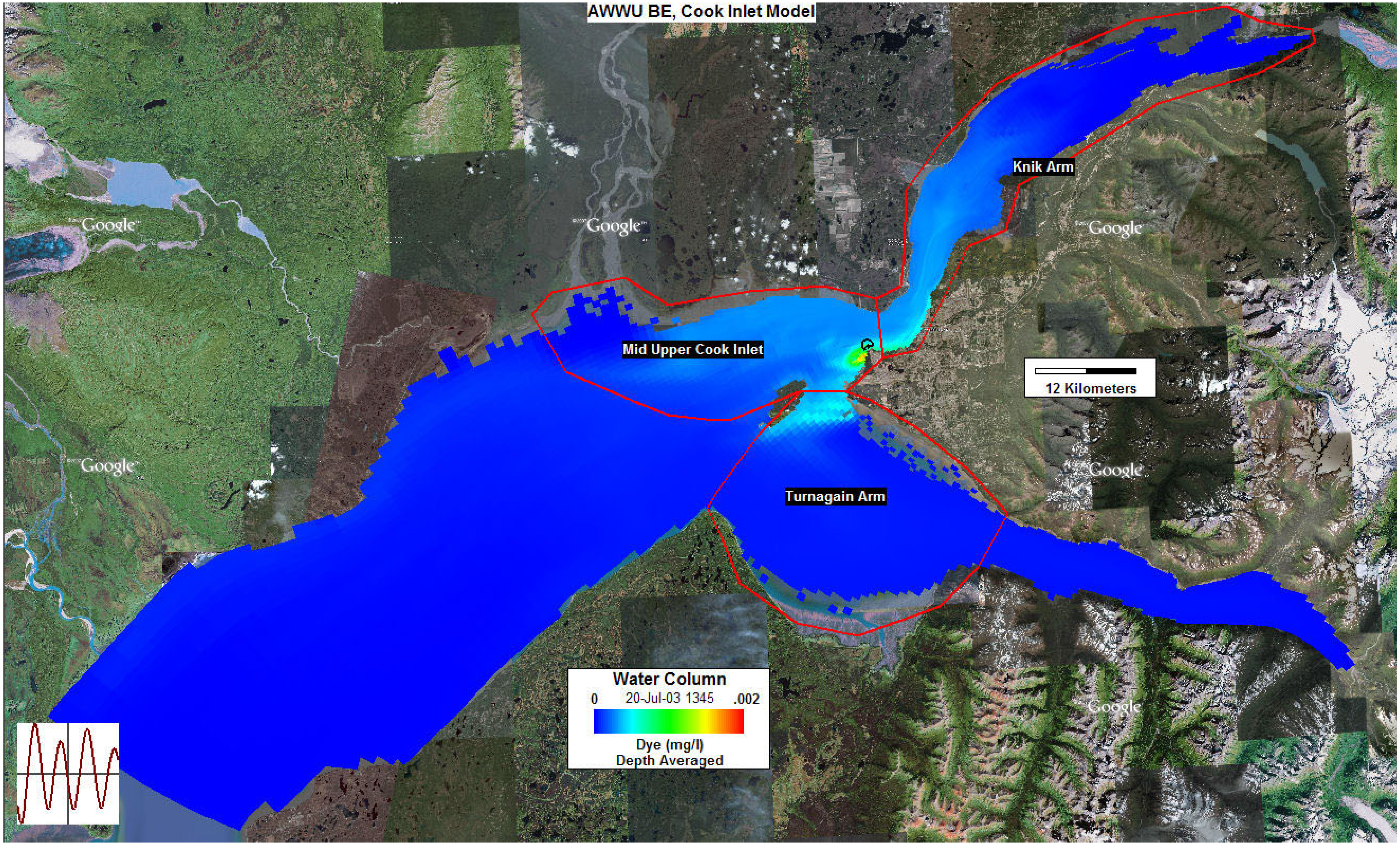


FIGURE ES-1
WATER COLUMN SUMMARY ZONES
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

This line of evidence starts with defining toxicity reference values (TRV) for the POCs. The objective was to identify the highest exposure level considered to be without adverse ecological impact. Chemical-specific TRVs were obtained from the following general sources and databases (listed in order of preference):

- NOAA – Pharmaceuticals in the Environment, Information for Assessing Risk Data Base; Available at: http://www.chbr.noaa.gov/peiar/search.aspx
- EPA – AQUIRE (AQUatic toxicity Information REtrieval) as part of ECOTOXicology database (ECOTOX); Available at: http://cfpub.epa.gov/ecotox/Other primary peer-reviewed literature

The potential for ecological risks to beluga whales was then estimated by calculating a hazard quotient (HQ) for each effluent-related POC (measured or inferred). Because fish populations are the primary focus of evaluating beluga prey, population-type endpoints such as reproduction or survival are of greatest concern.

If the estimated exposure concentration for any individual constituent exceeds its TRV, the HQ will exceed unity (one). An HQ that exceeds unity indicates that there is a potential for adverse ecological effects associated with exposure to that constituent. An HQ value less than or equal to one is considered protective of fish populations. In all cases, the HQ was less than one. Therefore, this line of evidence indicates that there are no adverse impacts on beluga whale populations associated with continued Asplund WPCF discharge.

The second major line of evidence, represented by the AWWU WET test data, also results in a finding of no adverse toxicity impacts. WET tests conducted quarterly by AWWU for the years 2000 through 2009 were reviewed. Without respect to the presence or absence of unregulated POCs, if levels of any POC present are high enough to cause toxicity, the WET test results should reflect this.

Over the entire 10-year period evaluated, there was no toxicity exhibited for any of the test species, with the exception of two urchin fertilization tests conducted in 2005. However, these sporadic results were attributed to plant construction activities, and low clarifier performance. These conditions were subsequently mitigated, and retesting indicated non-toxic conditions. The test species most relevant to this evaluation of beluga prey species is the top smelt test, where WET test results have indicated the absence of toxicity over the entire 10-year period evaluated.

Conclusions

The results of the ecological risk analysis, as supported by the WET test results, indicate the following, even under extremely conservative assumptions:

- Measured concentrations of regulated and unregulated POCs detected in the Asplund WPCF effluent are not likely to adversely affect the fish species that serve as a food source for the Cook Inlet beluga whale.
- Inferred concentrations of unregulated POCs in the Asplund WPCF effluent are similarly not likely to adversely affect the fish species that serve as a food source for

the Cook Inlet beluga whale. The HQs for all constituents either measured or inferred in the WPCF discharge are orders of magnitude below unity. .

In summary, the results indicate that none of the concentrations of measured regulated, unregulated or inferred unregulated POCs is at a level that exceeds toxicological thresholds for the beluga whale or its primary prey species, even when considering the levels of conservatism associated with this evaluation. Therefore, considering the lines of evidence evaluated in this BE, the Asplund WPCF effluent is considered **not likely to adversely affect** the Cook Inlet beluga whale.

SECTION 1

Introduction

1.1 Background

The Municipality of Anchorage Water and Wastewater Utility (AWWU) discharges treated wastewater from the John M. Asplund Water Pollution Control Facility (Asplund WPCF or WPCF) to the receiving waters of Knik Arm in Cook Inlet (CI), at Point Woronzof in Anchorage, Alaska (Figure 1-1). This discharge is in accordance with a National Pollutant Discharge Elimination System (NPDES) permit administered by the U.S. Environmental Protection Agency (EPA) as prescribed by the Clean Water Act (CWA).

In January 2005, AWWU applied to the EPA to renew the discharge permit and 301 (h) modifications of its NPDES Permit (CH2M HILL, 2004). During the preparation of these permit renewal documents, AWWU worked closely with EPA and Alaska Department of Environmental Conservation staff to address all potential environmental concerns. While developing the permit renewal applications, a comprehensive review of the physical environment, water quality, biological community and habitat, and protected beneficial uses of the water body in the affected region was completed. No impacts have been measured from the existing discharge, as documented in extensive monitoring since 1986 and the analyses developed for the permit applications. EPA has granted conditional status to the AWWU for the purposes of Endangered Species Act (ESA) consultation on the 301(h) application for modification determination and permit reauthorization for the Asplund WPCF. EPA retains primary consultation status.

The receiving waters and environs of the CI are atypical of estuaries and provide ideal conditions to discharge nonindustrial primary effluent without harm to the environment. Knik Arm's extreme tidal range (average of 30 feet), current ranges of 3 to 5 knots, and typical sediment levels of 1,000 milligrams per liter result in a capacity to easily assimilate the municipality's treated wastewater effluent. The NPDES permit includes extensive effluent monitoring, as well as extensive physical, chemical, and biological monitoring of the receiving waters. This comprehensive monitoring program has been actively documenting Asplund WPCF treatment performance and receiving water conditions in CI since 1986. No impacts have been measurable from the existing discharge as demonstrated by the ongoing monitoring program. The permit renewal application demonstrates that the treatment plant discharge will comply with all federal and state requirements for discharging primary effluent to CI.

On October 22, 2008, the National Marine Fisheries Services (NMFS) published a Final Rule to list the CI beluga whale (*Delphinapterus leucas*), a distinct population segment, as an endangered species (73 FR 62919). In accordance with the listing of belugas as endangered, NMFS must designate critical habitat for the CI beluga whale under the ESA. The process for designating critical habitat was initiated with the publication of an Advance Notice of Proposed Rulemaking on April 14, 2009 (74 FR 17131), and is currently undergoing a public review process, following publication of proposed critical habitat on December 2, 2009 (74FR63080).

EPA has tasked AWWU with drafting a Biological Evaluation **(**BE) for listed species to support EPA Section 7 consultations with NMFS and the U.S. Fish and Wildlife Service. Consultation letters from NMFS (June 2009) and U.S. Fish and Wildlife Service (USFWS) (May 2009) to EPA indicate that the CI population of beluga whales represents the only federally listed species to be included in this BE. The BE will be submitted to EPA and will be used by the agency, in whole or in part, to determine whether permit reauthorization is likely to affect the continued existence of species protected by the ESA, or adversely modify their habitat.

1.2 NPDES Permit Renewal

1.2.1 NPDES Permit

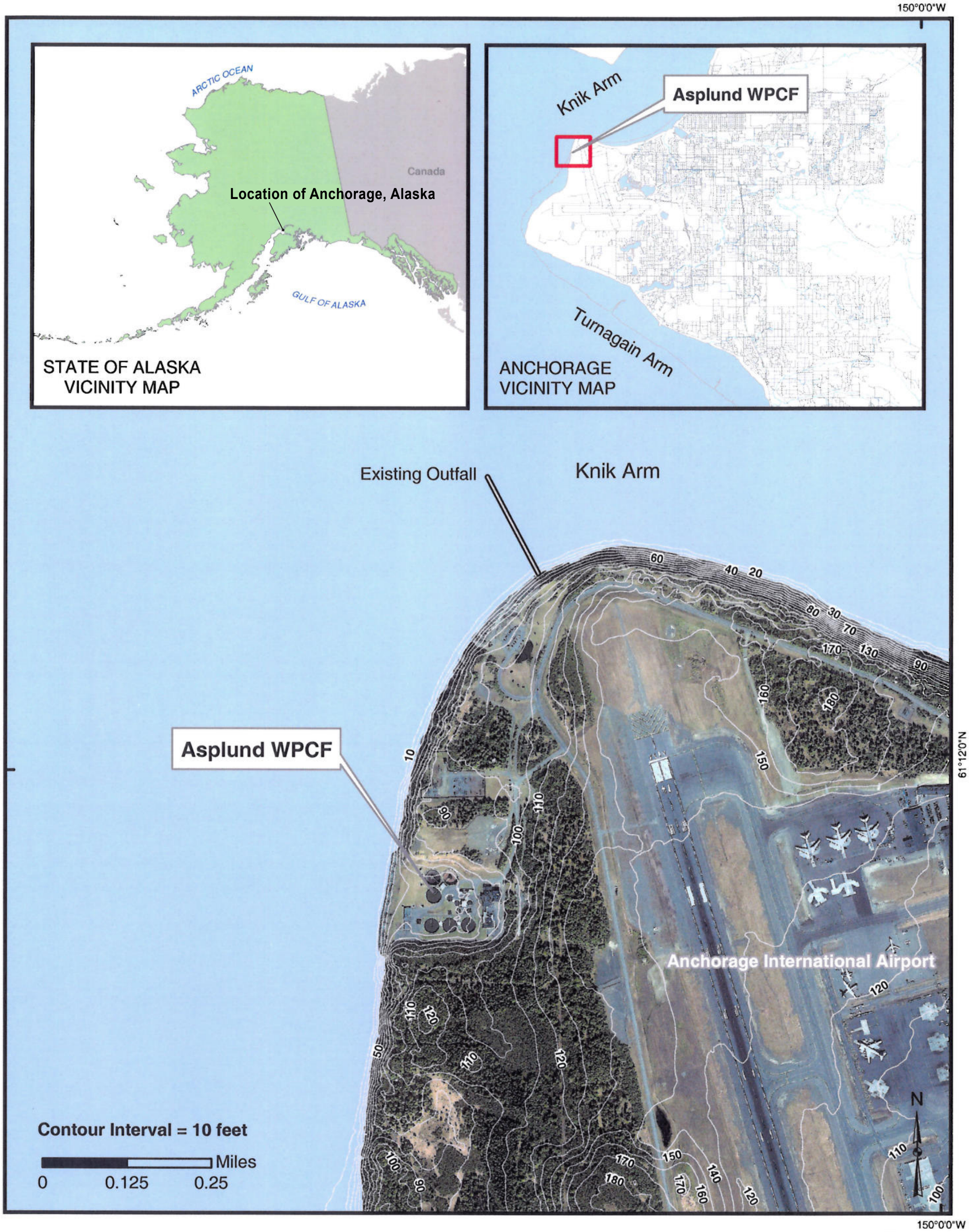
The John M. Asplund WPCF is currently operating under the NPDES permit AK-002255-1 that was signed on June 30, 2000, and became effective on August 2, 2000. This permit authorizes discharge of effluent from the WPCF. Wastewater from the Municipality of Anchorage is treated at this facility before discharge to the receiving waters of Knik Arm in CI. The NPDES permit incorporates the requirements necessitated by a 301(h) modification of secondary treatment requirements and complies with provisions of the Federal Water Pollution Control Act as amended by the CWA (CWA, 33 U.S.C. §1251 et seq.) and the Water Quality Act of 1987, P.L. 100-4.

The permit was administratively extended in August 2005 pending a permit renewal decision from EPA. The most recent application for a reauthorization of the NPDES permit and 301(h) modification was submitted in January 2005 and is currently being reviewed by EPA.

1.2.2 Permit History

In September 1979, the Municipality of Anchorage submitted to the EPA an application for a 301(h) modificiation of secondary treatment requirements, proposing an improved discharge that eliminated chlorination and required the addition of both a 610-meter (m) extension and a 305-m diffuser to the Asplund WPCF outfall. The outfall extension was intended to move the point of discharge beyond the influence of a gyre that was reported to exist off Point Woronzof on a flood tide that was presumed to carry effluent toward shore, causing bacterial contamination of the shoreline.

Further studies were subsequently undertaken to derive design criteria for the outfall improvements. The central issue was to evaluate outfall design alternatives and the chlorination/no chlorination option in relation to a system of eddies that occurs on the flood tide. These studies were completed as an Amendment to the Wastewater Facilities Plan for Anchorage (CH2M HILL et al., 1985). This amended plan recommended using the existing 245-m outfall with the addition of a three-nozzle diffuser. It was shown that chlorination would be required to meet bacterial standards, even with an extended outfall and diffuser. Because the same water quality standards could be met by chlorinating and installing an improved diffuser at the end of the existing outfall, there was no need to extend the outfall.



SOURCE: AWWU NPDES PERMIT APPLICATION

FIGURE 1-1
LOCATION MAPS AND CONTOURS FOR ASPLUND WPCF AND ANCHORAGE AREA

AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

Concurrent with the studies to amend the facilities plan, a revised 301(h) application was submitted to the EPA. After extensive EPA review, public comment, and hearings, the Final Permit Decision was issued, and the 5-year NPDES permit became effective on October 16, 1985. As required by this permit, a multi-port diffuser was installed in August 1987 prior to the second year of receiving water sampling.

The Municipality of Anchorage submitted an application to renew the 301(h) modification of secondary treatment requirements in 1990. A more recent application was submitted in 1998 with additional information provided to EPA in 1999. A draft NPDES permit that incorporated the 301(h) modification was issued in 1999 for public comment. The renewed permit was signed by EPA on June 30, 2000, to become effective on August 2, 2000, for 5 years. In January 2005, AWWU applied to the EPA for renewal of the discharge permit and 301 (h) modification of secondary treatment requirements (CH2M HILL, 2004).

1.3 Treatment Facility and Discharge System

The Asplund WPCF serves the Anchorage area and is located at Point Woronzof on the Knik Arm of CI (Figure 1-1). Plant influent is primarily of domestic origin, although a limited industrial component is included; the Municipality of Anchorage has local limits for pretreatment and a monitoring program. There are no combined sewers in the Anchorage sewer system. The existing facility is located on a 45.6-acre site adjacent to Ted Stevens Anchorage International Airport and CI. The plant provides treatment for a design average flow of 58 million gallons per day (mgd) and a maximum hourly flow of 154 mgd. The annual average daily discharge is approximately 28 mgd. Figure 1-2 is a site plan of the facility and Figure 1-3 is a flow diagram.

The Asplund WPCF receives and treats wastewater generated throughout the Anchorage Bowl, including Elmendorf Air Force Base and Fort Richardson Army Base. Sludge from both the Eagle River and Girdwood wastewater treatment plants is also received at the Asplund WPCF for treatment. Septage from septic tank haulers is transported to and disposed of at two dump stations connected to the Anchorage wastewater collection system.

Existing treatment units provide screening, grit removal, sedimentation, skimming, and chlorination. The treatment process achieves much higher removal rates than typical primary treatment facilities and higher than typical advanced (chemical) primary treatment. Sludge from the primary clarifiers is thickened and dewatered. The dewatered sludge and skimmings are incinerated and the ash disposed of in a sanitary landfill. Within the permit period, the sludge volume may increase above the incinerator capacity. If the incinerator capacity is exceeded, the excess sludge will be dewatered and disposed of at the landfill.

Chlorinated primary effluent is discharged through a 3.0-m-diameter (120-inch) chlorine contact tunnel and then through a 2.1-m-diameter (84-inch) outfall to Knik Arm of CI (Figure 1-4). The Point Woronzof outfall extends 804 feet from the shore at Point Woronzof and terminates as a trifurcated diffuser in water with a mean lower low water depth of 4.6 meters (15 feet). The outfall configuration is shown on Figure 1-5. The discharge depth of the diffuser during the typical 24-hour tidal cycle ranges from 12 feet to 41 feet. The outfall diffuser has a defined zone of initial dilution (ZID) with a radius of 650 meters from a point 30 meters inshore of the terminus, and the ZID is the region provided for immediate mixing and dilution of the wastewater discharge (Figure 1-6). The effluent plume occupies less than one-third of the ZID in any period of time (see Figure 1-7). Current speeds at the discharge site range from approximately 1 to 6 knots. Details of the tidal-driven currents, discharge plume transport, and dilution at the discharge site are discussed in a later section of this document. Table 1-1 shows design flows and projected flows at the end of the current NPDES permit period.

Table 1-1. Current and Projected Design Flows

	Design Flows	Projected Flows
Average daily flow	2.5 m^3/sec (58 mgd)	1.5 m^3/sec (33.7 mgd)
Maximum daily flow	5.6 m^3/sec (128 mgd)	1.7 m^3/sec (38.2 mgd)
Peak hourly flow	6.7 m^3/sec (154 mgd)	3.2 m^3/sec (73 mgd)

1.4 Zone of Initial Dilution

When effluent is discharged from the diffuser ports, there is an initial and very rapid mixing of the effluent jets with the ambient water. This results in a *plume* of mixed effluent and ambient water that moves away from the discharge point. The effluent in the plume becomes increasingly diluted along the plume trajectory until the point where the rapid mixing ceases because the relative velocities between the plume and ambient water are the same. This process is referred to as *initial dilution*. Following initial dilution, passive diffusion becomes the dominant physical process that results in further dilution of the effluent with the ambient water. These two processes; initial dilution and passive diffusion, are physically quite different and require different mathematical descriptions and models to simulate and predict the concentration of effluent in space and time.

The region surrounding the diffuser where initial dilution occurs is generally referred to as the *zone of initial dilution*. The process of initial dilution is so rapid and energetic, with time scales of seconds to minutes, that organisms temporarily entrained in or passing through in the initial plume are not present long enough to be exposed to chronic or lethal toxicity effects.

It is important to distinguish between the *physical* ZID and the *regulatory* ZID. For a given diffuser configuration, the process of initial dilution and the plume characteristics depend on the effluent flow, effluent density, ambient current speed and direction, water depth, and the density structure of the ambient water[2]. Therefore, at any given time the physical ZID will vary in location, size, and dilution achieved along the plume trajectory.

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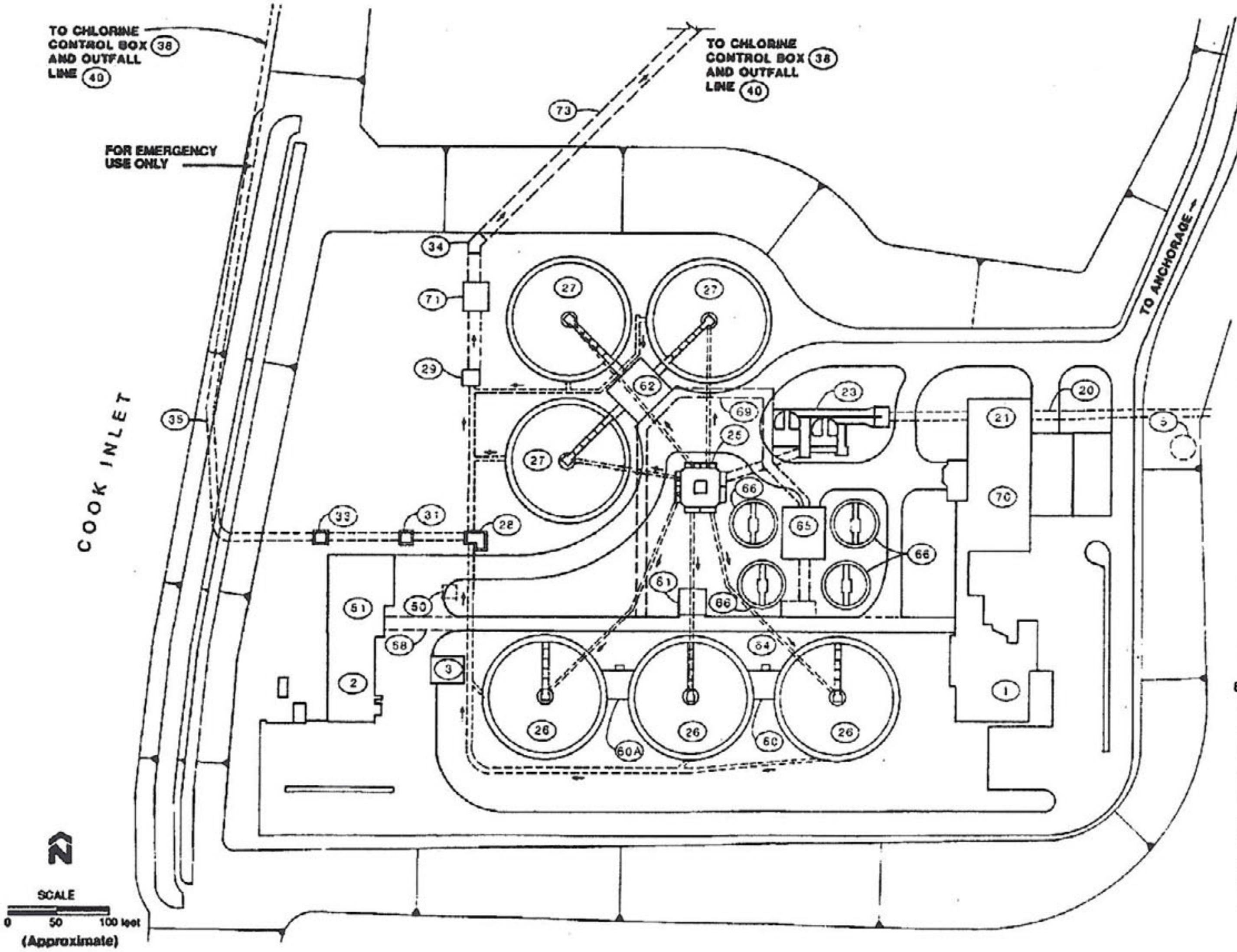
[2] Constraints on initial dilution may also arise from adjacent shoreline boundaries limiting plume spreading. However, such constraints are not involved in the case under consideration here.

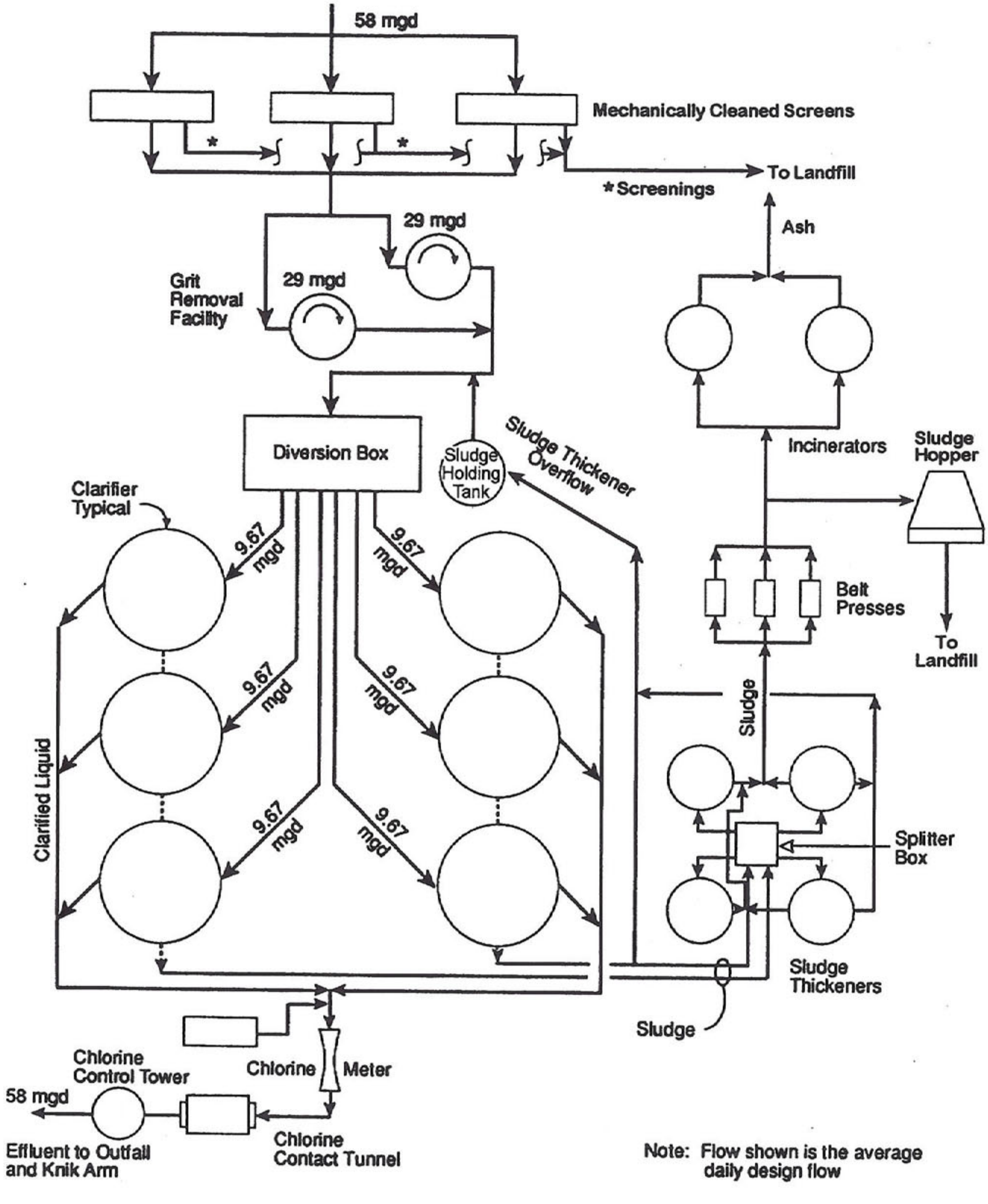


ASPLUND WPCF BUILDING AND STRUCTURE INDEX

NO.	NAME
1	ADMINISTRATION BUILDING
2	SHOP BUILDING
3	FLAMMABLE STORAGE BUILDING
5	WATER TANK
20	96 INCH INFLUENT
21	SCREEN BUILDING
23	GRIT REMOVAL FACILITY
25	DIVERSION BOX
26	PRIMARY CLARIFIERS (OLD)
27	PRIMARY CLARIFIERS
28	EFFLUENT BOX (OLD)
29	EFFLUENT BOX
31	METERING BOX (OLD)
33	DROP BOX (OLD)
34	DROP BOX
35	CHLORINE CONTACT PIPELINE (OLD)
38	CHLORINE CONTROL BOX (NOT SHOWN)
40	OUTFALL PIPE (NOT SHOWN)
50	CHLORINATION SUMP
51	CHLORINE BUILDING
60	DRAINAGE PUMP STATION 1
60A	DRAINAGE PUMP STATION 2
61	SLUDGE PUMPING STATION (OLD)
62	SLUDGE PUMPING STATION
65	THICKENER PUMP STATION
66	SLUDGE THICKENERS 1 THROUGH 4
68	UTILIDOR
69	UTILIDOR
70	INCINERATOR BUILDING
71	PARSHALL FLUME
73	EFFLUENT TUNNEL

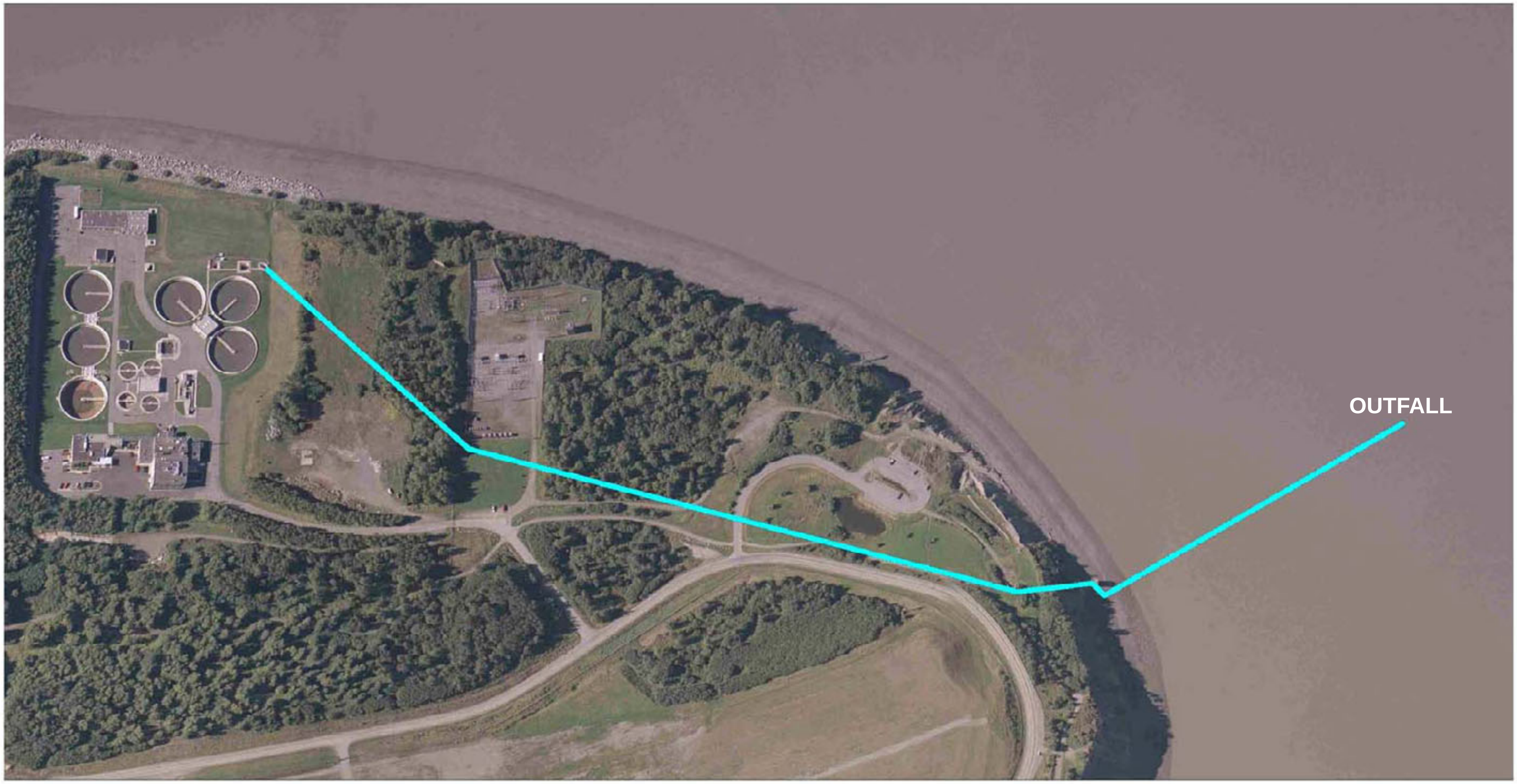
SOURCE: AWWU NPDES PERMIT APPLICATION

FIGURE 1-2
AWWU SITE PLAN
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)



SOURCE: AWWU NPDES PERMIT APPLICATION

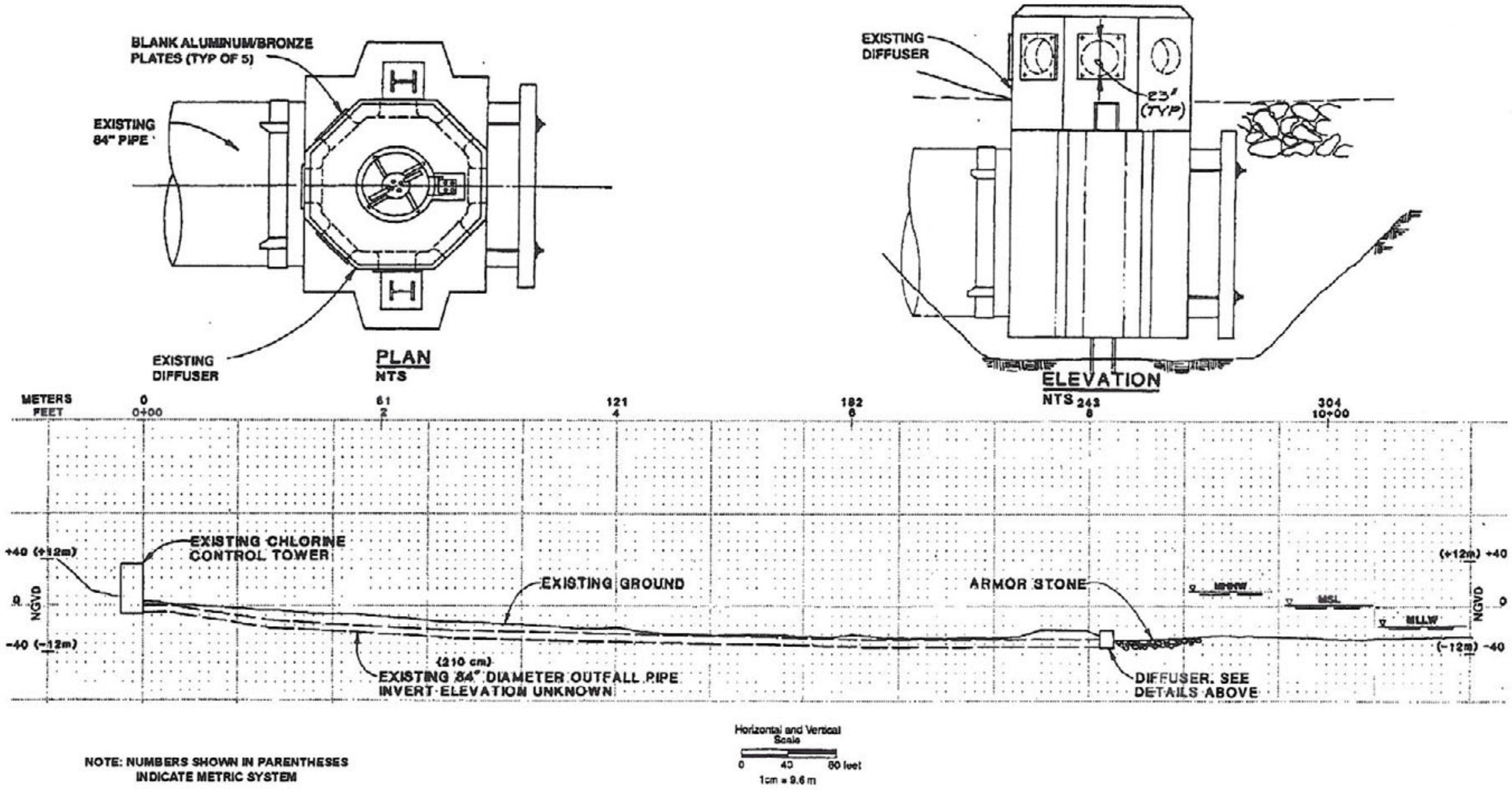
FIGURE 1-3
WASTEWATER FLOW
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)



NOTE:
FINAL EFFLUENT IS DISCHARGED THROUGH DIFFUSER 800’ OFFSHORE

SOURCE: AWWU BELUGA WHALE PPT

FIGURE 1-4
OUTFALL LOCATION
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)



SOURCE: AWWU NPDES PERMIT APPLICATION

FIGURE 1-5
OUTFALL AND DIFFUSER
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

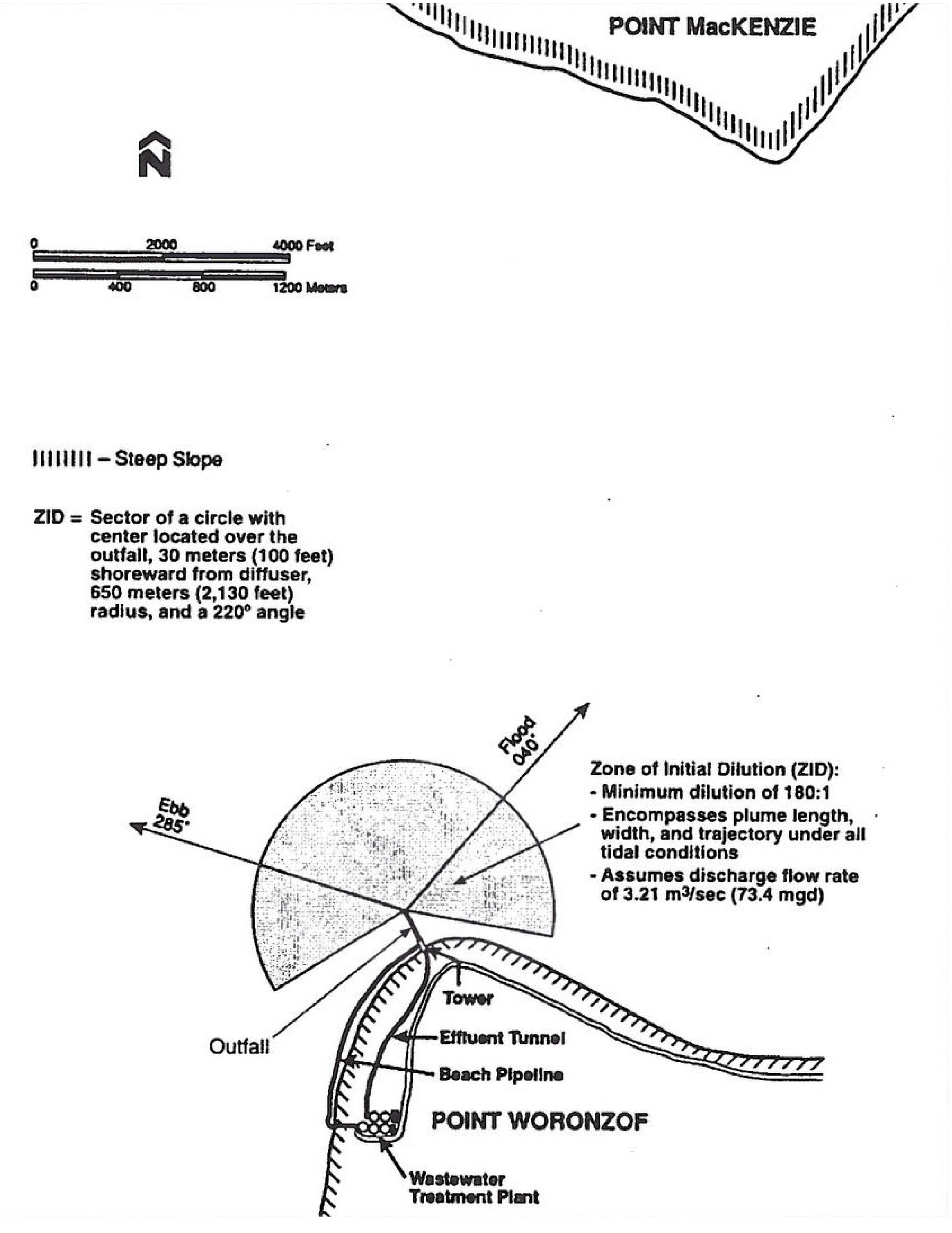


FIGURE 1-6
ZONE OF INITIAL DILUTION
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

The regulatory ZID is a volume in which the plume may be located (and in which initial dilution is taking place) under the entire range of effluent flows and ambient conditions. Therefore, the regulatory ZID is typically much larger than the physical ZID at any given time.

The regulatory ZID is defined by *critical conditions*. Critical conditions are those under which the initial dilution will be the lowest (*critical initial dilution* or CID) and the physical ZID will be the largest. To define the regulatory ZID, the plume characteristic and initial dilution must be evaluated for a range of effluent and ambient receiving water conditions. These conditions generally are the highest effluent flow, the minimum and maximum ambient currents, and the density structure of the effluent and receiving water that result in the lowest initial dilution.

1.4.1 Establishing the ZID for the Asplund WPCF

In the case of the Asplund WPCF outfall, because of the limited water depth, vertical homogeneity of ambient density, and the high ambient current speeds, the determinations of the CID and ZID are more complicated than in most locations. As a result of consultation between AWWU and EPA in 1989, it was determined that initial dilution would be considered to occur up to the point where the density difference between the plume and ambient water reaches one percent (1%) of the initial density difference between the effluent and the ambient water, as described in the 1998 renewal application (CH2M HILL, 1998). It was also agreed that the regulatory ZID would be defined by the distance from the diffuser to the point where the density difference between the plume and the ambient water reaches one percent.

The EPA initial dilution model UDKHDEN was used to determine the CID and ZID, as described in the 1998 renewal application (CH2M HILL, 1998). The critical effluent flow used in the 1998 Renewal Application was 73.4 mgd and is the same as that projected for the renewal permit period. Therefore, the regulatory ZID remains the same as that previously developed and defined in the existing NPDES permit. The ZID is defined as the water column above the area delineated by the sector of a circle with the center located over the outfall, 30 meters shoreward of the diffuser, 650 meters in radius, and with a 220º angle (Figure 1-6).

1.4.2 The Physical ZID

As mentioned previously, the plan view of the regulatory ZID shown on Figure 1-6 is an area that delineates where the effluent plume might be at any given time. The boundary of the regulatory ZID is the location beyond which the plume dilution will always be greater than the CID. At any given time, the actual physical effluent plume will occupy only a small part of the regulatory ZID, dilutions will generally be substantially higher than the CID, and effluent concentrations will be substantially lower than those calculated for on the CID. The initial dilution model was used to predict the plume locations and sizes over a representative tidal cycle at the maximum effluent flow (73.4 mgd), as shown on Figure 1-7.

The plots on Figure 1-7 show the portion of the effluent plume within the ZID with dilutions greater than the CID. The figure indicates that the effluent plume occupies a very small portion of the regulatory ZID at any given time. Furthermore, because the plots are based on critical conditions, including the projected maximum peak hourly effluent flow, under virtually all conditions the plume will be substantially smaller with substantially higher dilutions than the regulatory ZID.

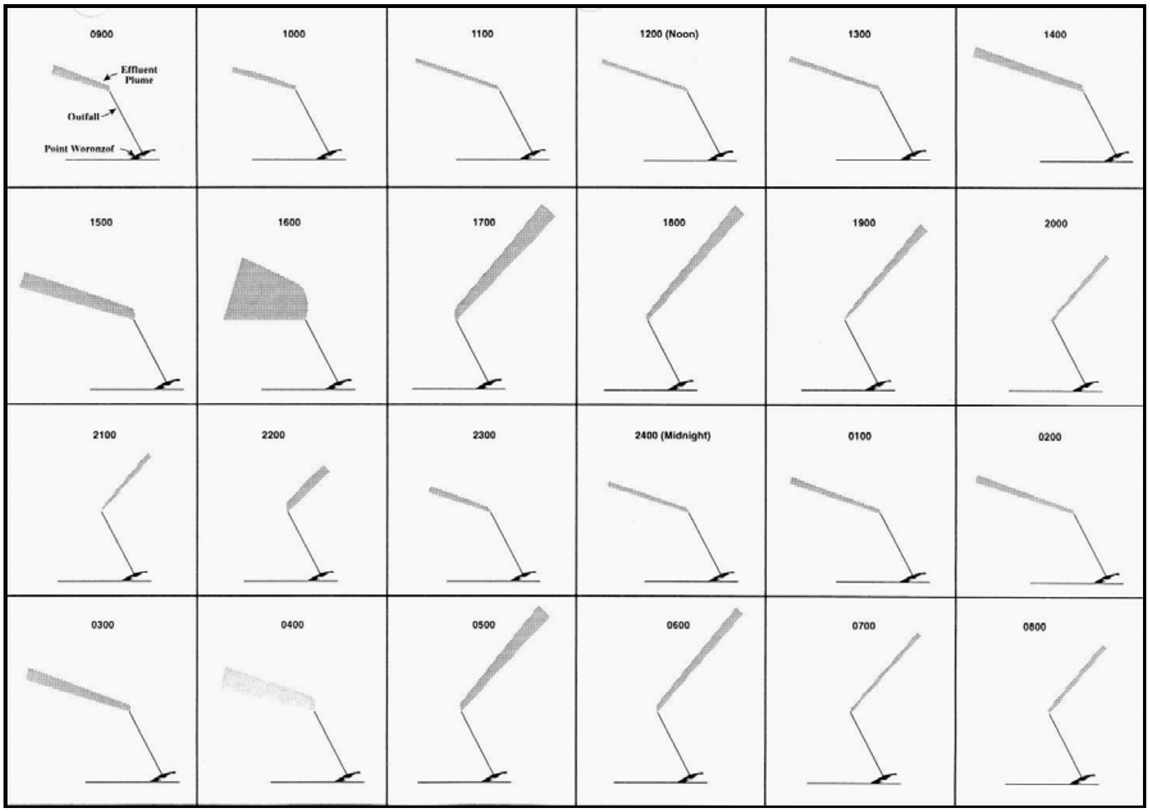


FIGURE 1-7. HOURLY PLOTS OF EFFLUENT PLUME FOR CRITICAL CONDITIONS

1.4.3 Critical Initial Dilution

The descriptions of the ZID presented above were based on the CID determined in the 1998 renewal application (CH2M HILL, 1998). The CID was based on critical (worst-case) ambient conditions and effluent flows that would result in the lowest expected dilution. The dilution model predicts dilutions that can be used to calculate effluent concentrations within uncontaminated receiving water.

The discharge is into a semi-enclosed body of water, and complete tidal flushing is not achieved over a single tidal cycle. Some reflux of previously-discharged effluent occurs on the flood tide. Therefore, the ambient water with which the effluent is diluted contains a background concentration of effluent from the continuous discharge. This condition was considered in determining the CID using the available information, modeling results, and estimates of flushing times for the water body. Using the dilution model results and the background concentrations, the model-predicted initial dilution was reduced to determine an effective CID.

The model-predicted CID based on uncontaminated receiving water was determined to be 180:1 in the 1998 renewal application (CH2M HILL, 1998). When the background effluent concentration in the receiving water is considered, an effective dilution ratio of 142:1 was calculated. This dilution is used to calculate maximum effluent constituent concentrations at the edge of the regulatory ZID based on the concentrations in the undiluted effluent. As noted above, this is a maximum expected concentration and will be applicable over only a very small portion of the ZID at any given time.

SECTION 2

Project Description

2.1 Federal Action

The federal action addressed in this BE is the renewal of the Asplund WPCF NPDES Permit No. AK-002255-1, which incorporates a 301(h) variance. The renewal application was submitted 180 days before the August 2, 2005, expiration of the current permit in accordance with regulation. The NPDES permitting program is authorized by Section 402 of the CWA and implemented by regulations appearing in Part 122 of Title 40 Code of Federal Regulations (CFR) as well as other Parts of 40 CFR.

The ESA of 1973 (ESA) requires that agencies of the federal government must consider the effects of their actions on species identified as “endangered” under the ESA by the USFWS or NMFS. Specifically, Section 7(a) (2) requires agencies, in consultation with USFWS/NMFS, to ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or result in the destruction or adverse modification of critical habitat for such species.

This BE analyzes the effects of reauthorizing the Asplund WPCF permit sufficiently to allow EPA, in consultation with NMFS, to determine whether adverse effects on endangered species, in this case, the CI beluga whale, and proposed critical habitat for the CI beluga whale, are likely to occur as a result of permit reauthorization.

2.2 Project Purpose and Objectives

EPA is reviewing the AWWU application for renewal of its NPDES permit and associated 301(h) modification. As a part of its decision process, EPA must consult with federal agencies to ensure that its proposed action (permit reauthorization) will not adversely affect threatened or endangered species or their critical habitats in the area, as listed by NMFS and USFWS. This must be done to comply with Section 7 of the ESA.

A BE is a critical component of consultation between EPA and the resource agencies with respect to the application for a 301 (h) modification.. application. AWWU proposed to voluntarily prepare a draft BE to support consultations with NMFS and USFWS and subsequently requested application status from EPA for purposes of consultation, Conditional status was granted with EPA retaining primary responsibility..

Consultation letters from NMFS (June 2009) and USFWS (May 2009) to EPA indicate that the CI population of beluga whales represents the only federally listed species to be included in this BE. The BE will be submitted to EPA and will be used by the agency, in whole or in part, to determine whether permit reauthorization is likely to affect the continued existence of species protected by the ESA, or adversely modify their habitat. Numerical modeling of the transport and distribution of effluent, and effluent constituents, from the Asplund WPCF is needed to support the ecological risk assessment requirements of the BE. This modeling plan describes the proposed approach.

Understanding the exposure of endangered species to regulated and unregulated constituents in relation to migration, residence, habitat requirements, and circulation (including nearfield plume dilution and farfield circulation) will be critical to producing an effective and acceptable BE. Numerical modeling will quantify effluent constituent concentrations in receiving waters and sediments affected by the discharge.

Experience with hydrodynamic models, plume modeling, CI, and the objectives of the BE indicates that the Environmental Fluid Dynamics Code (EFDC) model is recommended as the most appropriate farfield model to address the mixing, fate, and transport of the parameters of concern (POC). This model is in the public domain, has been widely applied in similar applications and is endorsed by EPA for complex modeling to support environmental permitting. Nearfield modeling has previously been done (CH2M HILL, 1998) for this discharge using the EPA UDKHDEN initial dilution model and subsequent dilution routines based on a passive diffusion analysis (the Brooks method), which is accepted by EPA. It is unlikely that additional detailed modeling will be required because discharge flows have remained about the same since the previous modeling. Therefore, results of the previous modeling can be applied directly without further analysis.

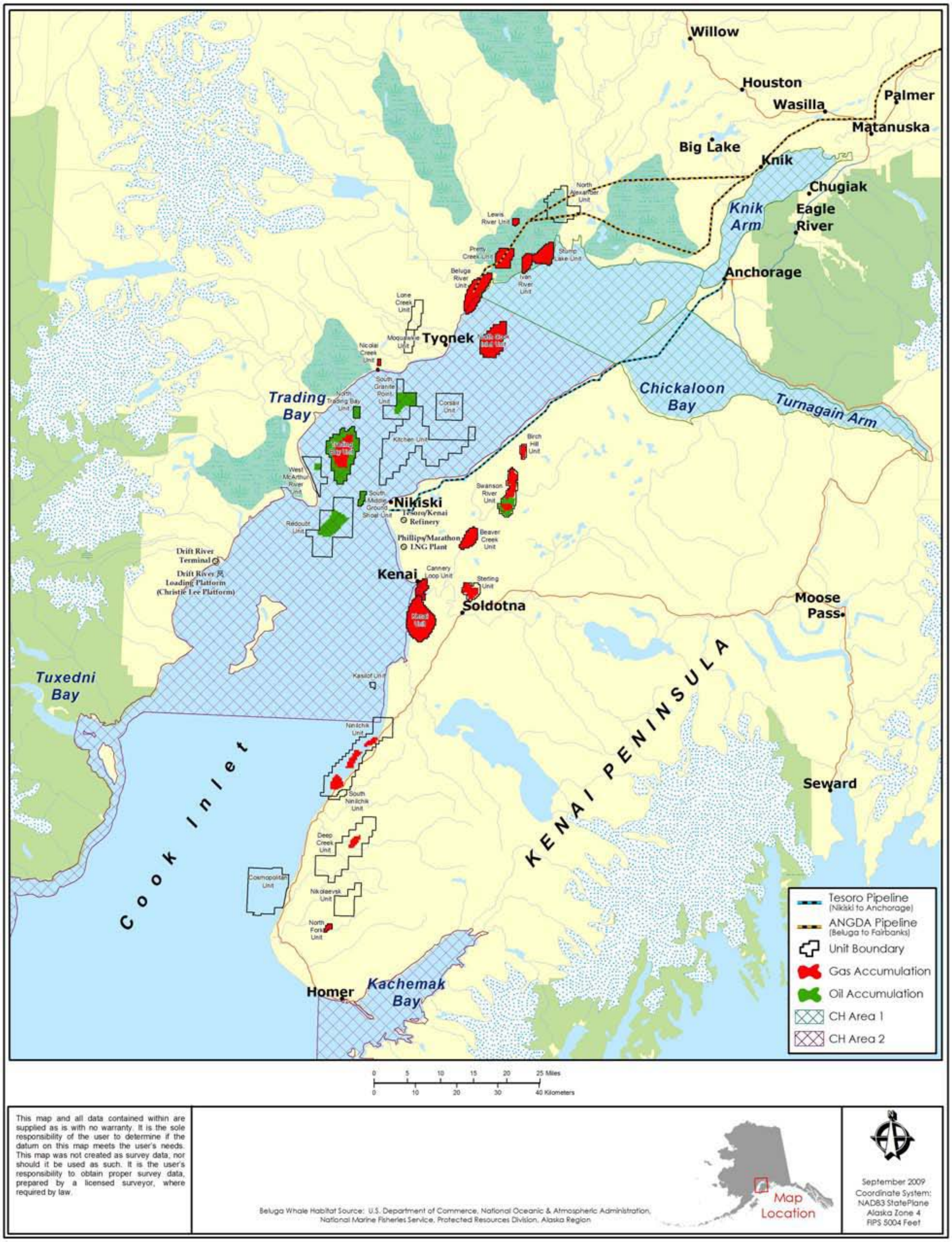
2.3 Project Area

The project area, defined as Upper CI, is bounded by the shores of CI from the East and West Forelands of CI in the south to the farthest extent of Knik Arm to the north. The area contains shallow tidal flats and estuaries. It includes portions of the Municipality of Anchorage as well as communities of the Matanuska-Susitna and the Kenai Peninsula boroughs. Elmendorf Air Force Base and Fort Richardson Army Base are adjacent to one another and located northeast of Anchorage on the southern shore of Knik Arm. The Asplund WPCF is located at Point Woronzof at the head of CI. The Ted Stevens Anchorage International Airport is adjacent to and east of the AWWU property. The Oil and Gas Operations within CI and Vicinity map, shown as Figure 2-1, includes physical features of the study area.

2.3.1 Physical Characteristics

The Knik Arm is a glacially formed estuary with numerous rivers and creeks entering the arm; the Knik River is the largest, entering the arm from the northeast. Other major rivers and streams contributing fresh water to Knik Arm include the Matanuska River, Eagle River, Ship Creek, and Chester Creek. The Susitna River from the west, Campbell Creek from the east and the Placer River, Twenty Mile River, Bird Creek, and Resurrection Creek of Turnagain Arm also contribute fresh water flow into Upper CI.

CI bottom sediments consist predominantly of cobbles, gravels, pebbles, and sand with admixtures of silt and clay. Seafloor conditions are extremely variable, with large submarine sand dunes and patches of boulders scattered through flat-floored bottom. Bottom gravels are typically well-rounded with 2- to 6-centimeter diameters. The surrounding beaches are composed of glacial silt and mud.



This map and all data contained within are supplied as is with no warranty. It is the sole responsibility of the user to determine if the datum on this map meets the user's needs. This map was not created as survey data, nor should it be used as such. It is the user's responsibility to obtain proper survey data, prepared by a licensed surveyor, where required by law.

Beluga Whale Habitat Source: U.S. Department of Commerce, National Oceanic & Atmospheric Administration, National Marine Fisheries Service, Protected Resources Division, Alaska Region

September 2009
Coordinate System:
NAD83 StatePlane
Alaska Zone 4
FIPS 5004 Feet

FIGURE 2-1
OIL AND GAS OPERATIONS WITHIN COOK INLET AND VICINITY
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

Of the many unique characteristics of Knik Arm, perhaps the most unusual are its tidal characteristics. The semidiurnal mixed tides in Knik Arm have a diurnal range of 30 feet and an extreme range of 39 feet. The tides produce swift currents and vigorous mixing off Point Woronzof. Knik Arm exhibits high tidal velocities (up to approximately 8.2 feet per second [ft/sec]), extensive intertidal mudflats (60 percent of Knik Arm), a brackish salinity range (from 4 parts per thousand [ppt] in summer to 21 ppt in winter), and ice flows from November through April.

Tidally driven alternating high current velocities, interspersed by brief periods (15 to 20 minutes) of low-speed slack, have been recorded in Knik Arm. Currents are influenced primarily by the tides, freshwater inflow, and geographic features. Figures 2-2 illustrate the generalized current patterns in Lower Knik Arm and in the vicinity of Point Woronzof during ebb and flood tides, respectively. These general patterns have been developed from years of field measurements of current transport in this region by AWWU and others.

The major rivers and streams contributing fresh water to Knik Arm, combined with other rivers flowing into CI, keep the salinity of Knik Arm generally below 20 ppt. Strong tidal mixing results in weak vertical density gradients year-round. Ambient currents in the vicinity of the Point Woronzof outfall diffuser vary in speed from 8 centimeters per second (cm/sec) to a maximum of 250 cm/sec. The lowest 10th percentile, the 50th percentile, and the 90th percentile current speeds are 46 cm/sec, 136 cm/sec, and 195 cm/sec, respectively. Flushing time in Knik Arm, the time required for the volume of water in Knik Arm to be replaced, is a function of advective flow (riverine input) and tidal excursion (net distance a particle moves each tidal cycle). Calculations of tidal excursion suggest a net excursion exists in the ebb direction of approximately 3 miles after a flood excursion of 19 to 20 miles, and an ebb excursion of 22.5 to 23.2 miles. These high excursions contribute to the rapid flushing rates for Knik Arm. In general, field studies demonstrate large tidal excursions and currents that provide an overall rapid flushing rate (on the order of days) that is greater in spring and summer (times of high freshwater inflow) than in winter. These physical characteristics result in conditions that are very advantageous for the Asplund WPCF treated wastewater discharge.

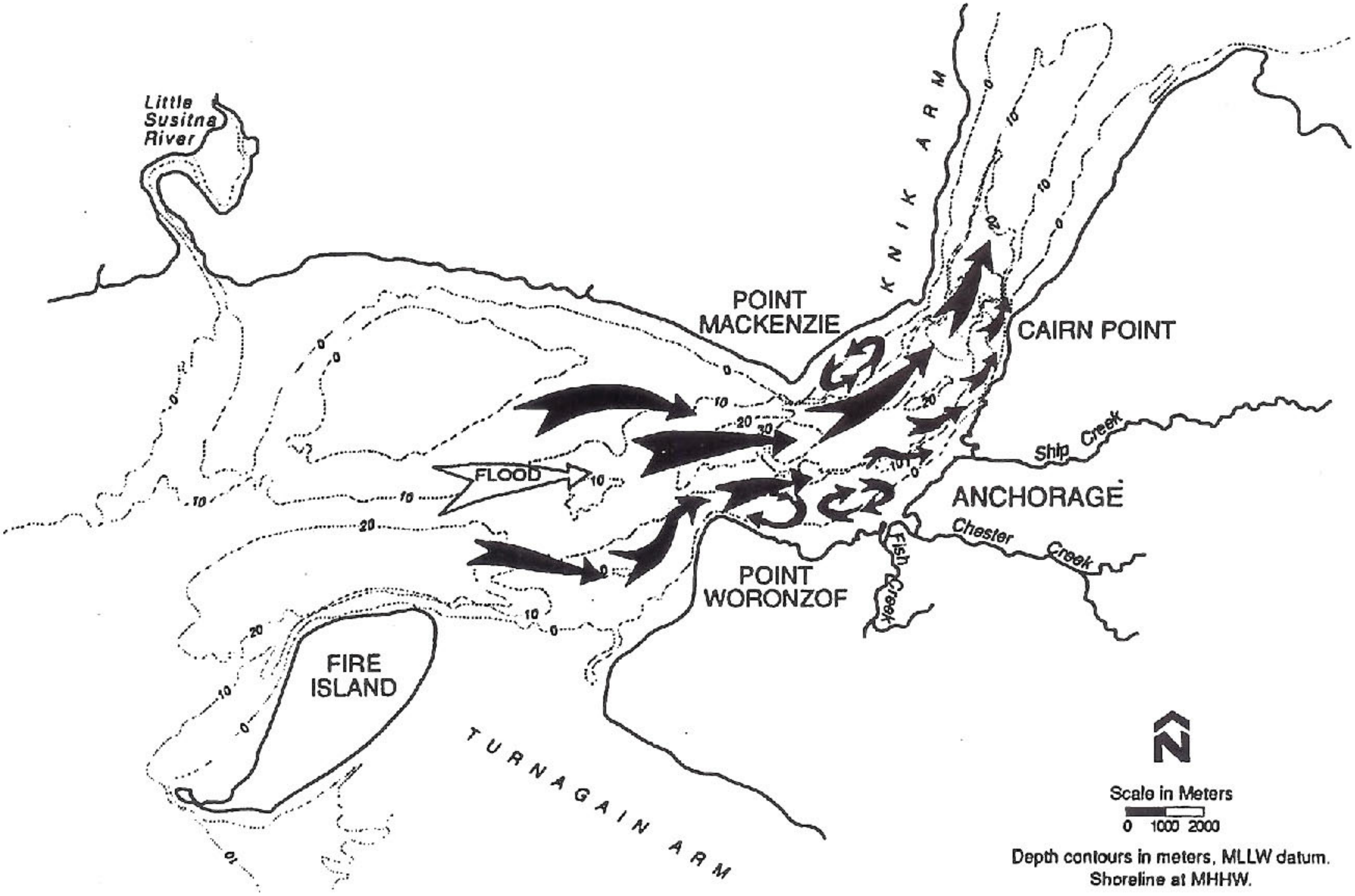
Figure 1-7 shows "snapshots" of the effluent plume transport from the Point Woronzof outfall discharge over a 24-hour time-series. The UDEKDEN model (CH2M Hill 1998) provided a time series of plume dilution and dispersion directions confirming the small spatial dimensions of the detectable discharge plume within the regulatory ZID. Figure 1.7 illustrates the plume and dispersion direction from the 1998 modeling work. The discharge plume is less than 1 percent of the cross section width of Knik Arm at its narrowest constriction point. During normal ebb or flood tidal currents, plume dilutions exceed 1,000:1 within 1,000 meters of the discharge, and under initial tidal reversals, dilutions would still exceed 400:1 within 1,000 meters along the trajectory of the discharge (CH2M HILL, 2004). With the extreme tidal ranges and highest current speeds at the discharge site, a short-lived minimum dilution of 180:1 is predicted by modeling the discharge (not including any turbulent mixing). The high current speeds and turbulent mixing also prevent any accumulation of wastewater solids in the bottom sediments, and the flushing rate prevents any buildup over time of pollutants in Knik Arm.

2.3.2 Fisheries

Although fisheries resources are abundant and diverse in CI as a whole, the resource and fisheries within Knik Arm are generally limited to salmonids. In Upper CI, there are important fisheries for all anadromous salmonid species present, including Chinook (*Oncorhynchus tshawytscha*), coho (*0. kisutch*), sockeye (*0. nerka*), pink (*0. gorbuscha*), and chum (*0. keta*) salmon; steelhead trout (*0. mykiss*); and Dolly Varden char (*Salvelinus malma*). Fisheries for Pacific herring (*Clupea pallasi*), Pacific halibut (*Hippoglossus stenolepis*), king crab (*Paralithodes camtschatica*), Tanner crab (*Chionoectes bairdi*), Dungeness crab (*Cancer magister*), various ground fish, and razor clams (*Silica patula*) are not exploited in the Knik Arm and Anchorage vicinity, mostly because they are not present or not present in sufficient quantity to support a commercial fishery. The primary reason for this is the glacial and estuarine nature of the area. The low salinity and high degree of turbidity due to glacial influence preclude many marine species from using this area extensively. The high degree of turbidity severely limits the amount of photosynthesis that can occur and, hence, biological productivity in general. Knik Arm is, however, an important migratory pathway for anadromous species using the many streams and rivers of the area. The major salmon-producing waters in the Anchorage vicinity are, in order of importance, the Susitna, Little Susitna, and Matanuska Rivers and Bird, Ship, and Campbell Creeks. The Susitna River, by far the most important salmon-producing river in the vicinity, is functionally outside of the project area.

2.3.2.1 Salmonids

The Anchorage area has all of the species of salmonids listed for CI present at various times of the year. Adult salmon arrive from late spring to early fall from open ocean areas where they reared for 1 to 7 years, depending upon species, genetic disposition, and environmental conditions. All spawn in freshwater systems, rear for variable periods, and emigrate back to estuarine and ocean rearing areas in spring. The abundance and importance of salmonids in the Anchorage area can be illustrated with a number of statistics. Abundance is described with spawning numbers (escapement), and run size (escapement + harvest). Importance can be described in terms of commercial and sport fishing harvest, but also includes subsistence harvest, secondary economic contribution, and social values that are unquantifiable. Salmon runs to the Anchorage area are dominated by those returning to the Susitna River system. Salmon runs to Knik Arm are a composite from many streams and rivers feeding the estuary without a dominant system. Despite the large relative size of the Matanuska and Knik Rivers, their salmon production is relatively modest. The production numbers for these systems are unknown as Alaska Department of Fish and Game does not monitor natural production in these systems. However, salmon escapement is regularly monitored in the rivers and streams in the immediate vicinity of Anchorage. Six Mile Creek has the largest returns, composed primarily of sockeye. Campbell and Ship Creeks are primarily Chinook- and Coho-producing systems with total runs of 2,500 and 1,400 salmon, respectively, in recent years. Hatchery-generated runs occur in Knik Arm as the result of four operations, two of which are owned by ADFG and two owned by the CI Aquaculture Association. The Eklutna operation began in the 1970s as a chum salmon enhancement facility. It was converted to sockeye culture in 1992. The Big Lake



Note: Size of current vector indicates the relative strength of the current.

FIGURE 2-2
GENERALIZED CURRENT PATTERN AT POINT WORONZOF DURING FLOOD TIDES
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

Hatchery, also a sockeye facility, was closed in 1992. The current Eklutna program calls for annual production of 1.0 million sockeye salmon smolts and 50,000 coho smolts to be released at the hatchery site and 5.0 million sockeye fry to be released in the Big Lake drainage. At this time, few fish are returning to this facility because early brood years of sockeye salmon were destroyed by outbreaks of Infectious Hematopoietic Necrosis (IHN) virus. The operation was shut down in 1999, but plants to Big Lake will continue from hatchery production at the Trail Lake facility in the Kenai River system.

ADFG owns two hatchery operations in the Anchorage area for local and regional enhancement purposes. The Elmendorf Hatchery is a mixed-species operation producing coho, Chinook, grayling (*Thymallus arcticus*), and Arctic char (*Salvelinus alpinus*). The Fort Richardson Hatchery produces coho, Chinook, and rainbow trout. The production goal for Elmendorf is 200,000 coho smolts. Production goals for Fort Richardson are 200,000 Chinook and 600,000 coho smolts.

2.3.2.2 Salmonid Smolt Production

Salmon, after rearing in freshwater for a variable period of time as juveniles, emigrate to sea in spring. They are called smolts at this time. Smolt production in Knik Arm is composed of natural production in the rivers and creeks of Knik Arm and in hatcheries at four locations. Because salmon are vulnerable to water quality and environmental conditions at this stage of their lives, their presence and residence in the area of the outfall vicinity are important. Natural production is poorly monitored by ADFG in most rivers and creeks because of the expense involved. Although numbers of outmigrant smolts are not available for wild, natural populations of salmon, their abundance can be assumed to be in the millions. Hatchery production is monitored closely and well documented. The 1997 releases totaled 11.7 million fish, with 8.77 million sockeye. All of the sockeye were produced at the Eklutna Hatchery. This number will decline because the Eklutna facility is being closed this year. Fish from both the Elmendorf and Fort Richardson Hatcheries are planted in the many lakes and streams in the Anchorage area, primarily for sport fishing enhancement. Some of the rainbow trout are planted in the Fairbanks area. The total number of smolts passing between Point Woronzof and Point McKenzie is unknown, but they number in the millions and are mostly sockeye salmon. The usage of nearshore waters during outmigration is extensive by the smaller smolt, such as those of pink salmon and chum salmon, although Chinook, coho, and sockeye are found nearshore and farther offshore.

2.3.2.3 Demersal Fish

Demersal fish live on or near the bottom. Attempts to sample this community in 1989 were unsuccessful because of bottom conditions and current velocities at Point Woronzof. However, some generalizations can be made in relation to bottom type and salinity. Flatfish are not likely to be present because of the cobble, rock, and gravel present around the outfall. Sculpins and snailfish are probably present in small numbers. Their abundance is likely to be limited because food resources are low in the vicinity because of high turbidity, high current velocity, and low salinity. Species found include saffron cod (*Eleginus gracilis*), ringtail snailfish (*Liparis rutteri*), starry flounder (*Platichthys stellatus*), yellowfin sole (*Pleuronectes asper*), and Pacific staghom sculpin (*Leptocottu armatus*). Of these, saffron cod were the most commonly caught

2.4 John M. Asplund WPCF Description

The Asplund WPCF is a primary treatment facility that provides treatment for a design flow of 58 mgd and a maximum hourly flow of 154 mgd. Projected flows for the end of 2010 are 33.7 mgd average daily flow and 73 mgd peak hourly flow. Peak flows have been continuously decreasing over the past 10 years due to reduction of infiltration and inflow of stormwater to the sanitary system.

The existing treatment process consists of influent screening, grit removal, primary sedimentation, and skimming and chlorination. Waste solids are removed, thickened, and incinerated at an onsite incinerator and deposited in the Anchorage regional landfill.

The WPCF has been designed to achieve EPA standards for well designed and operated primary treatment plants. It consistently removes between 76 and 82 percent of total suspended solids (TSS) with an average monthly removal of 78 percent compared to industry standards of 60 percent removal. The facility achieves between 29 and 39 percent removal of biological oxygen demand constituents with a monthly average removal of 34 percent, again, better than industry standard of 30 percent.

Figure 1-3 shows the process flow. Figure 1-1 shows the location of the plant at Point Woronzof and the discharge through an outfall to the Knik Arm.

2.5 Pretreatment Program

The EPA instituted the National Pretreatment Program across the United States to control pollutants from industrial or commercial users that could interfere with treatment processes, could contaminate waste sludge, or could flow through a wastewater treatment facility and affect the environment at the outfall.

AWWU conducts an industrial and urban area pretreatment program approved by the U.S. Environmental Protection Agency. A full description and status of the program is provided in Appendix I.

The following three types of discharge standards enforced under AWWU’s program are:

- Prohibited discharge standards
- Categorical standards
- Local limits

Prohibited discharges were created to address the safety of the facility or interference with treatment that the wastewater treatment facility was designed to accommodate.

Categorical standards were developed by EPA for those industries that are most likely to contribute toxic pollutants. Categorical Pretreatment Standards were then set by the EPA and must be followed by all dischargers that fall into these industrial categories. They compel industrial users to implement technology-based controls to limit pollutants and to achieve water pollution control nationwide.

Local limits are created by the local approved authority and cover the needs of the facility and its receiving waters. Each potential pollutant is considered against the most stringent effluent criteria required to establish the maximum allowable headworks loading for that pollutant. Whether or not industrial dischargers fall into an EPA industrial category, they must follow the most stringent of either the EPA promulgated rules or local limits.

AWWU also conducts an EPA-required program to manage pollutants that may make their way to the sewer from areas other than industrial users. Potential sources include runoff into combined sewers and household disposal of chemicals into sanitary sewers. (AWWU system is a separated system prohibiting runoff water to enter the sewer system.)

Anchorage developed its pretreatment program to meet EPA requirements and ensure compliance with Alaska water quality standards. The program was approved by the EPA in April 1982. The first NPDES permit issued to Anchorage after the acceptance of this pretreatment program required that Anchorage develop and adopt its own ordinances to control discharges into the municipal sewer system. The Anchorage Municipal Code now includes regulatory language in Title 26, Chapter 26.50-Sewer Service, also known as the Sewer Use Ordinance.

AWWU also pays for a portion of the Solid Waste Services program to collect household hazardous wastes. The program is available to the general public and Conditionally Exempt Small Quantity Generators as another method of keeping toxic wastes out of the landfill and sewer.

The industrial and urban area pretreatment program may be modified through local limits to address the control of pollutant constituents at the source and achieve the most effective reduction or elimination of toxics from entering the plant and passing through to marine waters.

2.6 Outfall Description

The outfall is an 84-inch-diameter pipe extending 245 meters (804 feet) from shore and terminating in a diffuser with three outlets designed to diffuse flow into receiving water and achieve critical dilution requirements at the edge of the ZID as described in Section 1.4. Figure 1-5 shows the outfall configuration.

SECTION 3

Approach to Evaluating Effects on the Endangered Species in Upper Cook Inlet

3.1 Steps to Analyze Effects

Effects of the Asplund treatment plant discharge on endangered species have been evaluated through a number of potential exposure pathways for regulated POCs detected in Asplund WPCF effluent and for non-regulated emerging parameters of concern (EPOC) that are inferred from sampling of other municipal waste water treatment plants and from sampling and analysis of Asplund influent and effluent during 2010.

At the start of this biological evaluation the approach to analyzing the affects of EPOCs on endangered species was to infer the presence and concentration of chemicals from studies conducted at other WWTFs. EPA's "Nine Plant Study", sampling and analysis of a number of Canadian WWTFs and the WERF study of the presence of EPOCs was used to infer the presence of EPOCs in the Asplund effluent. The approach is fully described in appendix A and B to this report.

Subsequently, AWWU initiated a program to sample and analyze the influent and effluent at the Asplund WWTF for EPOCs, fully described in Appendix H to this report. This program was completed in 2010.

Analysis of the affects of EPOCs inferred from other studies as well as the results of AWWU's sampling and analysis of the Asplund WWTF effluent are incorporated into this report.

The steps followed in evaluating the effects of the Asplund discharge on beluga prey and the beluga whale are illustrated on Figure 3-1.

Direct effects on prey species and direct and indirect effects on the beluga whale were evaluated through the exposure analysis pathways shown on Figure 3-1.

The following primary lines of effects evaluation were considered for this BE:

1. **Potential for direct effects on aquatic organisms (e.g., fish) that could serve as a food source for the beluga whale.** This evaluation assessed whether or not the measured and the inferred levels of EPOCs, in the Asplund WPCF effluent are high enough to significantly reduce populations of fish or invertebrates that serve as the beluga food sources.

2. **Potential for indirect effects on the beluga whale via dietary uptake of prey items that have accumulated EPOCs.** This evaluation incorporated use of a food-web exposure model to estimate dietary intake to the beluga of EPOCs that may have accumulated in prey species that comprise their diet. Tissue concentrations in beluga whale prey items were estimated using either data from measured levels in fish caught within CI, or estimated from levels projected to occur in surface water

within the Asplund WPCF mixing zone area. The beluga food web is illustrated on Figure 3-2.

For each of these two lines of evaluation, a hazard quotient (HQ) approach was used to determine the potential for direct and indirect effects. The HQ is defined as the ratio of the estimated POC exposure concentration (in surface water in the case of whale prey) or dietary intake (via diet in the case of the whale itself) to the highest exposure level known to be protective. Thus, an HQ exceeding unity indicates that the level of exposure exceeds the protective level and that a potential for risk exists.

Appendices A and B present the sources of information used to determine the exposure levels of each POC for beluga whale prey and the beluga whale, including HQs.

3.1.1 POCs Evaluated

POCs in the exposure pathway analysis include those EPA-defined “priority pollutants” detected through the normal required sampling and analysis of Asplund WPCF discharge, POCs inferred to be in the discharge from published studies of North American wastewater treatment plant influent, POCs measured in the Asplund WPCF discharge and POCs found in tissues of prey species collected in Upper CI. Appendices A and B present the approach used to screen constituents for evaluation and to calculate the HQ for each.

Of the more than 130 inorganic and organic chemical parameters regularly analyzed in the WPCF effluent over the period 2000 to 2009, only 48 have been detected. The concentration ranges and detection frequencies of those constituents are summarized in Table A-2 of Appendix A.

Inferred POCs are unregulated constituents, or EPOCs, as defined by EPA. This analysis conservatively assumed that maximum levels of EPOCs reported in published literature were plausible levels of EPOCs in the Asplund WPCF discharge. The EPOCs measured during the 2010 sampling and analysis program generally showed a lower concentration than the inferred levels. Both inferred and measured have been included in the calculation of HQ. Literature sources are described in Appendix A.

Constituents were screened for their ability to move through the food chain, resulting in higher concentrations at higher trophic levels. The logarithm of the octanol to water partition coefficient, or Log K_{ow}, for each constituent was used to screen for identifying EPOCs with meaningful potential for bioaccumulation. The Log K_{ow} is a measure of the affinity of a compound to accumulate in the lipids of an exposed organism. All constituents with a Log K_{ow} equal to or greater than 3.5 were assumed to bioaccumulate and included in the analysis of toxicity in accordance with the Alaska Department of Environmental Conservation *Ecoscoping Guidance* (Alaska Department of Environmental Conservation, 2009).

3.1.2 Direct Effects Exposure Pathway

Concentrations of effluent-derived POCs in CI were evaluated using a tiered approach. As an initial screening step, the maximum POC concentrations were assumed to occur in the Asplund WPCF effluent. The CID, which is the minimum theoretical dilution at the edge of the ZID, was applied to end-of-pipe effluent POC concentrations (whether measured under the NPDES program or inferred from literature sources) to estimate the potential exposure concentration at the edge of the ZID. This initial tier estimated HQs directly using the anticipated concentrations at the edge of the ZID. Subsequently, HQs were calculated for edge of the ZID for the measured concentrations of POCs using the CID.

A second, and more realistic, tier evaluation of POC exposure concentrations was then performed for three general areas of CI: Knik Arm, Turnagain Arm, and Upper CI, as described in Appendix F. POC concentrations were estimated from transport and circulation modeling results, also described in Appendix F. The transport and circulation model of Upper CI was developed to trace the transport and fate of pollutants dissolved in the water or adsorbed/adhered to suspended solids.

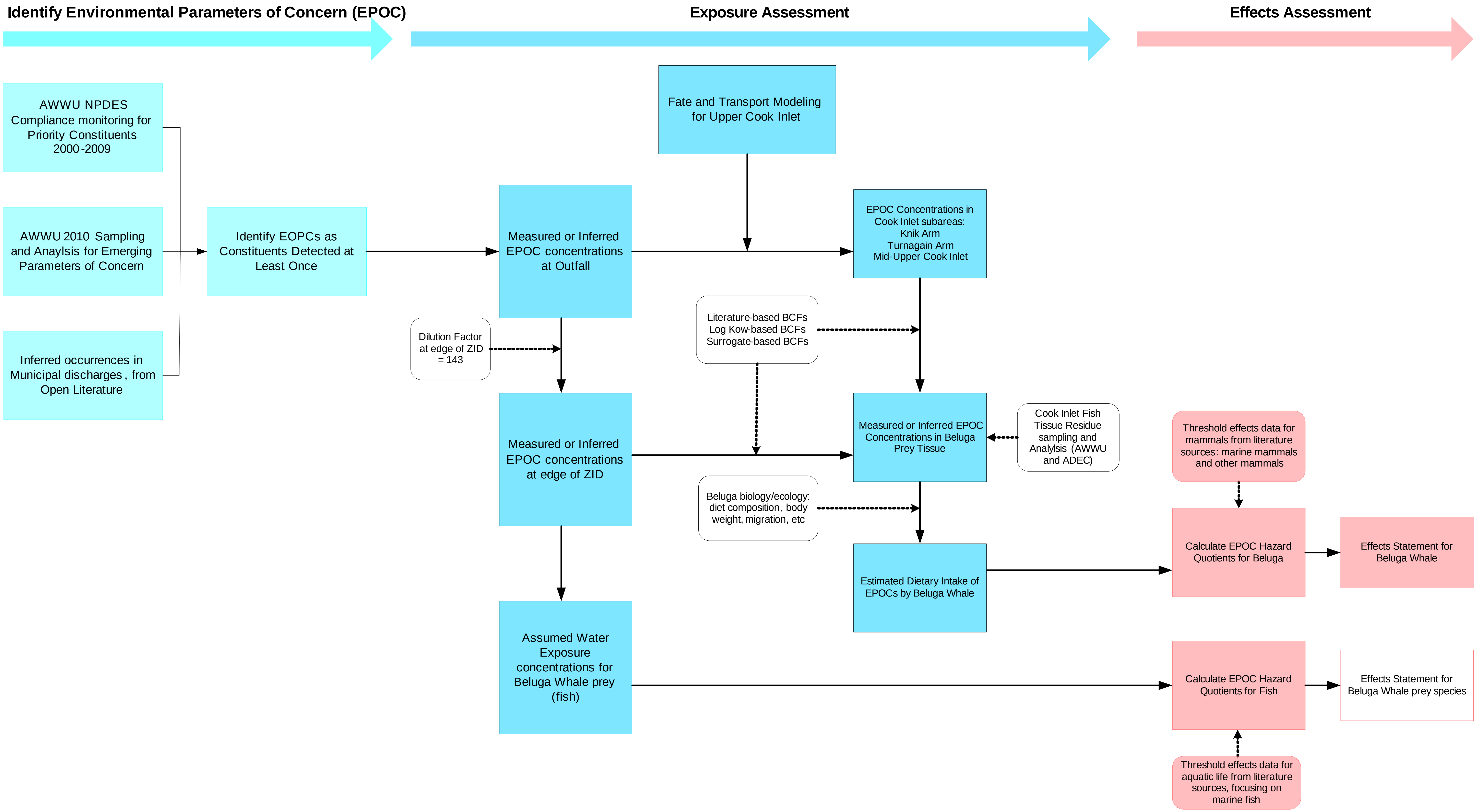


FIGURE 3-1
STEPS TO ANALYSIS OF EFFECTS
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

WBG020810173433RDD_3-1

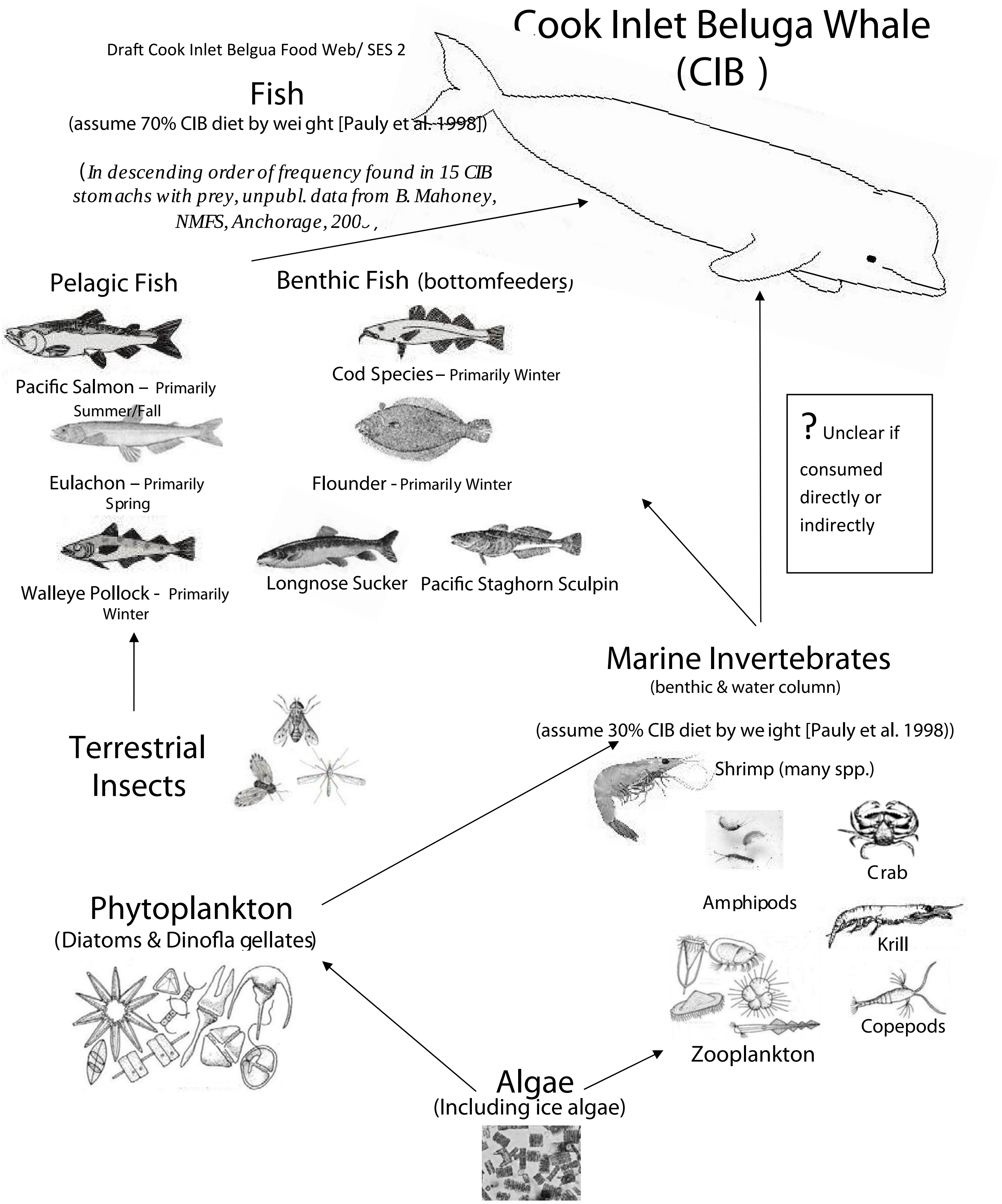


FIGURE 3-2
BELUGA WHALE FOOD WEB DIAGRAM
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

Conservative assumptions used for the direct effects HQ are described in Appendix B. The following critical assumptions were made:

- Maximum effluent levels of priority pollutants detected
- Maximum reported levels of non-regulated POCs inferred to be present in effluent

2010 Measured levels of non-regulated POCs using CID at edge of ZID

- Point of exposure at the edge of ZID
- No observed effect concentrations for most sensitive marine species assumed to represent toxic threshold

A second line of evidence considered for evaluating direct effects of Asplund WPCF effluent on beluga prey was the result of whole effluent toxicity (WET) testing completed by AWWU over the last 10 years. The WET tests regularly conducted by AWWU under its NPDES program provide a very strong line of evidence to assist in characterizing whether any of the constituents discharged from the Asplund WPCF may pose significant direct risk to marine resources present in CI. If EPOCs are present in concentrations high enough to cause toxicity, the WET test results should reflect this.

Table A-5 of Appendix A provides the quarterly WET test results from 2000 through 2009 for echinoderm fertilization tests; bivalve survival, growth, or larval development; and topsmelt survival and growth. Topsmelt was considered the most relevant test species among those used in WET testing, because fish comprise the large majority of the beluga diet. The results for this test species indicated the absence of toxicity over the entire 10-year period evaluated

Indirect Effects Exposure Pathway

Indirect effects are those resulting from consuming prey that have accumulated POCs. Exposure to POCs was evaluated for those constituents found in fish tissue, those measured in the Asplund WPCF discharge (including the 2010 sampling and analysis results), and those inferred to be in the discharge.

Figure 3-2 illustrates the food web and biomagnification route from prey species to the beluga whale. CI beluga whale ecology provided the basis for direct and indirect exposure factors. These are described in Section 4.2 and Appendices B and E. Key factors in the analysis were literature studies reporting stomach content information (to determine prey species and fraction of total diet for each prey species), whale weight, and whale distribution. Conservative assumptions were used to estimate the indirect effects on the beluga whale. The complete suite of assumptions is described in Appendix B. The following critical assumptions were used in this evaluation:

- Maximum concentration of POCs detected in discharge and reported levels EPOCs from the literature
- POCs with a Log K_{ow} greater than or equal to 3.5 have potential to bioaccumulate[3]

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[3] The list of constituents and their associated Log K_{ow} are shown in Appendix A.

- All uptake through bioconcentration from water column into beluga prey species, with no reduction of uptake estimates for POC fraction adsorbed to sediments
- No accounting for environmental degradation
- Toxicity to beluga whales interpolated from terrestrial mammals and scaled for body size differences

SECTION 4

Existing Environmental Conditions

4.1 Upper Cook Inlet and Knik Arm

CI is a large (370-kilometer-long), semi-enclosed, subarctic tidal estuary located in south central Alaska that opens into the Gulf of Alaska (Figure 2-1). The Inlet is bordered by 1,350 kilometer of coastline and covers an area of roughly 20,000 square kilometers (km^2) (Rugh et al., 2000). The bathymetry of CI is varied but mostly consists of shoals, canyons, and mudflats. Upper CI is generally shallow, with most waters less than 73 meters (240 feet) deep (NMFS, 2008). At its northern end near Anchorage, CI branches into two shallower extensions: Knik Arm north of Anchorage and Turnagain Arm southeast of Anchorage. Both Knik and Turnagain Arms are glacially formed estuaries fed by numerous rivers and creeks. The large tidal ranges in this area (see below) result in the exposure of extensive mudflats in both Knik and Turnagain Arms, as well as the area between Anchorage and Fire Island and other shorelines of Upper CI.

Knik Arm waters are considered a harsh, extreme marine environment in terms of the powerful interacting effects of large tidal changes, strong currents, massive glacial and coastal sediment inputs from rivers and coastal erosion, and extreme winter ice scour (Pentec, 2005). These harsh conditions limit primary productivity and thus populations of marine flora and benthic invertebrates to relatively low densities including on the beaches and in the water column (Bakus et al., 1979; Dames & Moore, 1983; Pentec, 2005). Compared to central and southern CI, Knik Arm is characterized by low benthic and water column primary productivity, low to moderate densities of epibenthic and pelagic invertebrates, and few invertebrates of a size that could provide prey for juvenile salmonids. The physical characteristics of Knik Arm and the existing marine habitats and organisms are described below. These factors directly or indirectly affect the presence, occurrence, distribution, and behavior of beluga whales, the primary focus of this BE.

4.1.1 Tides and Currents

CI tides are semidiurnal, with two unequal high tides and two unequal low tides per day. The period between slack-water times is about 6.2 hours (FHWA, 2007). Upper CI experiences the second-largest tidal range in the world, with fluctuations as high as 9 to 12 meters (30 to 40 feet). The high tidal range produces strong currents and tidal bores exceeding 3.5 meters per second (m/sec) (11 feet/sec). Many of the freshwater sources running into Upper CI are glacially fed (FHWA, 2007). Strong tidal currents cause suspension of large volumes of sediment from the Matanuska and Knik Rivers in Knik Arm. Tidal energy is the dominating force influencing water circulation in CI. As a result, the upper inlet is a highly turbid marine environment. Because of predominantly shallow water depths, tidal ranges within Knik and Turnagain Arms are much larger than in the main body of CI (KABATA, 2006).

4.1.2 Sea Ice, Water Quality, and Substrate

In October and November, tributary rivers and streams begin to freeze. In winter, ice fills much of the upper inlet. Ice typically begins breaking up and receding in March and April, and summer and early fall are ice free (Moore et al., 2000). The large amounts of fresh water entering Knik and Turnagain Arms contribute to relatively higher concentrations of ice in the upper inlet (NMFS, 2008). Ice rafts up to 2.5 feet thick sometimes occur in the upper inlet (Mulherin et al., 2001). However, ice cover in CI is rarely uniform because of extensive tidally driven movements.

The waters of Knik and Turnagain Arms are generally brackish and well mixed, both laterally and vertically, by strong tides and currents (Pentec, 2005). However, water temperature and salinity vary seasonally. Water temperatures range from about 31°F in winter to more than 63°F during summer, although the high rate of tidal mixing throughout CI causes water temperatures to be relatively uniform in summer (Bakus et al., 1979; Moore et al., 2000). Underwater visibility is poor and turbidity is very high. Levels of light penetration are very low throughout the year due to high suspended sediment loads (Pentec, 2005). Bluff erosion and glacially fed rivers are the most significant sources of sediment load in Upper CI waters. The Knik and Matanuska Rivers contribute the largest sediment load to Knik Arm; average summer loads range from approximately 6.84 million tons in mid-May to 5.45 million tons in mid-October. Approximately 80 percent of the annual suspended sediment load from the Knik and Matanuska Rivers is discharged to Knik Arm from June to September (Funk et al., 2005). Additionally, the bluffs along Knik Arm probably contribute substantially to the inlet water sediment load via erosion by wind, rain, slope failure and continuous exposure to wave action (KABATA, 2006).

The strong currents typically prevent all but the heavier sand particles from settling to the bottom, resulting in a generally scoured sea floor. As a result, mud and sand flats are the most prevalent intertidal habitat types in the upper inlet (KABATA, 2006). Predominant intertidal substrates in the northern CI consist of mud and sand flats and gravel and cobble mixes, with occasional clay bands in the mid-tidal range, as well as occasional boulders (FHWA, 2007). The subtidal zone of Upper CI is mostly flat, silty, and fine- to medium-grained sand bottoms, with cobble and boulder bottoms in areas of greater relief (KABATA, 2006). The middle and upper beaches north of the Port of Anchorage, on the eastern shore and north of Point MacKenzie on the western shore, consist primarily of gravel and cobble mixes; occasional bands of sand occur at the high tide line, and more widespread silt/clay deposits occur in the middle intertidal range (Pentec, 2005).

4.1.3 Marine Flora

Marine flora typically associated with benthic substrates of southeast Alaska are relatively scarce in Upper CI given the predominant lack of suitable bottom substrate resulting from tidal and likely ice scour. Marine vegetation in the intertidal zones varies from no populations to small, scattered populations according to the aforementioned sampling studies in Knik Arm (Pentec, 2005). These include green algae (*Enteromorpha linza, E. intestinalis,* and *E. prolifera)*, unicellular or filamentous algal mats of possibly yellow-green vaucheria (*Chrysophyta*) that grow occasionally on clay but more often attach to small rocks and boulders in some scattered areas. Rockweed (*Fucus gardneri*) was found to be relatively dense in only a few areas of Knik Arm where it attached mostly to the sides of cobbles where some protection against ice scour was provided (Pentec, 2005).

4.1.4 Marine Invertebrates

The most extensive, detailed, and up-to-date study of marine organisms and habitats in Knik Arm and nearby Upper CI waters, including invertebrates, was conducted in association with the proposed Knik Arm Bridge crossing for the Knik Arm Bridge and Toll Authority (KABATA) (Pentec, 2005). This study expanded on earlier marine studies conducted there in 1983 (Dames and Moore, 1983). Nearshore or offshore sampling of invertebrates and fish were conducted monthly from July through November 2004 and from April through July 2005 (Pentec, 2005). Sampling was conducted using beach seines, otter trawls, benthic cores, and surface tow nets from pre-determined stations or along transect lines located between Fire Creek in Upper Knik Arm south to Six Mile Creek near the mouth of the arm (Pentec, 2005).

Overall, invertebrate numbers, diversity and distribution relative to intertidal beach, benthic, and water column habitats are lower and different in Knik Arm compared to the invertebrate communities in central and Lower Knik Arm (Pentec, 2005). Beaches of Knik Arm are generally devoid of obvious macroinvertebrates (Pentec, 2005). The highly turbulent waters of Knik Arm cause normally infaunal and bottom-dwelling invertebrates to be suspended in the water column where they appear to be swept back and forth with the tidal currents (Pentec, 2005). This condition is indicated by their general absence observed during sampling conducted along Knik Arm beaches (Pentec, 2005); in contrast, these species are typically abundant at beaches of central and southern CI where waters and tidal influences are reduced. Only three species of intertidal animals were found in Knik Arm beach samplings: a fairly widespread polychaete, one bivalve with very limited distribution, and a small snail species found only at Point Woronzof (Pentec, 2005). In both nearshore and offshore waters, most invertebrates were amphipods, mysids, and crangonids. Density of these species was very low during early spring, then steadily increased across the non-ice season, peaking in August through October, with a drop in numbers again in late fall. An apparent near absence of invertebrates has been reported for Knik Arm during winter from November through April (Pentec, 2005).

Unlike in typical estuarine environments, invertebrates in Knik Arm (e.g., crustaceans) are believed to subsist primarily on organic material deposited and suspended in the water column from streams (Pentec, 2005). This is attributed to the general lack of suitable benthic habitat, the lack of organic forage material on the bottom of Knik Arm, and the abundance of typical bottom-dwelling invertebrates within the water column related to strong tidal currents and seasonal ice scouring.

4.1.5 Marine Fish

A total of 18 species of fish, including 5 species of adult and juvenile salmonids, have been documented in Knik Arm (Dames and Moore, 1983; Pentec; 2005;

Rodrigues et al., 2006, 2007). The salmon species include sockeye (*Oncorhynchus nerka*), coho (*O. kisutch*), Chinook (O. *tshawytscha*), chum (*O. keta*), and pink salmon (*O. gorbuscha*). Fish species diversity and abundance are similar in both nearshore and deeper offshore waters of Knik Arm but vary seasonally (Pentec, 2005). During the April to November study period, overall fish catch per unit effort (CPUE) at sampling stations in Knik Arm ranged from 8.2 in April to a high of 20 in June, with numbers remaining relative high (approximately 16 CPUE) though October; a steep decline in fish numbers occurred in November (2.5 CPUE) (Pentec, 2005). With the onset of winter, data indicate that most fish species move out of Knik Arm with the exception of bottom fish (e.g., cod) (Pentec, 2005). The seasonal abundance, locations and type of use of various fish species in Knik Arm and the analysis area are summarized in Table 4-1. Figure 4-1 shows the salmon life cycle.

Overall, the most common fish taxon documented in Knik Arm is juvenile salmon; their major outmigration occurs over a short period of time between late April and early June as they feed on invertebrates (e.g., mysids, amphipods) and osmoregulate, although juveniles continue to occur there through September, depending on species; after this period, their numbers drop (Dames & Moore, 1983; Pentec, 2005). Eulachon (an anadromous smelt species) occur in abundant numbers in Knik Arm only during the May or early spring spawning period (Pentec, 2005) when they aggregate at natal river mouths, then migrate upstream to spawn. Eulachon spawn and hatch in freshwater and mature at sea where, as juveniles and adults, they feed mainly on euphausids (i.e., krill). Adult eulachon do not feed while in fresh water (ADFG, 2009). Longfin smelt are seasonally abundant from June through October in the lower and middle portions of Knik Arm (Pentec, 2005). Adult salmon migrate through Knik Arm to spawn in rivers between May and September, with peak abundances varying with species and location (Table 4-1). The threespine stickleback is the most common single species after salmon and peaks in July and August (Pentec, 2005). Saffron cod are relatively common through most of spring, summer, fall, and early winter in Knik Arm (Pentec, 2005). In general, cod consume polychaetes, shrimp, amphipods, mysids, and other fish (e.g., walleye pollock [*Theragra chalcogramma*] and flatfish) (see Seaman et al. 1982; Clausen, 1981; Cohen et al., 1990). In Knik Arm, amphipods and mysids are known to be important prey for saffron cod (Dames & Moore, 1983).

There does not appear to be any preferential habitat use by fish in Knik Arm, with the exception of aggregations of adult spawning salmon and eulachon at river mouths, and longfin smelt that have been found in significantly higher numbers near the mouth of the arm (e.g., Point Woronzof) (Pentec, 2005). Small fish such as sticklebacks and juvenile salmon are likely swept back and forth through Knik Arm entrained in strong tidal currents, as few are found along the shorelines (Pentec, 2005). Available data indicate that juvenile salmon occur throughout Knik Arm waters (Moulton, 1997; Pentec, 2005); in contrast, in other estuarine areas, they are strongly tied to the shoreline to forage, avoid predation, and osmoregulate during their outmigration and smolting periods (Heiser and Finn, 1970; Simenstad et al., 1982; Myers et al., 1998; Brennan and Culverwell, 2001). A limited number of fish stomachs examined from Knik Arm suggest that terrestrial insects rather than marine invertebrates appear to be the predominant prey consumed by juvenile salmonids, with small numbers of marine invertebrates also

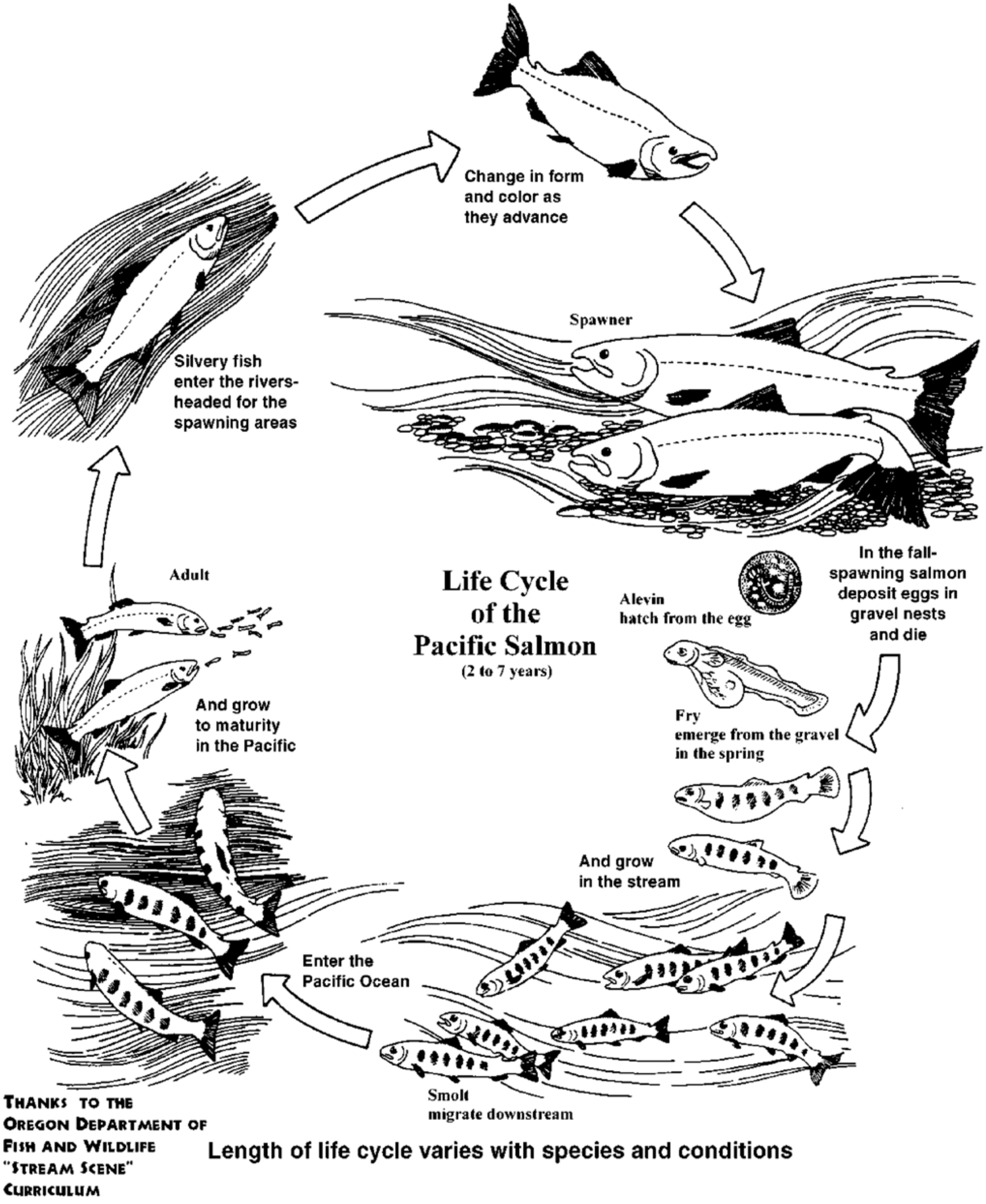


FIGURE 4-1
SALMON LIFE CYCLE DIAGRAM
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

Table 4-1. Timing, Locations, Habitat Use and Feeding Habits of Primary Fish Species Occurring in Upper Cook Inlet, Focused on Species Known to be Most Commonly Consumed by Cook Inlet Beluga Whales

Fish Species	Ship Creek (1)	Susitna River and Delta (2)	Knik Arm (3)	Spawning (4) In-Migrating Adult Salmon (6, 7, 11)	Early Juvenile Rearing (5) Out-Migrating Juvenile Salmon (6, 7, 11)	Prey (6, 7, 8, 10, 11,12)
Adult Chinook (King)	HA, SP, MC	HA, SP	SP, MC	May - July		Do not feed while spawning/ in-migrating in Upper CI. At sea, feed on fish, pelagic amphipods and krill.
Juvenile Chinook (King)	EJ, MC	EJ	EJ, MC		April - June (occur until September but peak is in spring/early summer)	Generally invertebrates (e.g., mysids, amphipods). In Knik Arm, juvenile salmon found to feed throughout the arm primarily on terrestrial insects.
Adult Coho (Silver)	SP, EJ, MC	SP, EJ	SP, EJ, MC	June - August		Do not feed while spawning/ in-migrating in Upper CI. At sea, feed on fish, pelagic amphipods and krill.
Juvenile Coho (Silver)	EJ, MC	EJ	SP, EJ, MC		April - June (occur until September but peak is in spring/early summer)	Generally invertebrates (e.g., mysids, amphipods). In Knik Arm, juvenile salmon found to feed throughout the arm primarily on terrestrial insects.
Adult Pink	MC	SP	SP, MC	June - August		Do not feed while spawning/ in-migrating in Upper CI. At sea, feed on fish, pelagic amphipods and krill.

Table 4-1. Timing, Locations, Habitat Use and Feeding Habits of Primary Fish Species Occurring in Upper Cook Inlet, Focused on Species Known to be Most Commonly Consumed by Cook Inlet Beluga Whales

Fish Species	Ship Creek (1)	Susitna River and Delta (2)	Knik Arm (3)	Spawning (4) In-Migrating Adult Salmon (6, 7, 11)	Early Juvenile Rearing (5) Out-Migrating Juvenile Salmon (6, 7, 11)	Prey (6, 7, 8, 10, 11,12)
Juvenile Pink	MC	SP, EJ	SP, EJ, MC		April - June (occur until September but peak is in spring/early summer)	Generally invertebrates (e.g., mysids, amphipods). In Knik Arm, juvenile salmon found to feed throughout the arm primarily on terrestrial insects.
Adult Sockeye (Reds)	MC	SP, EJ	SP, EJ, MC	Late June - August		Do not feed while spawning/ in-migrating in Upper CI. At sea, feed on fish, pelagic amphipods and krill.
Juvenile Sockeye (Reds)	MC	SP, EJ	SP, EJ, MC		April - June (occur until September but peak is in spring/early summer)	Generally invertebrates (e.g., mysids, amphipods). In Knik Arm, juvenile salmon found to feed throughout the arm primarily on terrestrial insects.
Adult Chum	MC	SP, EJ	SP, EJ, MC	Mid July - Mid August		Do not feed while spawning/ in-migrating in Upper CI. At sea, feed on fish, pelagic amphipods and krill.
Juvenile Chum	MC	SP, EJ	SP, EJ, MC	Mid July - Mid August	April - June (occur until September but peak is in spring/early summer)	Generally invertebrates (e.g., mysids, amphipods). In Knik Arm, juvenile salmon found to feed throughout the arm primarily on terrestrial insects.

Table 4-1. Timing, Locations, Habitat Use and Feeding Habits of Primary Fish Species Occurring in Upper Cook Inlet, Focused on Species Known to be Most Commonly Consumed by Cook Inlet Beluga Whales

Fish Species	Ship Creek (1)	Susitna River and Delta (2)	Knik Arm (3)	Spawning (4) In-Migrating Adult Salmon (6, 7, 11)	Early Juvenile Rearing (5) Out-Migrating Juvenile Salmon (6, 7, 11)	Prey (6, 7, 8, 10, 11,12)
Eulachon	MA, SP, EJ	HA, SP, EJ, MC (May and July: 2 major spawning migrations, early run=several hundred thousand, later run=several million) (8, 10)	SP, EJ, MA (May - early spring)	May and June	April - June	Adults do not feed while spawning/in-migrating in freshwater or estuarine waters such as Upper CI. At sea, feed on euphausids (i.e., krill) (8,10).
Saffron Cod	MA	MA	HA (found through most of spring, summer, winter and fall, year-round residents, migrate offshore during winter months)			In general, this species feeds on polychaetes, shrimp, amphipods, mysids, and other fish (e.g., walleye pollock (*Theragra chalcogramma*) and flatfish). In Knik Arm, amphipods and mysids are known to be important prey for saffron cod.
Longfin Smelt	MA	MC, EJ	HA (June - October)	Mid November - Mid May		Shrimp, copepods, amphipods.
Threespine Stickleback	MA	HA	HA	July - August		Invertebrates and small fish, plankton.

SP = spawn
EJ = early juvenile rearing
MC = migratory corridor
HA = high abundance
MA = moderate abundance

Table 4-1. Timing, Locations, Habitat Use and Feeding Habits of Primary Fish Species Occurring in Upper Cook Inlet, Focused on Species Known to be Most Commonly Consumed by Cook Inlet Beluga Whales

Fish Species	Ship Creek (1)	Susitna River and Delta (2)	Knik Arm (3)	Spawning (4) In-Migrating Adult Salmon (6, 7, 11)	Early Juvenile Rearing (5) Out-Migrating Juvenile Salmon (6, 7, 11)	Prey (6, 7, 8, 10, 11,12)

1. Tributary of Susitna River, large spawning location for adult Chinook salmon.
2. Susitna River and Delta include the Yentna, Skwentna, Chulitna, and Talkeetna Rivers, Willow Creek, Little Willow Creek, Kashwitna River, Caswell Creek, Sheep Creek, Goose Creek, Montana Creek, Sunshine Creek, Birch Creek, Rabideux Creek, Fish and Clear Creeks. Susitna River and Delta are a large migratory paths for both spawning adults and juvenile salmon, many of the Susitna tributaries are spawning locations for all five species of Pacific salmon and Eulachon (6, 7, 10)
3. Knik Arm includes the Knik, Eagle and Matanuska Rivers, Cottonwood Creek, Five Mile Creek, Six Mile Creek, Little Su, Goose Bay and Eagle Bay. Knik Arm is not believe to be a preferential habitat for fish however large aggregations are observed at the river mouths, fish migrate through Knik Arm to reach the rivers (6, 7, 10).
4. After 1 to 8 years, salmon return to their home rivers to spawn where they had hatched and spawn – after spawning they die (6).
5. Later winter salmon eggs hatch from the redds (nests) in the gravel, young alevinl live off their yolk sac until spring (up to 4 months) until they begin to feed on live prey, juvenile salmon swim downstream while smolting (physical changes, adapting to salt water in estuaries). Juvenile salmon stay in fresh water and estuaries for 1 to 3 years before migrating to the ocean (6).
6. Alaska Department of Fish and Game 2010. Cook Inlet Fisheries (Sport, Commercial, Personal Use, and Subsistence Fisheries) <www.cf.adfg.state.ak.us/region2/finfish/salmon/uci/cookinlet.php>. Accessed February 2010.
7. Alaska Department of Fish and Game. 2004. Fish Distribution Database – Interactive Mapping. <www.sf.adfg.state.ak.us/sarr/FishDistrib/FDD_ims.cfm>. Accessed February 2010.
8. Calkins, D.G. 1989. Status of belukha whales in Cook Inlet. In: Gulf of Alaska, Cook Inlet, and North Aleutian Basin information update meeting. L.E. Jarvela and L.K. Thorsteinson (Eds). Anchorage, Alaska., Feb. 7-8, 1989. Anchorage, Alaska.: USDOC, NOAA, OCSEAP P.109-112.
9. Funk, D.W., T.M. Markowitz, and R. Rodrigues (eds.) 2005. Baseline studies of beluga whale habitat use in Knik Arm, Upper Cook Inlet, Alaska, July 2004-July 2005. Rep. from LGL Alaska Research Associates, Inc., Anchorage, Alaska, in association with HDR Alaska, Inc., Anchorage, Alaska, for Knik Arm Bridge and Toll Authority, Anchorage, Alaska, Department of Transportation and Public Facilities, Anchorage, AK, and Federal Highway Administration, Juneau, Alaska.
10. Lowry, L.F. 1985. The belukha whale (*Delphinapterus leucas*) Pp. 3-13 in J.J. Burns, K.J. Frost and L.F. Lowry (eds.), marine mammals species accounts. ADFG, Game Tech. Bull. 7.
11. National Marine Fisheries Service. 2008. Conservation Plan for the Cook Inlet beluga whale (*Delphinapterus leucas*). National Marine Fisheries Service, Juneau, Alaska.
12. Pentec. 2005. Marine fish and benthos studies in Knik Arm, Anchorage, Alaska. Prepared for Knik Arm Bridge and Toll Authority and HDR Alaska, Inc., November 30, 2005. 12214-10/12214-12. Prepared by Pentec Environmental, Edmonds, Washington.

consumed (Dames & Moore, 1983; Pentec, 2005). This is likely related to the relatively low densities of marine invertebrates or the poor visibility of these sediment-laden waters: these fish species are believed to rely primarily on vision for foraging, which is likely impeded by the highly turbid, low-light waters of Knik Arm (Pentec, 2005).

Another interesting difference in fish between Knik Arm and typical estuarine waters is that schooling fish do not appear to school in Knik Arm (Pentec, 2005). This is possibly because the predation rate is relatively low given the reduced water clarity and, thus, the difficulty for predators to see and consume these fish.

4.2 Baseline Primary Constituent Habitat Elements for Cook Inlet Beluga Whales

As indicated in Section 3.7, NMFS has identified proposed critical habitat for the CI beluga population. The analysis area for this BE is located entirely within Area 1 and portions of Area 2 of this critical habitat boundary (Figure 4-2); Area 1 represents the most intensively used habitat by belugas for foraging and calf rearing. The focus of this BE is to assess potential effects of the proposed project on CI belugas. Thus, it is important to identify the resources or habitat elements that are most important to the continued existence, health, and recovery of this population, and to evaluate potential project effects on these elements.

NMFS (2009) identified five “primary constituent elements” (PCE) in the proposed critical habitat ruling that are considered “essential to the conservation of CI beluga whales” as defined in Table 4-2. Three of the five PCEs (PCEs 1, 2, and 3) occur in and are relevant to the project analysis area and proposed activity. No in-water structures that could restrict beluga passage (PCE 4), and no in-water noise that could result in the abandonment of habitat by CI belugas (PCE 5) are associated with the project. Thus, this BE focuses on potential effects of the project to PCEs 1, 2, and 3. Existing conditions for the three relevant PCEs are described below. This PCE analysis provides a baseline against which to assess whether project activities could result in a change in these PCEs that could affect CI belugas.

4.2.1 PCE 1

Intertidal and subtidal habitat in the analysis area are extensive given the high tidal range of Upper CI (see Section 4.1). In addition, there are numerous streams with medium- and high-flow accumulation that support anadromous fish.

Streams with medium- and high-flow accumulation used by anadromous fish were identified in the analysis area by Goetz (2007). Goetz (2007) conducted a GIS-based integrative, quantitative modeling analysis using 12 years of beluga aerial survey data to assess how well bathymetery, mudflats, and stream-flow accumulation could be used to predict the occurrence and distribution of CI beluga whales. This analysis indicated that a total of 29 medium- and high-flow accumulation streams occur in the analysis area (Figure 4-3). This includes 6 streams in Knik Arm, 15 streams in Turnagain Arm,

Table 4-2. Primary Constituent Elements of Proposed Critical Habitat for Cook Inlet Beluga Whales as Identified by NMFS (2009)

Primary Constituent Element (PCE)	Definition	Relevant to Proposed Project Activity?	Occurrence in Analysis Area
PCE 1	Intertidal and subtidal water of CI with depths <30 feet and within 5 miles of high- and medium-flow accumulation anadromous fish streams	Yes	All 9 species documented in Knik Arm or Upper CI. Salmon and eulachon seasonally highly to moderately abundant. Saffron cod common except mid-winter in Upper CI. Walleye pollock and yellowfin sole rare in Knik Arm. Pacific cod found in central CI, not documented in Knik Arm.
PCE 2	Primary prey species of CI belugas consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole	Yes	All 9 species documented in Knik Arm or Upper CI. Salmon and eulachon seasonally highly to moderately abundant. Saffron cod common except mid-winter in Upper CI. Walleye pollock and yellowfin sole rare in Knik Arm. Pacific cod found in central CI, not documented in Knik Arm.
PCE 3	The absence of toxins or other agents of a type or amount harmful to beluga whales	Yes	Upper CI is a designated Category 3 water body (a water for which data are insufficient or lacking to determine if any designated use is impaired); currently, no known water quality concerns or total maximum daily loads for CI
PCE 4	Unrestricted passage within or between the critical habitat areas for CI belugas	No; no in-water structures or other project features would restrict passage	NA
PCE 5	Absence of in-water noise at levels resulting in the abandonment of habitat by CI beluga whales	No; no such in-water noise would be produced by the project	NA

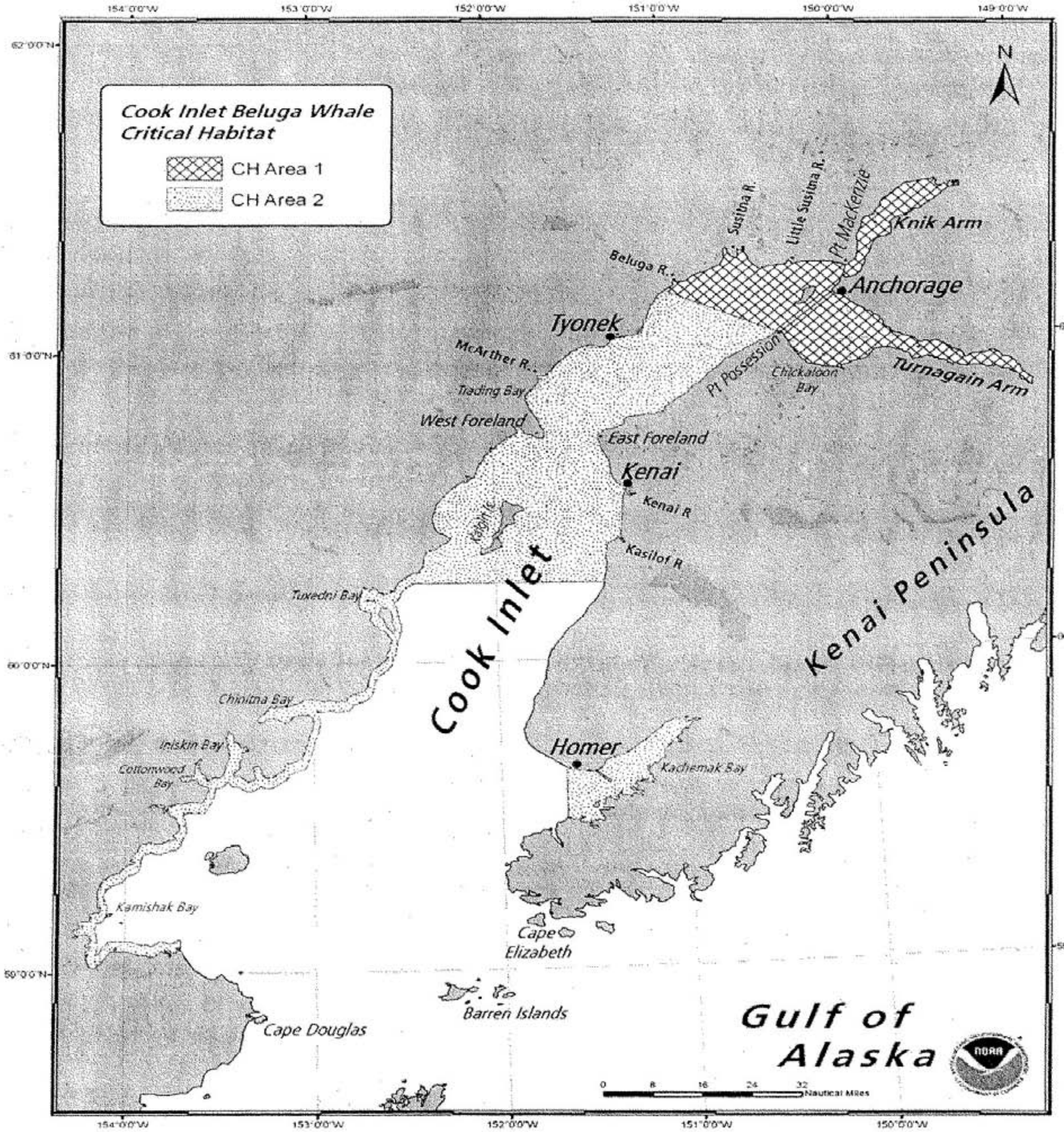


FIGURE 4-2
PROPOSED CRITICAL HABITAT FOR COOK INLET BELUGA WHALES
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

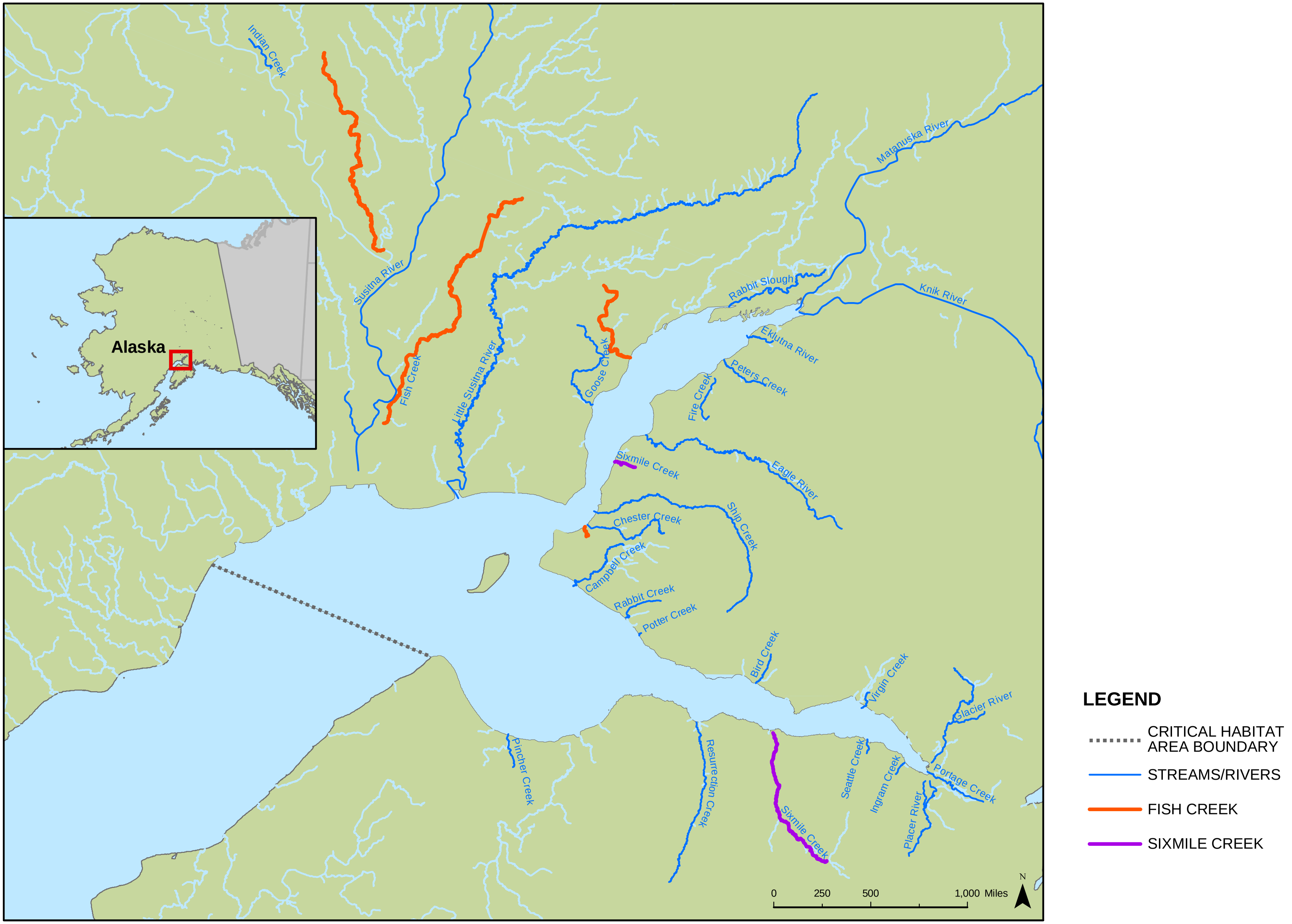


FIGURE 4-3
CRITICAL HABITAT STREAMS
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

WBG020810173433RDD_4-3

and 8 streams in waters in the analysis area outside these two arms (Table 4-3). Goetz (2007) used flow accumulation as a proxy for prey distribution, as suitable data were not available for CI. The latter assumption was based on studies showing that prey distribution varies with the rate of river runoff and primary production (Kleinenberg et al., 1964; Roberts et al., 1999). The streams and tributaries within the analysis area that are known to support anadromous fish species are identified in Table 4-3. Overall, Goetz (2007) found that belugas were associated with inlets with higher flow accumulation within the CI study area.

4.2.2 PCE 2

PCE 2 refers to the beluga whale prey species identified in Tables 4-4 through 4-6. They further indicated that there is a strong seasonal influence on the availability of each of these prey.

4.2.2 PCE 3

The definition of PCE 3 is “the absence of toxins or other agents of a type or amount harmful to beluga whales” (Table 4-2). There are currently no known water quality concerns or total maximum daily loads for CI. Upper CI is a designated Category 3 water body (a water for which data are insufficient or lacking to determine if any designated use is impaired). Assessing whether the proposed activity would result in any change to current baseline conditions in terms of water quality and potential harmful impacts to CI belugas is the primary focus of this BE and is thus described in detail in Appendices A and B. Existing baseline conditions relative to the nature of effluents discharged by AWWU at the project outfall is presented in Section 1.

Table 4-3. Streams with Medium and High-flow Accumulation used by Anadromous Fish in the Analysis Area

River/Stream/Creek	High (H) or Medium (M) Flow Accumulation[a,b]	Tributary/Flows Into
Bird Creek	M	Turnagain Arm
Bradley River	M	Susitna River/Delta
Campbell Creek	M	Anchorage, Upper CI, Turnagain Arm
Chester Creek	M	Anchorage, Upper CI
Eagle River	H	Susitna River/Delta
Eklutna River	H	Knik Arm
Fire Creek	M	Knik Arm
Fish Creek	H	Susitna River/Delta
Glacier River	M	Turnagain Arm
Goose Creek	M	Susitna River/Delta
Indian Creek	M	Turnagain Arm

Table 4-3. Streams with Medium and High-flow Accumulation used by Anadromous Fish in the Analysis Area

River/Stream/Creek	High (H) or Medium (M) Flow Accumulation[a,b]	Tributary/Flows Into
Ingram Creek	M	Turnagain Arm
Knik River	H	Knik Arm
Little Susitna	H	Knik Arm
Matanuska River	M	Knik Arm
Peters Creek	M	Turnagain Arm
Pincher Creek	M	Upper CI, mouth of Turnagain Arm
Placer River	H	Turnagain Arm
Portage Creek	M	Turnagain Arm
Potter Creek	M	Turnagain Arm
Rabbit Creek	M	Upper CI, mouth of Turnagain Arm
Rabbit Slough	M	Susitna River/Delta
Resurrection Creek	H	Turnagain Arm
Seattle Creek	M	Turnagain Arm
Ship Creek	H	Susitna River/Delta
Six Mile Creek	H	Knik Arm
Susitna River	H	Susitna River/Delta
Twenty Mile River	H	Turnagain Arm
Virgin Creek	M	Turnagain Arm

[a] Medium Flow = Flow accumulation 5063.5-140897.5 (Goetz 2007)
[b] High Flow = Flow accumulation >140897.5 (Goetz 2007)

Source: Goetz, 2007.

Table 4-4. Characteristics of 23 Cook Inlet Beluga Whales Analyzed for Stomach Contents Collected Between 2002 and 2008

Collection Date	Specimen ID	ID	Sample Date	Year	Sex	Length (cm)	Color	Cause of Death
22 July 2002	DL-CI-02-01 (692-BLKA-076)	1	22 July	2002	M	434	White	Harvest
28 September 2002	DL-CI-02-02	2	28 September	2002	F	366	White	Stranding
28/29 August 2003	28/29 August 2003	3	28/29 August	2003	M	442	White	Stranding
11 September 1999	11 September 1999	4	12 September	2003	F	372	White	Stranding
15 October 2003 Motorcross	15 October 2003 Motorcross	5	15 October	2003	M	463	White	Stranding
05 November 2003	05 November 2003	6	05 November	2003	F	369	White	Stranding
04 August 2003	DL-CI-01-03 (BLKA-079)	7	04 August	2003	F	366 (est)	White	Harvest
31 March 2003	DL 2003-017 (692-BLKA-078)	8	31 March	2003	F*	365	White/ gray	Stranding
24 July 2005 (692-BLKA-080)	24 July 2005 (692-BLKA-080)	9	24 July	2005	M	427	White	Harvest
31 August 2005 (AF68540)	31 August 2005 (AF68540)	10	31 August	2005	M	310	White	Stranding
11 October 2006 (692-BLKA-081)	11 October 2006 (692-BLKA-081)	11	11 October	2006	F*	370	White	Stranding
30 September 2006 (DL06KN001)	30 September 2006 (DL06KN001)	12	30 September	2006	F	355	White	Stranding
29 June 2007 (DL062907)	29 June 2007 (DL062907)	13	29 June	2007	M	256	Gray	Stranding
03 October 2007	03 October 2007	14	07 October	2007	F	379	White	Stranding
07 October 2007	07 October 2007	15	09 October	2007	M	423	White	Stranding
15 August 2007	15 August 2007	16	16 August	2007	M	266.2	White	Stranding
07 August 2007	07 August 2007	17	07 August	2007	F	160	Black	Stranding
01 October 2007	01 October 2007	18	04 October	2007	M	374	White	Stranding
23 July 2008	2008-CIB-05	19**	24 July	2008	U	128	Gray	Stranding
29 July 2008 2008-CIB-06	2008-CIB-06 (29 July 2008)	20	29 July	2008	U	368.3	Gray	Stranding
08 August 2008	2008-CIB-07	21	08 August	2008	F	317	White	Stranding
08 August 2008	2008-CIB-08	22	12 August	2008	F	391	White	Stranding
19 September 2008	2008-CIB-13	23**	9 October	2008	U	368	White	Stranding

* denotes pregnant

** denotes partial stomach

Source: Unpublished data courtesy of B. Mahoney, NMFS, Anchorage, AK, December 2009.

Table 4-5. Fish Species Available to Belugas in Knik Arm, Upper Cook Inlet, Alaska, by Month Based on Available Data

Month	Available Fish Species
April	Eulachon, saffron cod
May	Eulachon, Chinook salmon, saffron cod
June	Chinook salmon, saffron cod (questionable)
July	Pink, chum, sockeye, and coho salmon
August	Coho salmon, saffron cod
September	Saffron cod, longfin smelt
October	Saffron cod, longfin smelt
November	Saffron cod

Source: Houghton et al., 2005a as presented in Rodrigues et al., 2006).

Table 4-6. Stomach Contents from 15 Cook Inlet Beluga Whales Collected between 2002 and 2008 Consisting of 12 Stranded and 3 Harvested Individuals[a]

Taxon		Percent Number	Percent Frequency
Fishes (n= 14)			
Catostomidae		1	7
	Long nose sucker (*Catostomus catostomus*)	1	7
Cottidae		1	7
	Pacific staghorn sculpin (*Leptocottus armatus*)	1	7
Gadidae		42	43
	Saffron cod (*Eleginus gracilis*)	25	21
	Cod species (*Gadidae sp.*)	5	21
	Pacific cod (*Gadus macrochephalus*)	1	7
	Walleye pollock (*Theragra chalcogramma*)	11	21
Osmeridae		13	14
	Eulachon (*Thaleichthys pacificus*)	13	14
Pleuronectidae		3	14
	Yellowfin sole flounder (*Limanda aspera*)	2	14
	Starry flounder (*Platichthys stellatus*)	1	7

Table 4-6. Stomach Contents from 15 Cook Inlet Beluga Whales Collected between 2002 and 2008 Consisting of 12 Stranded and 3 Harvested Individuals[a]

Taxon		Percent Number	Percent Frequency
Salmonidae		37	71
	Chum salmon (*Oncorhynchus keta*)	8	21
	Coho salmon (*O. kisutch*)	22	36
	King salmon (*O. tshawytscha*)	1	7
	Salmon species (*Oncorhynchus sp.*)	6	29
Stichaeidae		1	7
	Slender eelblenny or snake prickleback (*Lumpenus sp.*)	1	7
Unidentified fish		2	14
Invertebrates (n= 8)			
Annelid		–	13
	Polychaete	–	13
Crustacea			
	Amphipod	–	13
	Lysianassidae (*c.f. Orchomene sp.*)	–	13
	Decapoda		
	Shrimp	–	75
	Shrimp (*Caridea sp.*)	–	38
	Shrimp (*Crangon sp.*)	–	13
	Shrimp (*Crangon alaskensis*)	–	13
	Shrimp (*C. franciscorum*)	–	13
	Shrimp unknown sp.	–	25
	Crab (*Chionoecetes bairdi*)	–	13
Mysidacea		–	13
	Neomysis rayii	–	13
Echiura		–	13
	Echiurid	–	13
Porifera		–	13
	Sponge	–	13
	Unknown Invertebrate	–	13

[a] An additional 8 stomachs were empty and are not included in this table.

Source: Unpublished data courtesy of B. Mahoney, NMFS, Anchorage, AK, December 2009.

SECTION 5

ESA Species and Critical Habitat Information

5.1 Species and Critical Habitat Presence

To identify ESA-listed species proposed for listing, and critical habitat occurring in the analysis area (defined in Section 2.7), NMFS's online species list was first reviewed (http://www.nmfs.noaa.gov/pr/pdfs/esa_factsheet.pdf). NMFS and USFWS were then contacted to verify or provide this list (Appendix J). Two marine mammal species, listed as endangered with proposed or designated critical habitats are known to occur within the analysis area: the endangered CI Distinct Population Segment (DPS) of beluga whales (CI beluga whale), listed under the authority of the NMFS, and the endangered Western Steller sea lion DPS (Table 5-1). The beluga occurs in the analysis area year-round, and the Steller sea lion is considered rare to the analysis area as described below. NMFS proposed a rule to list the CI beluga DPS as an endangered species under the ESA on April 20, 2007 (Fed. Register 72, 19854). NMFS extended the final determination date on the listing for an additional 6 months on April 22, 2008 (Fed. Reg. 73, 21578). The CI beluga whale was listed as an endangered species under the ESA on October 22, 2008 (Fed. Register 73, 62919).

Table 5-1. Federally ESA-listed or Proposed Species and Critical Habitat In or Near the Project Analysis Area

Species Scientific Name	Status	Jurisdiction	Critical Habitat	Habitat Use
Marine Mammals				
Beluga Whale DPS *(Delphinapterus leucas)*	Endangered	NMFS	Proposed; Designated December 2009 (50 CFR Part 226); encompasses analysis area and beyond	Occurs year-round in analysis area, primarily May-Sept
Western Steller Sea Lion DPS (*Eumetopias jubatus)*	Endangered	NMFS	Designated 1993 (50 CFR 226.202); includes a 20-nautical-mile buffer around all major haulouts and rookeries; none occur near the analysis area or CI waters	Uncommon in Upper CI, rare and unlikely to occur in analysis area

DPS = Distinct Population Segment

The only federally identified critical habitat that occurs in the analysis area is proposed critical habitat for the CI beluga (Table 5-1) (Figure 4-2). The western DPS of Steller sea lions occurs in CI, primarily in Lower CI (Allen and Angliss, 2009). However, there are no haulouts, rookeries, or critical habitat for Steller sea lions designated in either Upper or Lower CI. This species is considered uncommon to the Upper CI, although single individuals have been reported in Susitna River and Turnagain Arm (NMFS, 2008). All Steller sea lions sighted during aerial surveys conducted in CI in June 2001 through 2004 were south of 60˚N latitude in the Lower CI (Rugh et al., 2005).

The nearest designated critical habitat for the western Steller sea lion is located outside of CI, well outside the analysis area; thus, this species is not further addressed in this document.

The following subsections provide background information on the CI beluga whale, and proposed designated critical habitat for the CI beluga whale.

5.2 Cook Inlet Beluga Whale

This subsection describes the general biology, behavior, distribution, movements, known contaminant loads, and sources of mortality of the federally endangered stock of CI beluga whales. Emphasis is placed on providing detailed information on geographical and seasonal distribution, occurrence, movements, and foraging habits of this species. These factors are considered important to understanding potential exposure pathways for CI belugas relative to AWWU effluent.

5.2.1 Stock and Population Status

Beluga whales are circumpolarly distributed in the Arctic and Subarctic. The species shows strong site fidelity to preferred summering areas associated with high fish runs and typically moves seasonally with changes in sea ice concentrations (Jefferson et al., 2008). The global population of beluga whales is estimated to be well above 150,000 (Jefferson et al., 2008). A total of 29 stocks are currently recognized for management purposes, the largest of which occur in the Beaufort Sea, Canadian eastern High Arctic, Western Hudson Bay, and eastern Bering Sea. In Alaska, beluga whales belong to five distinct stocks, totaling nearly 103,000 belugas, based on summering habitat: Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and CI (O'Corry-Crowe et al., 1997; Allen and Angliss, 2009).

CI belugas are the most geographically and genetically isolated of the five Alaskan stocks (O'Corry-Crowe et al., 1997; Allen and Angliss, 2009). This stock was listed by NMFS as endangered under the ESA in 2008, and is depleted under the Marine Mammal Protection Act. Annual aerial surveys have been conducted by NMFS from 1994 to 2009 to monitor this population, mainly during early summer (e.g., NMFS, 2005, 2008; Allen and Angliss, 2009; NOAA, 2009). Associated abundance estimates indicate that the population declined an average of 14 percent per year during the mid-1990s (Figure 5-1). For example, from 1994 to 1998, beluga whale abundance declined from an estimated 653 to 347 whales. Since 1998, abundance estimates have declined an average of 1.49 percent per year (NOAA, 2009). The abundance estimates for 2007

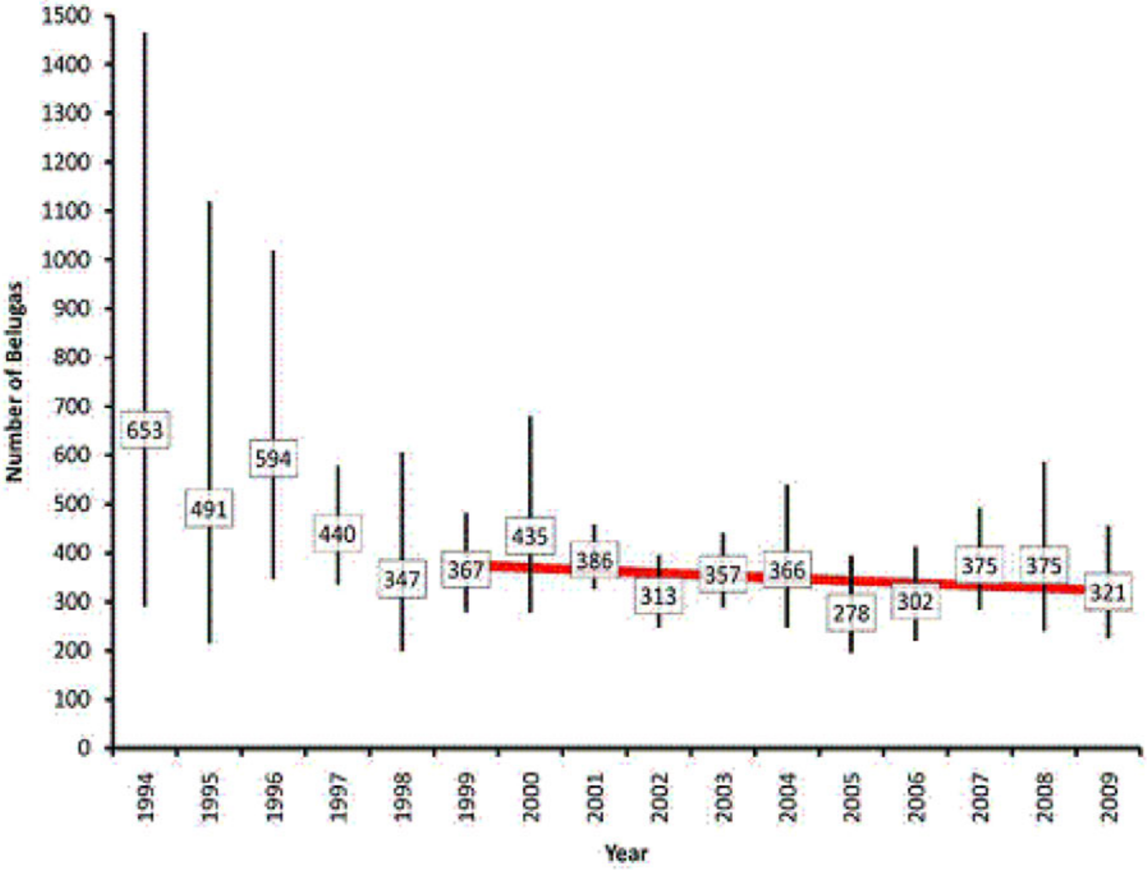


FIGURE 5-1
ABUNDANCE ESTIMATES FOR BELUGAS IN COOK INLET
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

and 2008 were 375 whales both years; the most recent 2009 estimate was 321 individuals (Allen and Angliss, 2009; NOAA, 2009) (Figure 5-1). This most recent estimate suggests that the population may still be declining (NOAA, 2009). However, the accuracy of these population estimates varies each year as indicated by the 95 percent confidence intervals displayed in Table 5-1.

5.2.2 General Biology and Behavior

Beluga whales change color from dark gray when born to white when mature at 5 to 12 years old (Jefferson et al., 2008; NMFS, 2008). White coloration implies sexual maturity in both males and females, but not necessarily social maturity (actually breeding age) for the male (Brodie, 1989). Females and males become sexually mature at ages 5 and 8 years, respectively (Jefferson et al., 2008). Adult male belugas are usually less than 5.5 meters long and weigh around 1,500 kilograms (3,307 pounds); adult females are typically less than 4.3 meters long and weigh around 1,360 kilograms (2,998 pounds) (Jefferson et al., 2008).

Breeding is seasonal, with a gestation period of about 11 to 16 months, and an inter-birth interval of 2 to 3 years (Jefferson et al., 2008; NMFS, 2008). Beluga whales calve from mid-May to mid-July (Calkins, 1983; NMFS, 2008). Alaska natives reported a slightly longer calving period from April through August, with calving believed to occur in Kachemak Bay in the lower inlet in April and May, off the Beluga and Susitna Rivers in May, and in Chickaloon Bay during summer (Huntington, 2000). Belugas with near-term fetuses have been harvested in the Susitna River delta in May; in addition, neonates are seen there throughout summer, indicating that the area may be important for calving or nursing (Huntington, 2000); however, calves are seen frequently during this period in other areas of Upper CI as well (Funk et al., 2005; NMFS, 2008). Mating is believed to occur after the calving period (NMFS, 2005, 2008). Calves nurse for up to 2 years (Jefferson et al., 2008) and likely remain with their mothers until adulthood (Braham, 1984; Norris, 1994). However, some young belugas are known to eat prey when 12 months old (Burns and Seaman, 1986). Molting occurs each summer when worn yellow skin is replaced with new white skin (Martin, 1996). Longevity is estimated at 25 to 50 years, with age of last pregnancy at about 21 years (Reeves et al., 2002; Jefferson et al., 2008; NMFS, 2008). However, some female belugas may lactate well beyond this age (Burns and Seaman, 1986).

Belugas are very social animals and typically travel, hunt, and interact together, often in tight-knit groups. Groups of 10 to more than 100 belugas are commonly seen in early summer in CI, although lone individuals and mother-calf pairs are also seen. Social structure and genetic relationships among group members are not yet well documented for CI belugas, although native hunters have noted that beluga whales apparently form consistent family groups with whales of different ages traveling together (Huntington, 2000). Beluga whales exhibit a vocal repertoire of chirps, squeals, buzzes, and trills (Reeves et al., 2002).

5.2.3 Geographical and Seasonal Distribution and Occurrence

The distribution of CI beluga whales is likely influenced by a number of inter-related variables including prey availability and location, sex/reproductive/age class of whales, and environmental conditions such as water temperature and depth, tidal stage, and sea ice cover, as well as human activities and predation pressure (e.g., killer whales are known to prey on CI belugas) (Rugh et al., 2000; Kingsley, 2002; NMFS, 2008).The current distribution of CI beluga whales appears to be limited to CI, particularly the mid-to-upper inlet north of Kalgin Island (NMFS, 2008; Allen and Angliss, 2009). Historically, CI belugas were apparently spotted outside of CI, including in Yakutat and Prince William Sound (NMFS, 2008). However, their range appears to have decreased markedly over the last 30 years, and now appears to be limited mainly to the upper northern one-half of CI; this is based on anecdotal information coinciding with decreased abundances (Speckman and Piatt, 2000; Hobbs et al., 2005, 2006; NMFS, 2008, 2009) (Appendix D, Figures D-1 through D-10).

Information on seasonal habitat use by CI belugas is limited largely to seasonal aerial survey data (e.g., Rugh et al., 2002; Shelden et al., 2003), satellite tracks for a small number of whales (e.g., Hobbs et al., 2005; NMFS, 2008) and more recently, small-vessel and shore-based surveys in Upper CI conducted in association with nearshore development (Funk et al., 2005; KABATA, 2006; Cornick and Kendall, 2008; McGuire et al., 2008; Prevel-Ramos et al., 2006). (See Appendix D for GIS maps of survey data collected on seasonal abundance and distribution of CI belugas and Figure D-9 for beluga shore station locations.) Available data indicate that the population concentrates in Upper CI during spring through fall, then spreads out and generally moves farther south to the mid-inlet during winter (Rugh et al., 2004; NMFS, 2008). However, some individuals continue to use the upper inlet during winter (Funk et al., 2005; Hobbs et al., 2005; NMFS, 2008). During spring and early summer, the highest whale numbers occur near mouths of rivers and along tidal flats, particularly the mouth of the Susitna River, but also Turnagain Arm and Chickaloon Bay (Rugh et al., 2000, 2002, Funk et al., 2005; Hobbs et al., 2005; Rugh et al., 2005; NMFS, 2008). In fall, highest numbers occur in Knik and Turnagain Arms (e.g., Funk et al., 2005; NMFS, 2008). CI belugas commonly swim several kilometers up major river systems to forage (Becker, 2000).

Seasonal and geographical movements and changes in distribution appear to be closely related to changes in the local abundance and location of prey as well as tidal fluctuations and other factors (Funk et al., 2005; Hobbs et al, 2005; NMFS, 2008). The timing, peak numbers, and locations of fish in Upper CI vary with species and river locations (Table 4-1). During spring and summer, CI belugas concentrate primarily near the Susitna River mouth during the peak of eulachon and some salmon spawning runs and the outmigration of juvenile salmon (Funk et al., 2005; Hobbs et al., 2005; Rugh et al., 2005; NMFS, 2008) (Table 4-1) (Appendix D, Figures D-3, D-6, and D-7). The eulachon run is particularly short-lived (mainly May); however, annual spawning runs of several hundred thousand to several million occur at the Susitna River every May (Calkins, 1989; NMFS, 2005) (Table 4-1). Eulachon are particularly fat-laden compared to other fish species in CI, and likely provide an important source of energy and winter fat stores for CI belugas (Moore, 2000; NMFS, 2008). Blubber thickness appears to vary seasonally. During spring, the blubber has been reported by Native CI hunters as being relatively thin (5 to 8 cm) compared to the fall (up to 30 cm)

(Huntington, 2000; NMFS, 2008). Sergeant and Brodie (1969) reported that beluga blubber may constitute up to 40 percent of an individual's body mass.

Beginning in early summer, salmon abundance increases in Upper CI and beluga numbers remain concentrated nearby at the Susitna River delta and Chickaloon Bay (Appendix D, Figures D-3, D-7, D-10). These in-migrating adult salmon provide important seasonal prey for belugas. The adult salmon have spent years feeding in the open ocean and begin to in-migrate into Upper CI to spawn in rivers where they then die; out-migration of CI juvenile salmon born in streams earlier in the year also begins in early summer in Upper CI (Table 4-1). Notably, adult eulachon and salmon do not feed during the in-migration just prior to and during spawning; out-migrating juveniles feed throughout Upper CI on invertebrates, and in Knik Arm they appear to eat primarily **terrestrial** insects (see Section 3). During late summer and fall when other species and runs of salmon begin to peak, CI belugas accordingly shift their main concentrations to these areas in Knik and Turnagain Arms and Chickaloon Bay (Funk et al., 2005; Hobbs et al., 2005; Rugh et al., 2005; NMFS, 2008) (see Appendix D).

Relatively few data are available on CI beluga distribution during the winter. However, winter occurrence is believed to be influenced by the distribution and availability of prey, similar to other seasons. This assumption is based on the movement of a small number of tagged individual belugas, a limited number of aerial surveys, and strandings. These data indicate that wintering belugas tend to occur in offshore deeper waters of the Middle to Lower CI as far south as Chinitna and Tuxedni Bays on the west side of CI (Hobbs et al., 2005). During 10 aerial surveys conducted in 1997 from mid-February to mid-March, 94 percent of 160 total whale sightings occurred in the Central CI, despite most of the 9,406 kilometers of effort occurring near shore (MMS, 1997; Hansen and Hubbard, 1999). Beluga whale sightings in January have also been reported from offshore drilling platforms south of Tyonek (Rugh et al., 2000). During this time, CI belugas are believed to forage primarily on bottom fish (e.g., cod) based on results of a small number of satellite-tagged belugas that made repetitive deep dives in the central inlet and stomach contents of a few belugas (Hobbs et al., 2005; NMFS, 2008) (Appendix D, Figures D-1, D-2, D-4, and D-5).

5.2.4 Local Movements and Residency Patterns

Most information on local movements of CI belugas has been collected from spring through fall during the ice-free season when the whales are in Upper CI. Studies indicate that at this time, beluga movement appears to be related to tidal stage and accessibility of habitat (Funk et al., 2005; Cornick and Kendall, 2008; Hobbs et al., 2008; NMFS, 2008). During low tide, belugas occur predominantly in the middle and lower portions of Knik and Turnagain Arms, when the upper inlets are largely inaccessible because of exposed mudflats. During flood tide, whales travel up the two arms and reach the now-flooded upper inlets during high tide. When ebb tide begins, belugas start traveling back down the arms. Group structure also appears to be influenced by tidal stage. During high tide, belugas tend to clump tighter together compared to low-tide periods; this suggests that their movements and destinations are coordinated with every tidal cycle (Hobbs et al., 2008). Each day in summer and fall, tagging data indicate that CI belugas travel approximately 30 to 50 kilometers in these patterns, feeding at the same river mouths depending on the season and available prey (Hobbs et al., 2008).

Although CI belugas are known to exhibit strong site-fidelity during spring, summer and fall, little is known about habitat use or residency patterns of individual belugas. Most data come from satellite-tagged belugas and, more recently, photo-identification studies. Seventeen individual belugas have been tagged with satellite or radio tags in CI for periods of up to 8 months (Hobbs et al., 2005; Allen and Angliss, 2009). Results indicate that home range size and distances traveled vary with the season. During spring through fall in Upper CI, individual belugas often remain stationary for many weeks, or move back and forth between the main aggregation areas, often with the daily tidal cycle (e.g., Susitna delta, Chickaloon Bay, Knik and Turnagain Arms) in response to fish runs (Hobbs et al., 2005). In contrast, winter movements are longer and farther. Data from 14 satellite-tagged whales indicate that the monthly home ranges were smallest in August (982 km^2), increased across fall, and were highest in winter (up to approximately 5,000 km^2) (Hobbs et al., 2005). Recent photo-identification studies indicate that a large number of belugas possess distinct natural marks that can be effectively identified and re-sighted (McGuire and Kaplan, 2009). The most recent studies include population estimates from individuals photographed in 2008 (McGuire and Kaplan. 2009).

5.2.5 Beluga Occurrence and Behavior Near the Point Woronzof Outfall

Appendix D includes figures (D-1 through D-10) showing the movement, occurrence, and behavior of Upper CI beluga whales. Over approximately the last 5 to 7 years, considerable site-specific data on the movements, occurrence, and behaviors of CI belugas have been collected near the Point Woronzof outfall location at the southern end of Knik Arm. These studies provide baseline and monitoring data for belugas in association with the ongoing Port of Anchorage Marine Terminal Development Project (http://www.portofanchorage.org/) and proposed construction of the Knik Arm Crossing (KAC) project (http://www.knikarmbridge.com/project.html). The majority of these research efforts have consisted of land-based observations, with some small-vessel surveys. The most comprehensive of these efforts near the Point Woronzof outfall were land- and small boat-based surveys in Knik Arm conducted by LGL Alaska Research Associates, Inc., for the proposed KAC project to assess spatial and temporal habitat use patterns of belugas relative to group composition and activity in Knik Arm (Funk et al., 2005). Observations were conducted daily throughout the year during daylight hours, from nine stations located on prominent points/cliffs along Knik Arm. Across all stations, 1,863 observation sessions averaging 6 hours in length were conducted for a total of 11,124 hours of land-based monitoring. In addition, 405 hours of boat-based surveys across 76 days were conducted primarily at higher stages of the tide from August to October 2004 and May to July 2005 in Knik Arm. Point Woronzof was the southernmost land station, located on a bluff near the Tony Knowles Coastal Trail and the Anchorage International Airport. The view from this station encompassed waters to the west-southwest around Fire Island and the Susitna Flats, including the AWWU outfall, as well as waters to the west and north (Funk et al., 2005).

Funk et al. (2005) revealed the following with respect to beluga distribution, occurrence, and behavior within Knik Arm and specifically, near Point Woronzof and the AWWU outfall (see Appendix D):

- Beluga use of Knik Arm was related to month, season, location, tidal cycle, and, in some areas, time of day. Overall, sighting rates were lowest in winter, increased during spring and summer, and peaked in fall. While present in Knik Arm, belugas occurred mainly in the middle to upper arm from Six Mile Creek to Eklutna.
- Throughout the year, beluga sighting rates were lowest at Point Woronzof compared to the more northern observation stations. Funk et al. (2005) suggested that this is because belugas do not feed near Point Woronzof, but rather spend most of the fall farther north in Knik Arm to remain near the most productive salmon spawning streams.
- Although sighting rates were relatively low at Point Woronzof (typically <1 whale per 20-minute sampling period), sightings were most common from August through September. Sightings began to decline in November and subsequently dropped quickly with none during the winter, and increasing again during the spring and summer months (Funk et al., 2005).
- The waters near Point Woronzof were used by belugas primarily as a transit corridor, to travel up and down and in and out of Knik Arm, compared to the other sighting stations in Knik Arm. In contrast, farther up the arm at Eagle Bay and Six Mile Creek, belugas spent more time diving and foraging and presumably feeding (Funk et al., 2005; Ireland et al., 2005). Resting was observed most frequently at the northern end of the arm near Eklutna.
- In Knik Arm, belugas followed tidal directions, currents and speeds (i.e., generally riding the flood tide north and east and riding the ebb tide south and west). Moving into Upper Knik Inlet during flood tides allows belugas to access salmon prey at the mouths of rivers that are too shallow to access during low tides (Ezer et al., 2008).
- At Point Woronzof, belugas were seen primarily during mid-tide height (approximately 15 feet) but also during a wide range of heights. In contrast, belugas in Upper Knik Arm were seen only during high tides. During lower tides, most belugas were seen and remained north of Point Woronzof, but still in the lower part of Knik Arm near Six Mile Creek and Eagle Bay.
- On average, belugas observed from shore were primarily adults (range 40 to 60 percent), followed by subadults (15 to 30 percent) and calves (≤10 percent). However, relative sighting rates of calves were higher north of Eklutna, than the area south, including Point Woronzof.
- From August through October, no large beluga groups were observed moving into or out of Knik Arm. Funk et al. (2005) suggested that most belugas may remain within Knik Arm during this period.

5.2.6 Estimated Time that Belugas Spend near Point Woronzof Outfall

A literature review was undertaken for information to approximate the proportion of time individual CI belugas may occur within 1 kilometer of the AWWU outfall. This estimate was based on the following information or assumptions considered relevant to the analysis:

- Near Point Woronzof, belugas predominantly travel (Funk et al., 2005) and thus do not appear to linger or feed in the outfall area.
- Belugas inhabit Knik Arm primarily during late summer and fall (August through December) (Rugh et al., 2004; Funk et al., 2005; Hobbs et al., 2005; Ireland et al., 2005; NMFS, 2008; ICRC, 2009), representing 25 percent of the year. Relatively few belugas are seen near Point Woronzof during winter, spring, and early summer (December through July) based on available data (Funk et al., 2005; see also previous sections).
- Belugas appear to move up and down Knik Arm twice per day during each of two sets of flood and ebb tides (Funk et al., 2005; Hobbs et al., 2005; Ireland et al., 2005; Ezer et al., 2008). Thus, each whale may pass Point Woronzof four times per day.

  However, studies indicate that most belugas that use Knik Arm during fall probably remain largely north of Point Woronzof or move into other areas of Upper CI on some days, such as Turnagain Arm or Chickaloon Bay (Funk et al., 2005; Hobbs et al., 2005; NMFS, 2008). Thus, some belugas probably do not pass Point Woronzof four times per day or even once daily.
- Average CI beluga travel speed is approximately 5 kilometers per hour based on a small number (<18) of satellite-tagged whales (Ezra et al., 2008).
- At a speed of 5 kilometer per hour, it would take ≤25 minutes for a point-to-point traveling beluga to pass the area within 1 kilometer of the Point Woronzof outfall on its way up or down Knik Arm.
- It is conservatively assumed that all belugas pass <1 kilometer from the AWWU Point Woronzof outfall (although Knik Arm is approximately 4 kilometers wide there and belugas could easily pass the Point Woronzof outfall at distances > 1 kilometer).

Considering the above, CI belugas were estimated to spend <2 percent of their lives within 1 kilometer of the AWWU outfall. This estimate was calculated by assuming that each beluga makes four 25-minute passes per day within 1 kilometer of the AWWU outfall during 25 percent of the 365 days of the year. This estimate is considered approximate and may be an overestimate given the caveats identified above (e.g., not all whales appear to use Knik Arm every day, some whales likely pass the Point Woronzof outfall at distances greater than 1 kilometer, many whales may remain farther north of Point Woronzof within Knik Arm during the fall and not pass this point four times per day).

5.2.7 Feeding/Foraging Ecology

In general, belugas are considered opportunistic feeders whose diet varies with region and prey availability (Jefferson et al., 2008). More than 100 prey species have been identified in the diet of various beluga populations (NMFS, 2003). Belugas are known to consume salmonids, small schooling and other pelagic fish, bottom fish, crustaceans, mollusks, squid and octopus, and invertebrates such as amphipods, krill, and polychaetes (Burns and Seaman, 1986; Jefferson et al., 2008; NMFS, 2008) (Figure 3-2). Data on the diet of CI belugas come mainly from stomach content analyses and anecdotal observations. Stomach analyses have been conducted primarily on stranded animals, and to a lesser extent, native-harvested whales. However, the native harvest of CI belugas ended in 2000 (NMFS, 2008), and data since then have been limited to strandings. Strandings may not be representative of healthy individuals and may wash up far from where the animal was last feeding (Jefferson et al., 2008; personal communication, B. Mahoney, NMFS, Anchorage, December 2009). Furthermore, no stomachs have been collected during winter. In addition, currently available data are based on occurrence, not net wet weight of consumed prey, and some prey are under-represented because they do not leave traceable remains. Thus, frequency of prey species can be calculated, but this is not necessarily representative of the proportion of the diet that comprises different prey species by weight.

Given the above caveats, the most comprehensive published diet studies of CI belugas have been reported by Hobbs et al. (2008). More recently, NMFS/Anchorage, in cooperation with the ADFG, has been analyzing stomach contents from 23 strandings between 2002 and 2008 consisting of 12 stranded and 3 harvested CI belugas; however, the remaining 8 stomachs were empty. Results of these ongoing analyses are presented on Figure 5-2 and in Tables 4-4, 4-5, and 4-6 (unpublished data, B. Mahoney, NMFS, Anchorage, December 2009). However, nearly all (91 percent of 23 stomachs) were collected during July through October, including the 8 empty stomachs; thus, they are representative only of the late summer/early fall diet. From the 15 stomachs with food, results indicate that CI belugas appear to feed primarily on salmon (42 percent frequency) consisting of four different species. Both adult and juvenile salmon were consumed. Cod, a bottom feeder, was the second-most frequently consumed prey item at 26 percent. The remaining prey items of note were other fishes (Figure 5-2). Invertebrates were found in nearly all (75 percent) stomachs, but occurred in very small numbers (e.g., shrimp, crab, sponges, and polychaetes).

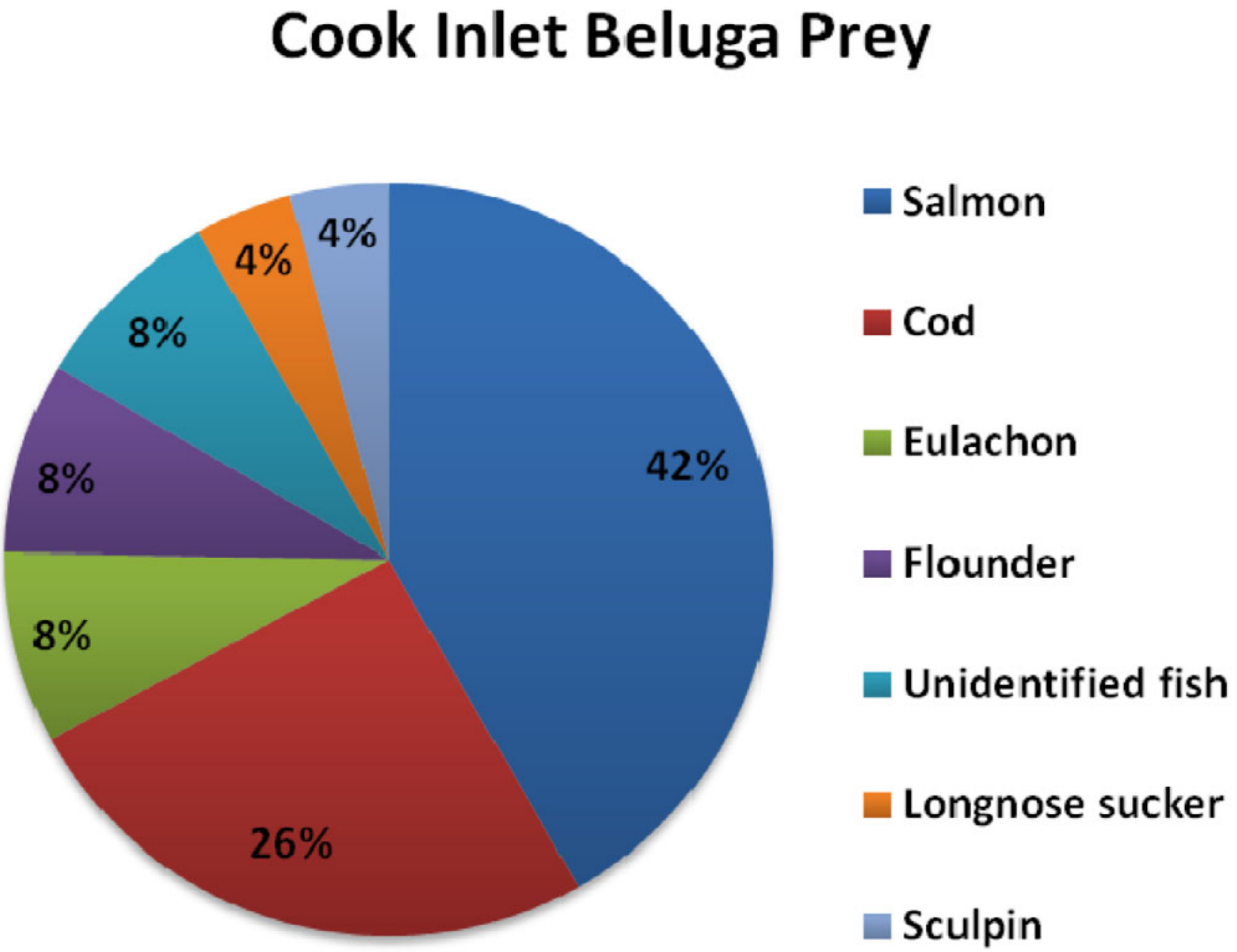
The stomach analyses are consistent with the observed concentrations and movements of CI belugas as described above. During the peaks of eulachon and salmon adult in-migration/spawning periods and juvenile out-migration periods the observed beluga diet correspondingly consists primarily of these species. However, in the summer and fall, some belugas also feed frequently on cod. During summer and fall, cod in Upper CI occur primarily near shore (Pentec, 2005); in contrast, during winter, some cod species move to deeper offshore waters where belugas also tend to occur at this time. The little available data suggest that belugas consume primarily bottom-feeding fish and other benthic species during winter. Stomach contents of a whale stranded in April included saffron cod, walleye pollock, Pacific cod, eulachon, tanner crab, bay shrimp, and polychaetes (NMFS, 2005). Although invertebrates are commonly found in beluga stomachs, it is not known whether they are consumed directly or indirectly by belugas (i.e., whether they are in whale stomachs because they were consumed by prey consumed by belugas (NMFS, 2008).

In a diet composition and trophic level study of marine mammals, Pauly et al. (1998) estimated that the overall beluga whale diet consists primarily (40 percent) of miscellaneous fishes, 20 percent benthic invertebrates, 20 percent small pelagic fishes, 10 percent meso-pelagic fishes, 5 percent small squids, and 5 percent large squids based on selected diet studies (Seaman et al., 1982; Lowry et al., 1985; Jefferson et al., 1993). These estimates are considerably higher in proportion of invertebrate consumption by belugas than indicated by the CI beluga stomach analyses, in which fish were far more frequently consumed than invertebrates). Pauly et al. (1998) also calculated that this diet places belugas at a relatively high trophic level (4.0) due to their proportionally high consumption of animals (on a scale for marine mammals ranging from 3.2 for largely invertebrate-consuming baleen whales to 4.5 for the mammal-consuming killer whale). In captivity, beluga whales may consume a daily average of 2.5 to 3 percent of their body weight in fish (NMFS, 2000). However, they are expected to consume more in the wild where they expend more energy traveling long distances. For example, beluga swim speed during typical foraging dives is about 1 to 2 meters per second (4 to 7 feet per second) and dives last 12 to 20 minutes, with roughly 5 minutes between dives (Martin, 1996).

Differential feeding habits by age and sex class have been reported for belugas in Alaska. Subadult belugas fed on small prey such as shrimp, adult females more often consumed small fish, and adult males generally preyed on larger fish such as adult salmon (Lowry et al., 1985). Feeding preferences by age/sex class are not known for CI belugas. It has been suggested that CI belugas may rely on the abundance of high-fat fish during spring through fall to build up fat reserves to sustain them through a relatively meager winter (Huntington, 2000; Moore et al., 2000). This suggestion reflects a combination of anecdotal data and small sample sizes. In 1986, 13 spaghetti tags deployed on adult salmon migrating up the Susitna River were collected from the stomach of a male beluga found dead in CI (Calkins, 1989). Native hunters found adult king salmon *(O. tshawytscha*) up to 4 feet long in the stomachs of harvested whales (Huntington, 2000).

5.2.8 Contaminants

CI belugas were found to have the lowest known levels of contaminants (e.g., polychlorinated biphenyls [PCB], chlorinated pesticides, heavy metals) in their blubber compared to eight other Arctic and North American beluga populations (Becker et al., 2000) (see Appendix C). This is despite their concentrated numbers for more than half of each year near Anchorage, an area exposed to substantially more human-related activities than belugas from the Arctic (Becker et al., 2000). CI belugas also had relatively low levels of mercury, selenium, and cadmium in their livers compared to the other beluga populations examined. Relative to other POCs, chlordane contributed substantially less to the total burden of compounds in CI belugas than in any of the



SOURCE: UNPUBLISHED DATA COURTESY OF B. MAHONEY, NMFS, ANCHORAGE, AK, DECEMBER 2009).

FIGURE 5-2
PERCENT FREQUENCY OF PREY ITEMS FOUND IN STOMACH CONTENTS OF 15 COOK INLET BELUGA WHALES
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

other belugas (Becker, et al. 2000). POC levels in CI beluga males were higher than those in CI females; however, this relative difference was considerably less than for the eastern Chukchi and Beaufort Sea populations. Becker et al. (2000) suggested that the substantially lower contaminant levels found in the CI whales may reflect a difference in where and how they are being exposed to contaminant compounds (e.g., different geography or food web). Given the lower POC concentrations in the CI belugas, Becker et al. (2000) concluded that potential effects of PCBs and chlorinated pesticides on their health may be less significant than for the other beluga populations studied. However, Becker et al. (2000) noted that very little is known about the potential role of multiple stressors on the health of individual whales and populations. Low levels of contaminants in a small, potentially declining population of CI belugas, combined with other potential stressors (e.g., biotoxins, infections, parasites, physical environment, periodic food shortages, and predation) could potentially compromise animal health (Becker et al., 2000). Becker is currently conducting contaminant analyses for NMFS/Anchorage, of beluga tissue collected since the earlier study, and is re-examining the same tissues for other POCs; this report is expected to be publicly available in spring or summer 2010 (personal communication, B. Mahoney, NMFS, Anchorage, December 2009).

5.2.9 Mortality

As with many cetaceans found in shallow, tidal habitats, beluga whales may strand during low tide. Stranding events are fairly common in CI, with reports of 804 stranded beluga whales in Upper CI, mostly in Turnagain Arm, between 1988 and 2005 (NMFS, 2005). Most mass strandings coincide with spring tides when belugas may be beached for more than 10 hours (NMFS, 2000). Although most whales survive these stranding events, at least 129 mortalities have been associated with stranding in this 17-year period (7.6 per year, NMFS, 2005). Stress, hyperthermia and damage to internal organs were often the causes of death (NMFS, 2005).

Killer whale predation is a documented, though apparently uncommon, cause of mortality for CI belugas (NMFS, 2000; Huntington, 2000). Belugas occasionally strand in tidal areas, apparently to avoid killer whale predation (Huntington, 2000). From 1985 to 2002, a mean of more than one beluga whale per year died from killer whale predation or stranding to avoid killer whales (Moore et al., 2000; Shelden et al., 2003).

The relative significance of documented endoparasite loads in beluga whale mortality rates is unknown (NMFS, 2000; Williams et al., 2005). CI beluga whales are not generally prone to entrapment in sea ice, a common cause of mortality in arctic beluga populations (Moore et al., 2000). Direct mortality due to vessel strikes and fishing net entanglements rarely occur in CI and do not currently appear to be a significant threat to CI beluga whales (NMFS, 2000; Moore et al., 2000).

5.3 Proposed Designated Critical Habitat for the Cook Inlet Beluga Whale

On April 14, 2009, NMFS released an advance notice of proposed rulemaking to identify issues to consider and evaluate when designating critical habitat for CI beluga whales (Federal Register 74, 17131). Critical habitat was proposed for this endangered stock by NMFS on December 2, 2009 (Federal Register. 74, 63080), to include ‘‘specific areas’’ identified by NMFS as occupied by the CI beluga. The proposed critical habitat includes all areas of Upper CI (Knik and Turnagain Arms) to south of Kalgin Island, Kachemak Bay, and nearshore waters from Tuxedni Bay to Kamishak Bay (Figure 4-2).

NMFS separated the proposed critical habitat into Area 1 and Area 2. Area 1 encompasses 1,918 km^2 of CI northeast of a line from the mouth of Three Mile Creek (61° 08.5′ N., 151° 04.4′ W.) to Point Possession (61° 02.1′ N., 150° 24.3′ W.) (50 CFR Part 226) (Figure 4-2). Area 2 consists of 5,891 km^2 of habitat with less-concentrated spring and summer beluga use, but known fall and winter use areas. It is located south of Area 1, north of a line at 60° 25.0’ N, and includes nearshore areas south of 60° 25.0’ N. along the west side of CI and Kachemak Bay on the east side of Lower CI (50 CFR Part 226) (Figure 4-2). The analysis area used to assess the potential effects of the proposed activity on CI belugas includes all of Area 1 and a large portion of Area 2, extending to the Forelands.

NMFS identified five PCEs in the proposed ruling that are considered “essential to the conservation of CI beluga whales,” all of which are present in the analysis area. These PCEs were described in Section 4.2.

SECTION 6

Essential Fish Habitat

6.1 Background

The Essential Fish Habitat (EFH) guidelines (50 CFR 600.05-600.930) outline the process for federal agencies, NOAA Fisheries, and the Fishery Management Councils to satisfy the EFH consultation requirement under Section 305(b(2)-(4)) of the Magnuson-Stevens Act. As part of the EFH consultation process, the guidelines require federal action agencies to prepare a written EFH Assessment describing the effects of that action on EFH (50 CFR 600.920(e)(1)). This section has been prepared to satisfy that requirement.

EFH is defined as “those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C 1802(10). For the purpose of interpreting this definition of EFH: “*waters* include aquatic areas (marine waters, intertidal habitats, and freshwater streams) and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; *substrate* includes sediment, hard bottom, structures underlying the waters, and associated biological communities; *necessary* means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and *spawning, breeding, feeding, or growth to maturity* covers a species' full life cycle (50 CFR 600.10).

The Sustainable Fisheries Act of 1996 (Public Law 104-297) amended the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (now called the Magnuson-Stevens Act [MSA]) to provide an Essential Fish Habitat (EFH) description in federal Fishery Management Plans (FMPs) and to require federal agencies to consult with NMFS on activities that may adversely affect EFH. Eight regional fishery management councils were established for the purpose of managing fisheries from 3 to 200 miles offshore of the United States coastline and for developing FMPs in conjunction with NMFS.

The North Pacific Fishery Management Council (NPFMC) is responsible for fisheries off the coasts of Alaska and has developed five specific FMPs:

- Bering Sea and Aleutian Island Groundfish
- Gulf of Alaska Groundfish
- Bering Sea and Aleutian Island King and Tanner Crab
- Alaska Scallops
- Alaska Stocks of Pacific Salmon

6.2 EFHs Analyzed

The presence of the EHFs in the action area were determined using the EFH mapping tool provided by NOAA Fisheries Alaska Regional Office for the North Pacific Region (http://sharpfin.nmfs.noaa.gov/website/EFH_Mapper). The mapping tool showed that only two of the five EFHs in the North Pacific Region are found in the action area, as well as in the upper half of Cook Inlet. These EFHs were **Pacific Salmon** and **Gulf of Alaska Groundfish**.

The Pacific Salmon EFH consists of five species of salmon (Chinook, sockeye, chum, coho, and pink salmon). The EFH mapping tool indicates that all five species are present in Cook Inlet, however, the data from the mapping tool states that only the lifestages of marine juveniles and marine immature and maturing adults would potentially be present in the area potentially affected by the WPCF structure and discharge (the upper half of Cook Inlet). The Gulf of Alaska Groundfish EFH consists of 22 species plus a general forage fish complex. Location specific data for the upper half of Cook Inlet retrieved from the EFH mapping tool states that only sharks, octopus, shallow water flatfish complex big skate, and longnose skate are present and no data indicating specific lifestages presence is available. However, it is reasonable to assume at least immature and maturing adults of these species are present and that other groundfish species such as Pollock, cod, sculpins, along with a few other groundfish species are present in the upper half of Cook Inlet at least during a portion of the year. The stomach samples taken from Beluga whales (Figure 5-2) appear to support this, although these species could have been eaten elsewhere..

Within an EFH, NOAA Fisheries also identifies particularly sensitive and ecologically important habitat zones designated as Habitat Areas of Particular Concern (HAPC). HAPCs are specific subsets of EFH and contain extremely important ecological functions and/or areas that are especially vulnerable to human-induced degradation. A search of the EFH mapping database found no HAPCs in the upper half of Cook Inlet.

6.3 EFH Effects Analysis and Determinations

There are three components of the outfall that could potentially affect the EFH for salmon and groundfish within the action area. These are:

- The outfall diffuser at the end of the discharge pipe is a physical structure that rises up from the seafloor.
- The physical force of the effluent that emanates from the diffuser.
- The water quality characteristics of the effluent within the action area (e.g. the edge of Zone of Initial Dilution, or ZID, as described in Section 3).

Physical Structure

The diffuser is a structure located about 800 feet offshore. It is a structure that is 84 inches in diameter and rises up from the sea floor about 20 feet. During the tidal cycle it is located 12 to 41 feet below the surface. This structure has no moving parts in which to injure fish, nor is it’s footprint of any consequence to the bottom habitat relative to the action area as a whole. Therefore, there will be No Adverse Effect of the physical presence of the diffuser structure on either the salmon or ground fish EFH.

Physical Force

The physical force of the effluent coming out of the diffuser will not affect fish behavior or habitat within the action area. As stated in Section 2.3.1 (Physical Characteristics), the Knik arm is subjected to a diurnal tide with a range of about 30 feet (with extreme tides being 39 feet). This extreme fluctuation can result in tidal currents of up to 8 feet per second. This velocity is somewhat lower than estimated discharge velocity (about 11 feet per second) of effluent from the diffuser. However, both velocities are extreme and both would affect a fishes swimming ability to some degree and the diffuser discharge is highy localized. Therefore, there will be No Adverse Effect due to the physical force of the effluent coming out of the diffuser structure on either the salmon or ground fish EFH.

Water Quality

Appendix A of this Biological Evaluation analyzed the potential toxicological effects of the effluent from the Asplund WPCF on the prey species of beluga whales. Salmon and groundfish constitute the largest portion of the diet for beluga whales (see Section 5). The conclusion of this analysis was that, based on the effluent concentrations discharged from the Asplund WPCF and the resulting receiving water concentrations of Parameters of Concern (POCs) *at the edge of the ZID* (action area), none of the toxicological concentrations exceeded the prescribed endpoints for native fish species. Therefore, there would be no effect on the EFHs within the action area.

Toxicological concentrations *within the ZID* may exceed some of the prescribed endpoints for some of the POCs for some species within the two EFHs during certain periods of time, but this was not evaluated in Appendix A. However, the area within the ZID represents only a very small portion of habitat within Upper Cook Inlet and is subjected to extreme tides that results in variable flushing and dilution throughout the entire ZID. In addition, the analysis in Appendix A states that whole effluent testing (WET) conducted quarterly at the Asplund WPCF on certain test species (top smelt, oysters, and mussels) for the past ten years showed an absence of toxicity to top smelt, a species that can be considered as sensitive to the fish in each EFH. The WET testing was conducted using 5 different dilution levels of effluent, including one that was 4 times higher than that at the edge of the ZID (action area). Therefore, there would be no effect on the EFHs relative to water quality at the edge of the ZID and would not adversely affect the EFHs within the ZID.

Overall EFH Effect Determination

The presence of the Asplund WPCF diffuser pipe and the discharge WPCFs effluent into action area (edge of the ZID) will not effect either the Pacific Salmon EFH or the Gulf of Alaska Groundfish EFH. If the area within the ZID is to be considered by NOAA fisheries relative to their analysis of EFH, the project will not adversely affect either the Pacific Salmon EFH or the Gulf of Alaska Groundfish EFH within the ZID.

SECTION 7

Effects Analysis Summary

7.1 Effects

The following sections address the effects of the project on beluga whale and prey species.

7.1.1 Mixing

Nearfield and farfield hydrodynamic modeling were used to understand the mixing, dilution, transport, and fate of Asplund WPCF constituents dissolved in the water or adsorbed/adhering to suspended solids. Considering the objectives of the BE, the model UDKHDEN was used to calculate the initial dilution of the plume as it exits at the Asplund WPCF diffuser. To supplement the nearfield initial dilution modeling, a farfield hydrodynamic model of Upper CI was developed using the EFDC model. The EFDC farfield model and results are described in Appendix F.

Model runs were conducted for two primary scenarios, one having to do with the no decay rate for constituents and a second showing the mixing and dilution when decay rates for POCs are considered. Each scenario was then run for summer and winter conditions.

Transport model results are presented in Appendix F.

7.1.2 Species and Habitat Presence

The USFWS and NMFS species lists were reviewed and the Services were contacted to confirm the endangered species list (Appendix J). The CI beluga whale was identified as a DPS and endangered species in CI. Prey species are listed in Section 5 of this report, and PCEs are described in Section 4 of this report. Table 6-1 provides the status of the CI beluga whale.

Table 7-1. Status of Cook Inlet Beluga Whale

Evolutionarily Significant Unit or Distinct Population Segment	Status	Presence in Action Area	Life Stage	Potential Exposure
Fish				
None				
Marine Mammals				
Cook Inlet beluga whale	Endangered	Resident/Migration	Adults/calves and juveniles	Ingestion, absorption

7.1.3 Effects Analysis

The effects analysis evaluates the likelihood that species will be exposed to POCs by their presence in the study area and through the food web. A detailed analysis of the potential for exposure to regulated and unregulated (emerging pollutants of concern) constituents, including metals, from the Asplund WPCF discharge to have either a direct or indirect effect through bioconcentration is presented in Appendices A and B.

This BE focuses on the discharge of all constituents and potential effect on the beluga whale regardless of water quality standards. However, the Asplund WPCF discharge must comply with Alaska Water Quality Standards as part of the certification of the NPDES permit under Section 401 and 301(h) of the CWA. Water Quality Standards are established in accordance with EPA's Aquatic Water Quality Criteria, which are devised to be protective of designated uses, including habitat for indigenous populations of fish, shellfish, and marine wildlife. The Asplund WPCF discharge meets all applicable water quality standards and effluent limitations established in its current NPDES permit.

7.1.3.1 Total Suspended Solids

TSS, suspended sediment, and turbidity provide different measurements of suspended particles in water. The EFDC model (Appendix F) analyzed the fate and transport of suspended solids discharged from the Asplund WPCF and information on the background load of suspended solids discharged in Upper CI from snow and glacial melt rivers and streams.

Primary findings from the model and this evaluation are: (1) the discharge of suspended solids from Asplund WPCF is de minimus relative to the extremely large load of sediment discharged naturally from rivers and streams, (2) the extreme tidal energy re-suspends a great deal of the sediment, creating marine bottom dunes, significant reconfiguration of the bathymetry, and (3) low quality of the substrate habitat leading to lower density of benthic organisms.

The discharge of suspended solids from the WPCF into a natural background of high turbidity and suspended solids marine environment does not interfere with beluga feeding.

Suspended solids from the discharge are unlikely to pose any risk or harm to aquatic life, including threatened beluga prey for several reasons: (1) TSS will be exposed to significant dilution after passing through the diffuser into the receiving water, (2) actual discharges of TSS are beneath the effluent limit, and (3) TSS from Asplund WPCF does not physically accumulate over time because it disperses broadly through high tidal energy and tidal activity in Upper CI.

The TSS limits will be protective of beluga whale and prey species, and will not result in a reduction of food supply. Adverse effects to beluga whales are unlikely because of the limited time the whale is migrating past the analysis area, and its prey species has no habitat requirement to enter or remain in the mixing zone. Therefore, the Asplund WPCF discharge of TSS is **not likely to adversely affect** the beluga whale or its prey species.

7.1.3.2 Biochemical Oxygen Demand

The amount of available oxygen in marine systems depends on several factors, including salinity, temperature, atmospheric exchange, barometric pressure, currents, upwellings, tides, ice cover, and biological processes (e.g., respiration and photosynthesis). Oxygen levels are highest in the surface water portion of marine and estuarine areas. Atmospheric exchange occurs at the surface, and sufficient light can penetrate surface waters to allow the oxygen-releasing processes of photosynthesis to occur (Davis, 1975a). In the euphotic zone, photosynthesis may exceed respiration, and there is a net production of oxygen; below the euphotic zone, a net consumption of oxygen occurs (Davis, 1975b).

Oxygen is essential for the respiration of most marine and estuarine organisms. Reduced oxygen levels have been shown to cause lethal and sublethal effects (physiological and behavioral) in a variety of organisms, especially in fish. Physiological studies indicate that reduced dissolved oxygen (DO) levels restrict the ability of fish to maximize metabolic processes (Birtwell, 1989). Consequently, the growth rates of fish are affected by reduced DO levels; reductions in the growth rate of salmon have been recorded at levels as high as 7 mg/L (EPA, 1986). Sockeye salmon showed signs of elevated blood and buccal pressure and an increased breathing rate at concentrations below 5.07 mg/L (Randall and Smith, 1967).

As oxygen availability is reduced in the aquatic environment, fish respond by attempting to maintain oxygen uptake by modifying their behavior, including avoidance, reduced feeding, and reduced swimming capacity. Under simulated estuarine conditions, juvenile Chinook salmon avoided DO levels less than 7 mg/L (Birtwell, 1989). For the coho salmon, DO concentrations lower than 4.5 mg/L caused erratic avoidance behavior (Whitemore et al., 1960). Reduced maximum swimming speeds were observed in coho and sockeye salmon below the ranges of 11.3 percent (9.17 mg/L) and 9.17 percent (8.53 mg/L), respectively (Davis et al., 1963; Brett, 1964). Reduced disease resistance and fecundity have also been reported for fish living under depressed DO conditions (Davis, 1975a, 1975b; Sprague, 1985).

Solubility of oxygen decreases as temperature increases and decreases with decreasing atmospheric pressure associated with elevation or barometric change of weather. High water temperature, which reduces oxygen solubility, can compound the stress on fish caused by marginal DO (Bjornn and Reiser, 1991). As with other constituents, such as metals, suspended solids, and temperature, the early life stages of fish (egg, embryo, alevin) are the most sensitive life stage to alterations of DO. Juvenile salmonids may be able to survive when DO concentrations are relatively low (less than 5 mg/L), but growth, food conversion efficiency, and swimming performance will be adversely affected.

The CWA requires the Administrator to determine that a discharge meets all applicable state-adopted water quality standards and EPA-established water quality criteria as one of nine criteria allowing publicly owned treatment works discharging to deep marine waters to receive a modification of NPDES permit requirements for secondary treatment. The state water quality standards and aquatic water quality criteria for DO are established to be protective of sensitive species.

The Asplund WPCF meets all water quality standards and requirements including DO standards. Moreover, the effluent quickly mixes with the receiving marine waters so the DO from the discharge rises within a relatively short distance. Therefore, the DO in the outfall discharge is **not likely to adversely affect** listed fish species and will have no effect on the beluga whale or prey species.

7.1.3.3 Temperature

Water temperature, along with salinity, is one of the most important physical factors affecting marine and estuarine organisms. Temperature affects almost every physical property of seawater and, likewise, many chemical and biological processes. Chemical equilibrium constants, solubilities, and the rates of chemical reactions are temperature-dependent (Whitehouse, 1984). Temperatures in the coastal and estuarine waters vary considerably depending on location, depth, freshwater inputs, extent of ice formation, upwellings, and currents (Dera, 1992). Often, there is a pronounced seasonal variability in nearshore surface temperatures.

Most marine and estuarine organisms are poikilotherms (i.e., cannot regulate their internal temperatures). As a result, biological processes, such as photosynthetic and respiration rates, spawning, uptake of toxic substances, and behavioral patterns, all respond to changes in temperature (Strickland, 1965; Houston, 1982; Aiken and Waddy, 1990). Because water temperature is important to biological process and the marine environment is variable with respect to temperature, organisms must be responsive to this variability. Many marine and estuarine organisms can adjust to alterations in ambient water temperatures through a variety of biological responses. This ability to acclimate can include behavioral, morphological, physiological, or biochemical responses. The length, frequency, and severity of exposure to temperature extremes, as well as thermal history, are important determinants of an individual organism's response to temperature changes and ability to acclimate (Fry, 1971; Hochachka and Somero, 1971; Thompson and Newell, 1985).

Water temperature affects the distribution, health, and survival of native salmonids and other aquatic organisms by influencing their physiology and behavior. Temperature-dependent life stages for salmonids include spawning, egg incubation, emergence, rearing, smoltification, migration, and pre-spawn holding. Small increases in temperatures (e.g., 2-3°C) above biologically optimal ranges can begin to reduce salmonid fitness in some of these life stages (EPA, 2001).

Water temperature changes that are not lethal can produce a wide variety of significant sublethal effects. For example, temperature changes can significantly affect photosynthesis, respiration, susceptibility to disease, osmoregulation, uptake of pollutants, susceptibility to the toxic effects of pollutants, and various behavioral patterns, including physical activity, reproduction, feeding, growth, migration, distribution, intra- and inter-specific competition, predator-prey relationships, community composition, and parasite-host relationships (Kinne, 1963).

The effects of extremely high temperatures include insufficient supply of oxygen, failures in process integration, desiccation (intertidal organisms), enzyme inactivation, change in lipid state, increase in protoplasmic viscosity, increase in cell membrane permeability, protein denaturation, and release of toxic substances from damaged cells. Death can result from exposure to either extremely high or extremely low water temperatures (Kinne, 1963).

The effluent discharge temperature from Asplund WPCF typically ranges between 11 degrees centigrade and 14 degrees centigrade. The temperature of the effluent discharge is warmer than the receiving marine waters, but not by a large amount. Calculations for the mixing zone have determined that the effluent temperatures equilibrate to approximately 11 degrees centrigrade at the edge of the mixing zone. Therefore, temperature effects of the effluent, if any, will be limited to such a small area as to be insignificant in terms of fish population survival, reproduction, and growth. Beluga whale and its prey species easily avoid the discharge and, as noted in Sections 4 and 5, have no habitat requirements within the mixing zone. Therefore, the temperatures of the discharges are **not likely to adversely affect** the beluga whale or its prey species.

7.1.3.4 Total Residual Chlorine

The main sources of reactive chlorine species to the environment are from wastewater treatment plants, cooling water effluents, drinking water system spills, and uncollected releases of drinking water. The chemistry of chlorine in fresh and marine waters is very complex, and numerous terms describing the various reactive forms of chlorine species are used in the literature. In general, the reactive chlorine species found in marine waters are referred to as chlorine-produced oxidants. These include bromine species (e.g. bromochloramines, bromamines, etc.) as the bromide ions present in marine systems are highly reactive with chlorine. Following is a summary of available marine literature for toxicity studies of chlorine on marine fish reviewed in the Canadian Water Quality Guidelines (Canadian Council of Ministers of the Environment, 1999):

The lowest reported chlorine acute toxicity values for fish are two 96-h LC_{50} values for plaice (*Pleuronectes platessa*) of 24 µg/L (larvae) and 28 µg/L (adult) (Alderson, 1970), a 48-h and 96-h LC_{50} for inland silversides (*Menidia beryllina*) of 37 µg/L (Roberts et al., 1975) and 128 µg/L (Fisher et al., 1994), respectively, and a 48-h LC_{50} for striped bass (*Morone saxatilis*) of 40 µg/L (Middaugh, 1977). Holland et al. (1960) also reported a 96-h LC_{50} for juvenile pink salmon (*O. gorbusha*) of 50 µg/L and a 24-h LC_{40} of 50 µg/L and a 72-h LC_{100} of 100 µg/L for juvenile Chinook salmon (*O. tshawytscha*). Fisher et al. (1999) reported a 96-h LC_{50} of 65 µg/L for inland silversides (*M. beryllina*).

The lowest reported chlorine chronic toxicity values for fish are a 9-d LC_{50} of 80 µg/L for coho salmon (*O. kisutch*) (Holland et al., 1960) and an 8-d LC_{50} of 120 µg/L for plaice eggs (*P. platessa*) (Alderson, 1970). Chronic toxicity studies for invertebrates include a 239-d EC_{50} (inhibition of shell growth) of 25 µg/L for littleneck clams (*Protothaca staminea*) (Hillman et al., 1980) and a 25-d LC_{10} of 140 µg/L for eastern oysters (*C. virginica*) (Scott and Middaugh, 1978).

Water Quality Standards for State of Alaska for marine waters set the total residual chlorine concentration to not exceed 13 µg/L (on a 1-hour average) acute, and 7.5 µg/L (4-day average) chronic for marine life.

The Asplund WPCF discharge of residual chlorine is far below the level required by state water quality standards and below the standard required in the Asplund NPDES permit. Because chlorine does not bioconcentrate, it is expected that chlorine discharges will have **no effect** on the beluga whale through dietary exposure or loss of prey availability. Additionally, the total residual chlorine from the Asplund WPCF will have insignificant and discountable effects on the fish that may swim through area of discharge; therefore, the total residual chlorine effluent is **not likely to adversely affect** the fish species in the action area.

7.1.3.5 Ammonia

Ammonia occurs naturally in water at low concentrations in equilibrium with other inorganic nitrogen compounds. Ammonia commonly enters the environment as a result of municipal, industrial, agricultural, and natural processes. Natural sources of ammonia include the decomposition or breakdown of organic waste matter, gas exchange with the atmosphere, forest fires, and nitrogen fixation processes. Point sources of ammonia include emissions and effluents from industrial plants, fertilizer plants, and oil refineries (Environment Canada, 1997; CCREM, 1987). Non-point sources of ammonia include agricultural, residential, municipal, and atmospheric releases.

Ammonia is highly soluble in water, and its speciation is affected by a wide variety of environmental parameters including pH, temperature, and ionic strength. In aqueous solutions, an equilibrium exists between un-ionized (NH_3) and ionized (NH_4^+) ammonia species. Un-ionized ammonia refers to all forms of ammonia in water with the exception of the ammonium ion (NH_4^+) (Environment Canada, 1997; CCREM, 1987). Ammonia is toxic to fish and other aquatic life when it is in the un-ionized form. It is thought that the un-ionized form is more toxic because these neutral molecules may pass through biological membranes more readily.

Fish are adept at sensing and avoiding very low concentrations of ammonia. Furthermore, fish have been reported to enter waters that contain acutely toxic concentrations of ammonia without suffering any obvious long-term effects, as long as these excursions are followed by periods in which the fish are in waters that contain ammonia concentrations below acute toxicity levels (Thurston et al., 1981). Concentrations of ammonia acutely toxic to fishes may cause loss of equilibrium, hyper-excitability, increased breathing, cardiac output and oxygen uptake, and, in very high concentrations, convulsions, coma, and death. At lower concentrations, ammonia has many effects on fishes, including a reduction in hatching success, reduction in growth rate and morphological development, and pathologic changes in tissues of gills, livers, and kidneys (EPA, 1999c). Factors that have been shown to affect ammonia toxicity include DO concentration, temperature, pH, previous acclimation to ammonia, fluctuating or intermittent exposures, carbon dioxide concentration, salinity, and the presence of other toxicants (EPA, 1999c). Invertebrates are generally more tolerant than fishes to the acute and toxic effects of ammonia (EPA, 1986). The following summary of toxicological testing is from the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (Canadian Council of Ministers of the Environment, 1999).

Studies conducted by Thurston et al. (1984) found that sensitivity of fish to un-ionized ammonia (NH_3) concentrations ranged from 0.01 to 0.07 mg/L over a period of 5 years.

No correlation between ammonia concentration and number of eggs produced was observed in the parental generation. Pathological lesions in the gills and extensive tissue degradation in the kidneys were directly correlated with ammonia concentrations above 0.04 mg/L, after 4 months of exposure.

Sockeye salmon (*O. nerka*) were exposed to total ammonia for 62 day from fertilization to hatching (Rankin, 1979). Concentrations of un-ionized ammonia were calculated and ranged from 0.00097 to 4.92 mg NH_3/L at 10°C and pH 8.2 and hatchability was the measured endpoint. Hatchability was 63.3 percent, 49 percent and 0 percent in controls at 0.12 mg/L and 0.46 mg/L, respectively. An effects concentration 20 (EC20) was calculated for this study by Environment Canada (1999) with correction for control mortality. The reported EC20 was 0.057 mg/L un-ionized ammonia. Bader and Grizzle (1992) exposed catfish (*Ictalurus punctatus*) fry to ammonia in a 7-day static renewal test. An inhibitory concentration 20 (IC20) for fry growth was determined by Environment Canada (1999) at 0.162 mg/L un-ionized ammonia. There was no incremental mortality up to 0.490 mg/L exposure. Smith et al. (1984) conducted a 30-day early life-stage test on bluegill sunfish (*Lepomis macrochirus*). The test exposed 28-day old embryos and monitored them to the swim-up fry life stage. No significant reduction was found in percent of hatch up to a concentration of 37 mg/L un-ionized ammonia. However, larvae were deformed and generally died within 6 days. An IC20 (survival and growth) of 0.060 mg/L was calculated (Environment Canada 1998) for this study.

The NPDES permit for the Asplund WPCF establishes an effluent discharge concentration of ammonia at 1,774 mg/L. The effluent achieves a monthly maximum discharge concentration far below this required level, averaging approximately 22.5 mg/L. These low ammonia concentrations in the effluent are diluted within a relatively short distance from the diffuser. Ammonia is **not likely to adversely affect** the beluga whale or its prey species.

7.1.3.6 pH

The pH of natural waters is a measure of the acid-base equilibrium achieved by the various dissolved compounds, salts, and gases in the water and is an important factor in the chemical and biological systems of natural waters. The pH of marine waters is usually stable because of the buffering capacity from strong basic cations such as sodium, potassium, and calcium. Normal pH values in seawater are 8.0 to 8.2 at the surface, decreasing to 7.7 to 7.8 with increasing depth (Capurro, 1970). Higher pH occurs at the surface because of solar radiation, which promotes photosynthesis and increases surface temperature. Both of these processes decrease the amount of free carbonic acid, resulting in increased pH.

Changes in pH affect the degree of dissociation of weak acids and bases, and thus, directly affect the toxicity of many compounds. The primary concern with changes in pH for fish in the marine environment is that pH changes can substantially affect the chemical forms and toxicity of other substances. For example, the acute toxicity of ammonia has been shown to increase as pH decreases. In addition, pH affects the solubility of metal compounds present in the water column and sediments of aquatic systems, thereby influencing the exposure dose of metals to aquatic species. pH activity has a significant impact on the availability and toxicity of metals.

A National Academy of Sciences review (NAS, 1974) indicated that plankton and benthic invertebrates are probably more sensitive than fish to changes in pH and that mature forms and larvae of oysters are adversely affected at the extremes of the pH range of less than 6.5 and greater than 9.0. In Quality Criteria for Water (EPA 1986) EPA concluded that a pH within the range of 6.5 to 9.0 provides adequate protection for the life of freshwater fish and bottom dwelling invertebrates. Outside of this range, fish suffer adverse physiological effects, increasing in severity as the degree of deviation increases until lethal levels are reached.

The maximum allowable range of effluent pH for the Asplund WPCF is 6.6 to 8.5. The discharge maximum concentration ranges between 6.6 and 7.7

The buffering capacity of marine water, relatively low effluent volume, and effluent mixing characteristics in the energy-intensive area of CI, indicate that the effluent does not have a reasonable potential to violate either the Water Quality Standards or maximum allowable effluent pH established in the Asplund NPDES permit. Therefore, the pH of the Asplund WPCF discharge is **not likely to adversely affect** the beluga whale or prey species within the action area.

7.1.3.7 Bacteria

Fecal coliform bacteria are found in the feces of warm-blooded animals. These bacteria are discharged to water bodies from dairy and livestock operations, wastewater treatment facilities, and aquaculture facilities. When discharged to water bodies, fecal coliform counts can indicate the presence of other disease-carrying organisms (pathogens). Human exposure to pathogens occurs during boating, swimming, or playing in water where pathogens can enter the body through cuts, abrasions, mucus membranes, or swallowing water. Where fecal coliform excesses are found, there are commonly other related water quality problems such as excess nutrients, low DO, or high ammonia concentrations. There is no information to suggest that fecal coliform limits that are protective of humans would be excessive to other aquatic organisms.

The NPDES permit requirements for the Asplund WPCF require the discharge to not exceed 850 coliform colonies per 100 milliliters on a monthly average (geometric mean). AWWU annual reports to EPA required as part of the Asplund WPCF NPDES permit indicate that WPCF discharge of fecal coliforms typically range around 60 colonies per 100 milliliters monthly average, which is significantly lower than the average monthly permit limit. Therefore, the Asplund WPCF effluent discharge levels of bacteria are **not likely to adversely affect** beluga whale.

7.1.3.8 Metals

Hazard quotients (HQs) were used to assess the affects of metals. Appendix A and B provide background on the methodology for calculating hazard quotients.

If the estimated exposure concentration for any metal exceeded its toxicity reference value (TRV), the HQ will exceed unity (one). An HQ that exceeds unity indicates that there is a potential for adverse ecological effects associated with exposure to that constituent. An HQ value less than or equal to one is considered protective of fish populations.

Fish tissue data was used to calculate the hazard quotients for metals. The HQs were segregated depending on whether the fish tissue sample was collected from the Point Woronzof station or from the background station and then compared to detect metals level elevated above background levels. The results of this comparison between tissue samples from Point Woronzof and background stations show that the tissue levels seen in fish from Point Woronzof (and resulting HQs) are largely attributable to naturally occurring levels of these metals. The HQs for available fish tissue data indicate that these constituents are **not likely to adversely affect** the CI beluga whale.

7.1.3.9 Emerging Parameters of Concern

The POCs investigated in this evaluation include those regulated and unregulated constituents with physical-chemical properties that make them sufficiently lipophilic to result in a potential for direct effects or indirect effects by bioaccumulation through the food chain.

Wastewater concentrations of regulated and unregulated constituents were obtained from the following three sources:

- Direct concentration measurements in representative samples of Asplund WPCF effluent during normal monitoring required by the NPDES Permit.
- Concentrations inferred from reported levels in wastewater treatment facilities worldwide[4]. In general influent concentrations were used since effluent data included both primary and secondary treatment which is not representative of Asplund WPCF. The use of influent concentrations introduces conservatism in the effects analysis. Direct concentration measurements of emerging parameters of concern in Asplund WPCF effluent in 2010
- Direct concentration measurements of emerging parameters of concern in Asplund WPCF effluent in 2010

Prior to the sampling and analysis done by AWWU in 2010, there were no available analytical results for currently unregulated EPOCs in final effluent from the Asplund WPCF. Appendix A contains a description of the target analytes and results of the 2010 sampling and analysis. One hundred sixteen EPOC constituents have been reported in literature where detectable concentrations were reported to occur at least once in municipal influent. The 116 EPOCs were included in this evaluation. The maximum concentrations reported in literature for influent for each of these constituents were assumed to occur in the Asplund WPCF effluent. The inferred value, therefore assumed no removal through the primary treatment process, a very conservative assumption as many EPOCs adhere to solids and would be removed through primary treatment processes.

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[4] Literature-based data were only used when concentration data from NPDES monitoring for the Asplund WPCF effluent were not available.

Sampling and analysis for EPOCs in 2010 identified 163 constituents reported with detectable concentrations in the final effluent. One hundred and three (103) of these constituents were identified as sufficiently lipophilic to result in a potential for bioaccumulation, and were evaluated for potential exposure to beluga whales through consumption of the prey species.The toxicity of POCs to beluga whales as a result of potential exposure to contaminated prey in CI was identified by using literature-derived critical toxicity values.

The potential for ecological risks to beluga food resources was estimated by calculating an HQ for each effluent-related POC (measured or inferred). The HQ is calculated as the ratio of the estimated exposure, E_{diet}, to the TRV as follows. Using both measured fish tissue constituent levels, inferred or NPDES required measured effluent concentrations and 2010 measured concentrations of EPOCs in Asplund effluent, modeled exposure levels were compared with toxicological threshold levels for the beluga whale. The results indicate that none of the concentrations of known,inferred POCs or 2010 measured EPOCs is at a level that exceeds toxicological thresholds for the beluga whale, even when considering the levels of conservatism associated with this evaluation. Considering the lines of evidence analyzed in this evaluation, the Asplund effluent is considered **not likely to adversely affect** the CI beluga whale via dietary exposure.

Evaluation of potential effects of Asplund wastewater on beluga whale prey species was conducted to determine whether whale food sources could be adversely affected. Using effluent concentrations that were either measured as required in the Asplund NPDES permit, inferred, or measured in the 2010 sampling analysis for EPOCs, projected receiving water concentrations were compared with aquatic toxicological endpoint concentrations. The results indicate that none of the concentrations estimated to be discharged are at a level that would be expected to exceed toxicological endpoints for native fish species, even when considering maximum measured or inferred levels at the edge of the ZID. Supporting these results, long-term WET testing conducted as part of the AWWU NPDES compliance monitoring program has not indicated toxicity at the edge of the ZID when very sensitive test organisms are exposed to final effluent. This result indicates that discharged levels of regulated or unregulated constituents are not measurably harming marine resources in CI. Considering all of the lines of evidence investigated for this BE, the Asplund WPCF effluent is **not likely to adversely affect** the fish species that serve as a food source for the CI beluga whale.

7.2 Cumulative Effects Determination

Cumulative effects are defined by the Council on Environmental Quality (CEQ) at 40 CFR 1508.7 as the “impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (RFFA) regardless of what agency (federal or nonfederal) or person undertakes such other actions.” This cumulative impact analysis draws from several recently completed environmental assessments regarding past, present and reasonably foreseeable future actions as well as the U.S. Environmental Protection Agency review of impacts associated with this outfall when the NPDES permit was renewed in 2000.

The key reference documents used to identify past, present and RFFAs were:

1. Environmental Assessment:
   Reissuance of a NPDES General Permit for Oil and Gas Exploration,
   Development and Production Facilities located in state and federal waters in
   Cook Inlet, Alaska
   Prepared by:
   Tetra Tech, Inc.
   10306 Eaton Place, Suite 340
   Fairfax, VA 22030
   Prepared for: U.S. EPA, Region 10

2. Knik Arm Crossing
   Final Cumulative Effects
   Technical Report
   Prepared for:
   Knik Arm Bridge and Toll Authority,
   Alaska Department of Transportation & Public Facilities, and the
   Federal Highway Administration

3. FACT SHEET:
   The U.S. Environmental Protection Agency (EPA)
   Proposes to Reissue a National Pollutant Discharge Elimination
   System (NPDES) Permit for Storm Water Discharges To
   Municipality of Anchorage and the Alaska Department of Transportation and
   Public Facilities

Each of these previous assessment reviewed the potential for the respective project(s) to have a cumulative effect on Cook Inlet taking into account past present and RFFAs; including the existing discharge from the Asplund WWTF. The Asplund WWTF discharge is an on-going operation and qualifies as a past, present and RFFA in Upper Cook Inlet. This on-going action is described in AWWU's application of January 28th 2005. *(January 28, 2005 Transmittal of NPDES Permit Renewal Application, NPDES Permit No. AK-002255-1, Municipality of Anchorage.)*

The Kink Arm Crossing Final Cumulative Effects Technical Report provided the most current listing of reasonably foreseeable future actions in Upper Cook Inlet. Below is the list taken from table 5-1 of the Technical Report. Many of these actions are land-use activities projected to occur within the Cook Inlet region. The listing has been modified to include only those RFFAs that would occur without the Knik Arm Crossing. The list has not been updated or modified to take into account changes in the economy over the last four years which may delay or eliminate these foreseeable projects.

Reasonably foreseeable future actions list by 2030:

POA expansion

Port MacKenzie development

Mat-Su Road/Rail corridor to Willow Road

West Mat-Su access road (Little Susitna River Crossing)

Mat-Su airpark for small aircraft

Increased cruise ship calls at POA

Hatcher Pass ski resort

South Denali Implementation Plan (major destination facility)

Cook Inlet Ferry

1,200-bed prison at Sutton creating 1,125 direct jobs at prison, 1,660 direct jobs total, and 2,550 direct and induced jobs.

200-MW gas-fired power plant built by Matanuska Electric Association (MEA) in the Mat-Su

200-MW coal-fired power plant at Beluga built by Chugach Electric Association

Gas pipeline spur to Glennallen or Nenana

New Airborne Brigade at Fort Richardson (net gain of 2,600 soldiers)

C-17 and F-22 missions become operational at Elmendorf in 2008

USCG adding 110 people to new base

Eklutna residential, commercial, and industrial property development

Residential development around lakes in the Mat-Su

Gravel mining at Port MacKenzie and continued gravel operations elsewhere in the Mat-Su

Timber harvesting in Mat-Su

Agricultural-only covenants lifted on Point MacKenzie

Agricultural area

Fish Creek (West Mat-Su) multiple use development

Increased fisheries/hatcheries (ADNR and Cook Inlet

Aquaculture Association will double fish production)

Alaska Railroad Corporation (ARRC) multimodal facility in Ship Creek area

ARRC and Municipality of Anchorage commercial/retail and residential development in west and south Ship Creek

Municipality of Anchorage convention center development and museum expansion

Wasilla master plan and extension of water and sewer to 320-acre Golden Triangle area—new city center

Commuter rail/mass transit on the Glenn Highway

Anchorage LRTP: Improvements to the Glenn Highway between Hiland and Artillery Roads

Mat-Su LRTP: Roadway connections from the proposed KAC project to Parks Highway along Point MacKenzie/Burma/Big Lake Roads

Development of urban/town centers in Anchorage

The Environmental Assessment for Reissuance of the General Permit for Oil and Gas Exploration in Cook Inlet prepared for U.S. EPA addressed cumulative effects of oil exploration and production facilities over a projected 20 year period. The report notes the following:

Based on a review of the lease sale documents, an estimated 20 new exploration wells are projected to be drilled, resulting in up to 60 new production wells drilled from as *many as 7 new platforms. The cumulative impact analysis considers the past and current lease sale activities; past oil and gas exploration and production; oil and gas discoveries that have a reasonable chance of being developed during the next 15–20 years; and speculative exploration and development of additional undiscovered resources (onshore and offshore) that could occur during the next 15–20 years. Based on a review of the lease sale documents, an estimated 20 new exploration wells are projected to be drilled, resulting in up to 60 new production wells drilled from as many as 7 new platforms. (Page 4-14* ENVIRONMENTAL ASSESSMENT:REISSUANCE OF A NPDES GENERAL PERMIT FOR OIL AND GAS EXPLORATION,DEVELOPMENT AND PRODUCTION FACILITIES LOCATED IN STATE AND FEDERALWATERS IN COOK INLET, ALASKA)

Other wastewater discharges to Upper Cook Inlet include AWWU's Eagle River WWTF with an approximate 2.0 -2.5 mgd discharge to Eagle River, and the Girdwood WWTF with an approximate 0.5 mgd discharge to Glacier Creek which flows to the upper reaches of Turnagain Arm and storm water dischargers from municipal, transportation and industrial facilities. Both WWTF are secondary treatment facilities.

Storm Water discharges are regulated under EPA's Storm Water Dischargers from Municipal Separated Storm Water Systems (MS4s) program.

EPA's approach to controlling storm water discharges is to continuously apply expanded or better tailored best management practices in order to attain water quality standards. The Fact Sheet for the MS4 permit for the Municipality of Anchorage and State of Alaska Department of Transportation and Public Facilities states:

EPA's permitting approach for storm water discharges uses best management practices (BMPs) in the first five year permit, and expanded or better tailored BMPs in subsequent permits to provide for the attainment of water quality standards. See "Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits," 61 Fed. Reg. 43761 (Aug. 26, 1996). EPA reiterated this approach to address how to incorporate WLAs for storm water discharges into NPDES permits in its November 2002 guidance entitled, "Establishing Total Maximum Daily Load Wasteload Allocations for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs" (TMDL Guidance Memo).

This approach for controlling storm water dischargers, supported by the completion of TMDLS and subsequent NPDES permits is designed to bring all discharges into compliance with water quality standards regardless of the growth in storm water volume, number of systems or changes in land use.

All discharges of waste water to Cook Inlet must meet industrial and/or municipal effluent limits and State Water Quality Standards, protective of the marine environment including fish, shellfish, and marine mammals. Indeed, one of the 9 criteria EPA uses to assess whether an application by a municipality for modification of the NPDES for discharge to marine waters may be granted is demonstration that all water quality standards can be met at the edge of the ZID and that Whole Effluent Toxicity testing demonstrates no toxicity to sensitive marine organisms.

With regard to oil and gas production and exploration facilities EPA concluded in their Environmental Assessment, for Cook Inlet, including consideration of the existing Aspllund WWTF, that:

"…, with respect to water quality, the Final EIS (FEIS) for the Cook Inlet Planning Area sales concluded that the "[p]otential effects from either or both sales would not cause any overall measurable degradation to Cook Inlet water quality" (MMS 2003). The FEIS concluded that any effects to threatened and endangered species would likely be due to "...noise and other disturbance caused by exploration, development, and production activities and disturbance from aircraft and vessels

In general, the amounts of pollutants in the other discharges from existing and projected facilities are expected to be relatively small (from 4 to 400 or 800 liters per month) and diluted with sea water several hundred to several thousand times before being discharged into the receiving waters. These routine other discharges associated with oil production are not expected to cause any overall degradation of Cook Inlet water quality, therefore, no cumulative effects would be expected under any of the alternatives. (See NPDES FONSI)

The Knik Arm Crossing cumulative effects technical report reached a similar conclusion, noting small cumulative impact resulting from increased land-use changes and greater human activity in shoreline areas. Page 154 Knik Arm Crossing Technical Report

These previous studies of proposed Cook Inlet Actions which take into account continued operation of the Asplund WWTF discharge conclude that there is either no or only a small incremental contribution to non-EFH fish and marine invertebrates in the BE study area.

These previous studies as well as this biological evaluation confirm that significant mixing from tides, wind and fresh water from rivers and streams contribute to either no cumulative effect and or small increment of accumulation to non-EFH fish and marine invertebrates. (Note: The small increment of cumulative effect is associated with Knik Arm Crossing which is considered by many to no longer be a RFFA.)

Further, the effluent from the Asplund WWTF outfall meets state water quality standards and maximum allowable limits for fecal coliform, TSS, BOD5, total residual chlorine, pH, and 13 specific metals limits.
(see AWWUAnnual Reports for 2008 and 2009), and is not expected to contribute significant amounts of POCs to the marine waters of Upper CI (see Appendices A and B).

Based on the results of this Biological Evaluation taken together with recently completed cumulative effects studies of Cook Inlet actions; The continuation of the 301 (h) modification to the NPDES permit for the Asplund WWTF discharge is **not likely to have cumulative effects**.

SECTION 8

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List of Appendices

Appendix A
Effects Assessment on Beluga Whale Prey Species

Appendix A

Effects Assessment for Beluga Whale Prey Species

Submitted to
U.S. Environmental Protection Agency, Region 10
Seattle, Washington

Submitted by
Anchorage Water and Wastewater Utility

Prepared by
CH2M HILL

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Tables
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Acronyms and Abbreviations

AWWU	Anchorage Water and Wastewater Utility
BE	biological evaluation
EPA	U.S. Environmental Protection Agency Region 10
HQ	hazard quotient
NOEC	no observed effect concentration
NPDES	National Pollutant Discharge Elimination System
PBDE	polybrominated diphenyl ethers
PCB	polychlorinated biphenyls
POC	parameters of concern
POTW	publicly owned treatment work
PPCP	pharmaceuticals and personal care products
SVOC	semivolatile organic compounds
TL	trophic level
TRV	toxicity reference value
TUc	chronic toxic units
VOC	volatile organic compounds
WERF	Water Environment Research Foundation
WET	whole effluent toxicity
WPCF	Water Pollution Control Facility
ZID	zone of initial dilution

APPENDIX A

Effects Assessment for Beluga Whale Prey Species

A.1 Purpose

This appendix presents an evaluation of the potential for effects on populations of aquatic organisms (e.g., fish) within Cook Inlet that could serve as a food source for the endangered Cook Inlet beluga whale, resulting from regulated and unregulated constituents known or suspected to be discharged from the Anchorage Water and Wastewater Utility (AWWU) Asplund Water Pollution Control Facility (WPCF). This evaluation represents one important line of evidence to identify whether the WPCF discharge could adversely impact the protected beluga whale, by reducing the availability of prey species that serve as their food resources. This appendix is, therefore, limited to addressing the potential for direct toxicity on these food-chain populations and not on the whale itself. Appendix B provides additional evaluation of the potential for chemical exposure to the Cook Inlet beluga whale from consuming wastewater-related constituents that may have bioaccumulated into their diets.

A.2 Beluga Prey Species

Beluga whales are opportunistic feeders known to consume a wide variety of prey species, focusing on specific species when they are seasonally abundant (NMFS, 2005, 2008). They are reported to eat octopus, squid, crabs, shrimp, clams, mussels, snails, sandworms, and fish such as capelin, cod, herring, smelt, flounder, sole, sculpin, lamprey, lingcod, and salmon. Ongoing analyses are being conducted by NMFS and others to identify much-needed evidence on prey availability and prey preferences of Cook Inlet belugas.

In spring, eulachon (*Thaleichthys pacificus*, also named hooligan and candlefish) and gadids are the preferred beluga prey. The stomach of a beluga harvested near the Susitna River in April 1998 was filled exclusively with eulachon (NMFS, 2008). Gadids, such as saffron cod (*Eleginus gracilis*), are indigenous to shallow coastal waters and are found near and in rivers within the zone of tidal influence. Natives report that Cook Inlet beluga whale also feed on freshwater fish such as trout, whitefish, northern pike, and grayling. Beluga whales in Cook Inlet often aggregate near the mouths of rivers and streams where salmon runs occur.

By late spring, belugas begin to shift from lipid-poor prey to lipid-rich species such as anadromous fish runs of Pacific salmon (*Oncorhynchus* spp.) that enter the inlet. From late spring and throughout the summer months, the majority of beluga stomachs contained Pacific salmon coincident with the timing of fish runs. In fall, as anadromous fish runs begin to decline, belugas again return to consume the fish species found in nearshore bays and estuaries, including cod species observed in the spring diet as well as other bottom-dwellers such as Pacific staghorn sculpin (*Leptocottus armatus*) and flatfishes such as starry flounder (*Platichthys stellatus*) and yellowfin sole (*Limanda aspera*).

Beluga whales in captivity may consume 2.5 to 3 percent of their body weight daily, or approximately 40 to 60 pounds. Wild beluga whale populations, faced with an irregular supply of food or with increased metabolic needs, may easily exceed these amounts while feeding on concentrations of eulachon and salmon.

Because fish comprise the dominant mass portion of the beluga diet (see Appendix B), this assessment focuses on evaluating toxicological studies demonstrating dose-effect relationships in fish species, as described in the following section.

A.3 Effects Assessment Methodology

To assess the plausibility that constituent concentrations in Asplund WPCF effluent could affect populations of fish that serve as the beluga food sources, the following two primary lines of evidence were evaluated:

1. Projected receiving water concentrations in Cook Inlet were compared with literature-based aquatic toxicological effects concentrations.
2. Whole effluent toxicity test results were evaluated to identify whether direct toxicity has been observed following exposure of fish or invertebrates to Asplund WPCF effluent.

The following subsections describe the sources of available data and methodology used for each of these lines of evidence.

A.3.1 Sources for Wastewater Concentration Data

Wastewater concentration data to evaluate regulated and unregulated constituents were obtained from three sources: (1) direct concentration measurements of regulated constituents in representative samples of Asplund WPCF effluent during normal monitoring required by the National Pollutant Discharge Elimination System (NPDES) Permit, 2) concentrations of emerging parameters of concern inferred from reported levels in similar municipal wastewater effluent, obtained from literature sources[1], and 3) direct concentration measurements of emerging parameters of concern in Asplund WPCF effluent in 2010. Each source is described in the following subsections.

A.3.1.1 Measured Asplund WPCF Effluent Concentration Data (NPDES-Regulated)

As required in the NPDES Permit, AWWU monitors for toxic pollutants and pesticides twice annually, typically once during early summer (summer dry) and once late summer (summer wet), in 24-hour composite effluent samples. These toxic pollutants and pesticides are defined by the permit as those substances listed in 40 Code of Federal Regulations 401.15, and are listed in Table A-1. This list includes more than 130 pollutants, including asbestos, volatile organic compounds (VOC), semivolatile organic compounds (SVOC), pesticides, polychlorinated biphenyls (PCB), metals, and cyanide.

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[1] Literature-based data were only used when concentration data from NPDES monitoring for the Asplund WPCF effluent were not available.

Constituents detected at least once during Asplund WPCF NPDES effluent monitoring over the period of 2000 through 2009 were identified for evaluation in this BE. Of the more than 130 inorganic and organic chemical parameters regularly analyzed over this period, 46 have been detected. The concentration ranges and detection frequencies of these constituents are summarized in Table A-2.

A.3.1.2 Hypothetical Effluent Concentrations of Emerging Parameters of Concern

Prior to 2010, there were no available analytical results for emerging parameters of concern (POC) in final effluent from the Asplund WPCF. In May 2010, sampling and analysis for these constituents in Asplund WPCF effluent was conducted, as discussed in the next subsection. However, to provide a basis of comparison with levels found elsewhere in the U.S., Canada, or other locations, literature-based concentration data were also identified and evaluated.

An extensive search of available literature sources was conducted to identify levels of emerging pollutants that have been reported in wastewater effluent similar to that from the Asplund WPCF. The sources include those described below. Many of these studies focus on the concentration of emerging constituents in the final effluent and in receiving waters. However, because the Asplund effluent represents primary treated wastewater, an attempt was made to focus on information on the concentrations in municipal wastewater influents (or primary effluent, or other points along the wastewater treatment process) to obtain relevant data. The primary studies include the following:

- In 2009m the U.S. Environmental Protection Agency's (EPA) completed a survey of the occurrence of contaminants of emerging concern at nine publicly owned treatment works (POTW). The study focused on pharmaceutical and personal care products (PPCP), steroids/hormones, alkylphenols/ethoxylates, bisphenol A, polybrominated diphenyl ethers (PBDE), and pesticides. Sampling points included influent, effluent, and for some POTWs, intermediate points along the treatment process.

  EPA, Office of Water. 2009. Occurrence of Contaminants of Emerging Concern in Wastewater From Nine Publicly Owned Treatment Works, August 2009 [EPA-821-R-09-009]. Available from URL: http://www.epa.gov/waterscience/ppcp/studies/9potwstudy.pdf

- The following Canadian occurrence studies were reviewed:

  Lee, H.B., Sarafin, K., Peart, T.E., and Svoboda, M.L. 2003a. Acidic Pharmaceuticals in Sewage – Methodology, Stability Test, Occurrence, and Removal from Ontario samples. *Water Quality Research Journal of Canada*, 38(4): 667-682.

  Lee, H.B., Peart, T.E., and Sarafin, K. 2003b. Occurrence of Polycyclic and Nitro Musk Compounds in Canadian Sludge and Wastewater Samples. *Water Quality Research Journal of Canada*, 38(4): 683-702.

Lee, H.B., Peart, T.E., Chan, J., and Gris, G. 2004. Occurrence of Endocrine-Disrupting Chemicals in Sewage and Sludge Samples in Toronto, Canada. *Water Quality Research Journal of Canada*, 39(1):57-63.

Lishman, L., Smyth, S.A., Sarafin, K., Kleywegt, S., Toito, J., Peart, T., Lee, B., Servos, M., Beland, M., and Seto, P. 2006. Occurrence and Reductions of Pharmaceuticals and Personal Care Products and Estrogens by Municipal Wastewater Treatment Plants in Ontario, Canada. *Science of the Total Environment*, 367: 544-558.

Metcalfe, C.D., Koenig, B.G., Bennie, D.T., Servos, M., Ternes, T.A., and Hirsch, R. 2003. Occurrence of Neutral and Acidic Drugs in the Effluents of Canadian Sewage Treatment Plants. *Environmental Toxicology and Chemistry*, 22(12): 2872-2880.

Miao, X.S., Yang, J.J., and Metcalfe, C.D. 2005. Carbamazepine and its Metabolites in Wastewater and in Biosolids in a Municipal Wastewater Treatment Plant. *Environmental Science and Technology*, 39(19): 7469-7475.

Servos, M.R., Bennie, D.T., Burnison, B.K., Jurkovic, A., McInnis, R., Neheli, T., Schnell, A., Seto, P., Smyth, S.A., and Ternes, T.A. 2005. Distribution of Estrogens, 17β-estradiol, and Estrone in Canadian Municipal Wastewater Treatment Plants. *Science of the Total Environment*, 336: 155-170.

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Smyth, S.A., Lishman, L.A., McBean, E.A., Kleywegt, S., Yang, J.-J., Svoboda, M.L., Lee, H.-B., and Seto, P. 2008. Seasonal Occurrence and Removal of Polycyclic and Nitro Musks from Wastewater Treatment Plants in Ontario, Canada. *Journal of Environmental Engineering and Science*, 7: 299-317.

- The Water Environment Research Foundation (WERF) has published a number of reports on removing PPCPs and other trace organic contaminants in wastewater and water reclamation processes. The 2008 report contains the following list of ongoing research efforts with web links.

WERF, Water Environment Research Foundation. 2005. *Technical Brief: Endocrine Disrupting Compounds and Implications for Wastewater Treatment* [04-WEM-6]. Prepared by AMEC Earth and Environmental, Inc. (Paul D. Anderson). Co-published by IWA Publishing.

WERF, Water Environment Research Foundation. 2006. *Removal of Endocrine Disrupting Compounds in Water Reclamation Processes* (Final Report) [01-HHE-20T]. Prepared by Colorado School of Mines (Jörg E. Drewes) and Wisconsin State Laboratory of Hygiene (Jocelyn D.C. Hemming, James J. Schauer, and William C. Sonzogni). Co-published by IWA Publishing.

WERF, Water Environment Research Foundation. 2007. *Fate of Pharmaceuticals and Personal Care Products Through Municipal Wastewater Treatment Processes*

(Final Report) [03-CTS-22UR]. Prepared by MWH (Roger Stephenson and Joan Oppenheimer). Co-Published by IWA Publishing.

WERF, Water Environment Research Foundation. 2008. *Technical Brief: Trace Organic Compounds and Implications for Wastewater Treatment* [CEC3R07]. Prepared by AMEC Earth and Environmental, Inc. (Paul D. Anderson). Co-Published by IWA Publishing.

- The following 2009 report was published on PPCPs in wastewater treatment plants worldwide.

  Miège, C., Choubert, J.M., Ribeiro, L., Eusèbe, M., and Coquery, M. 2009. Fate of Pharmaceuticals and Personal Care Products in Wastewater Treatment Plants – Conception of a Database and First Results. *Environmental Pollution*, 157: 1721 1726.

Table A-3 provides a list of those emerging POC reported to occur in primary influent or effluent from the above literature sources. Of the 212 target analytes reported in the above studies, 116 constituents have been reported with detectable concentrations at least once and were included in this evaluation[2]. The maximum reported concentrations and study sources of these constituents are summarized in Table A-4. The results of the 2010 sampling and analysis identified the actual number of emerging pollutants detectable in of Asplund WPCF effluent (discussed below).

A.3.1.3 Measured Asplund WPCF Effluent Concentrations of Emerging Parameters of Concern

On May, 2010, AWWU collected sample results of unregulated trace contaminants in the sewage influent and final effluent, with a focus on the following seven distinct classes of pollutants of emerging concern and endocrine disruptors:

- PPCPs (119 compounds)
- Sterols/Hormones (27 compounds: 10 sterols and 17 hormones)
- Pesticides (63 compounds: 34 Organochlorine, 20 Organophosphate, 7 Triazine, and 2 Pyrethroid)
- PBDEs (40 reported compounds, 46 with co-elutions)
- Perfluorocarbons (13 compounds)
- Alkylphenols (4 compounds)
- Bisphenol A (1 compound)

The protocols used for the sampling are described in the *Sampling and Analysis Plan for Emerging Pollutants of Concern* (AWWU, May 2010). To provide temporal representativeness, twenty-four hour composite samples of both influent and effluent aqueous and dissolved fractions were taken at the Asplund WPCF as flow proportioned grabs using ISCO compositing samplers. Solid-phase fractions were composited on 1.5

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[2] Constituents already included as part of the direct NPDES Permit analyses of Asplund WPCF effluent (e.g., organochlorine pesticides) were not included in this portion of this evaluation, but are addressed in Table A-2.

µm glass microfiber filters for separate analysis and comparison to dissolved phase concentrations. The sampling took place on a weekday to be representative of when normal influent and effluent quality was anticipated, and to capture average commercial, industrial, and domestic input.

Analyses were conducted by AXYS Analytical Services, LTD. of Sidney, British Columbia, who worked with USEPA to develop the appropriate test methods for their nine POTW study (EPA, 2009). Although analytical methods have evolved slightly to incorporate improvements, it is expected that the results from the May 2010 investigation are comparable to the Nine POTW USEPA study of 2009. The reported concentrations from the May 2009 sampling from Asplund WPCF are summarized in Table A-5. Concentrations reported for final effluent (combined dissolved and solid-phase fractions) were conservatively used for this assessment, even though it is only the dissolved phase that is accessible for gill uptake by fish. The complete results of the May 2009 sampling and associated QA/QC information will be reported by AWWU.

A.3.2 Sources of Aquatic Toxicity Data

The chemical toxicity to marine aquatic organisms is identified using literature-derived threshold concentrations, referred to as toxicity reference values (TRV).

For this evaluation, a literature review of the toxicological properties for effluent-related constituents (either measured or inferred) was conducted to identify the highest exposure level considered to be without adverse ecological impact to marine aquatic organisms (i.e., TRV). For marine aquatic organisms, the primary toxicological endpoint considered for the TRV is the chronic no-observed effect concentration (NOAC, in units of micrograms per liter [μg/L]). Because fish populations are the primary focus of this evaluation of beluga prey, population-type endpoints such as reproduction or survival are of greatest concern. The chemical-specific TRVs were obtained from the following general sources and databases (listed in order of preference):

- NOAA – National Centers for Coastal Ocean Science (NCCOS): Pharmaceuticals in the Environment, Information for Assessing Risk Data Base; Available at: http://www.chbr.noaa.gov/peiar/search.aspx
- EPA – AQUIRE (AQUatic toxicity Information REtrieval) as part of ECOTOXicology database (ECOTOX)[3]; Available at: http://cfpub.epa.gov/ecotox/
- Other primary peer-reviewed literature

When more than one toxicity study was available for a specific chemical, a prioritization scheme was used to select the most representative study. Because fish comprise the dominant mass portion of the beluga diet, this assessment focuses on evaluating toxicological studies demonstrating dose-effect relationships in marine fish species. When a suitable study using marine fish was not available, toxicity studies for freshwater fish or for invertebrates were considered. The toxicity study selection hierarchy used is as follows:

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[3] Full citations for primary sources for ECOTOX and other data are provided in Attachment A-1.

- Lowest marine chronic fish toxicity value
- Lowest marine acute fish toxicity value
- Lowest freshwater chronic fish toxicity value
- Lowest freshwater acute fish toxicity value
- Lowest marine chronic invertebrate toxicity value
- Lowest marine acute invertebrate toxicity value
- Lowest freshwater chronic invertebrate toxicity value
- Lowest freshwater acute invertebrate toxicity value

In accordance with standard convention for effluent toxicity testing, chronic studies were identified as studies of 7 days or greater duration. Studies with exposure durations less than 7 days were considered acute.

When a chronic TRV was unavailable, an available acute threshold value was extrapolated to a chronic TRV with an uncertainty factor of 10. That is, for all acute studies, the chronic TRV was estimated by dividing the acute value by a factor of 10. This factor is consistent with guidance in EPA *Technical Support Document for Water Quality-based Toxics Control* (U.S. EPA, 1991), based on evaluation of available data for acute-to-chronic ratios for multiple species and sources of exposure.

A.3.3 Source of Asplund WPCF Whole Effluent Toxicity Data

The AWWU Asplund WPCF NPDES permit (No. AK-002255-1) requires quarterly whole effluent toxicity (WET) bioassay testing on 24-hour flow composite effluent samples. Beginning in 2000, initial WET testing was performed as a screening period over the course of three quarters during each of which three toxicity tests were performed, each with one vertebrate and two invertebrate species. Screening included the vertebrate *Atherinops affinis* (topsmelt) for survival and growth; an invertebrate bivalve species (either *Mytilus* spp. [mussel; survival and growth] or *Crassostrea gigas* [oyster; larval development]; and an invertebrate echinoderm species fertilization test (*Strongylocentrotus purpuratus* [purple urchin] or *Dendraster excentricus* [sand dollar]). After the screening period was completed, the single most sensitive species was used for subsequent toxicity testing during that year. As required by the permit, re-screening must be performed each year during one quarter (different than the previous year) to determine the most sensitive species for testing that year.

The results of toxicity testing at Asplund WPCF are reported in chronic toxic units (TU_c). The TU_c is defined as the reciprocal of the effluent dilution that causes no unacceptable effect (referred to as the chronic no observed effect concentration, or NOEC) on the test organisms by the end of the chronic exposure period. The quarterly toxicity tests include testing a series of five dilutions and a control, including the concentration of the effluent at the edge of the zone of initial dilution (ZID) of 0.70 percent effluent. The toxicity testing dilutions used are 0.175, 0.35, 0.70, 1.4, and 2.8 percent effluent and dilution water alone for the laboratory control. Reference toxicant testing to document the sensitivity of the test organisms are tested concurrently with the effluent testing, using the same procedures. If the results of a WET test show chronic toxicity that is greater than 143 TU_c, the permit requires re-sampling and re-testing. If the TU_c is still greater than 143, the exceedence triggers a WPCF investigation into the source of toxicity. When the investigation indicates the source of toxicity (for instance, a temporary plant upset), then only one additional test is required.

For this BE, quarterly WET test results from 2000 through 2009 were considered. These results were taken from each of the AWWU Monitoring Program Annual Reports published over this time period (http://www.awwu.biz/website/Reports/Reports_Frame.htm). The results are presented in Table A-6.

A.4 Effects Assessment Results

A.4.1 Estimation of Potential Exposures to Beluga Prey Within Cook Inlet

Concentrations of effluent-derived constituents of potential concern in Cook Inlet were evaluated using a conservative approach. The maximum concentrations of these constituents, as reported from the sources cited above, were hypothetically assumed to occur in the Asplund WPCF effluent, and the end-of-pipe effluent concentrations (whether directly measured in the Asplund WPCF effluent or inferred from literature sources) were adjusted by a dilution factor to estimate the potential exposure concentration at the edge of the ZID. The Asplund WPCF NPDES Permit indicates that the concentration of the effluent at the edge of the ZID is 0.70 percent, which equates to a dilution factor of 143. Therefore, end-of-pipe concentrations were divided by 143 to derive screening-level exposure concentrations, which were compared with available TRVs as described in the next subsection. It should be recognized that these estimated concentrations are considered very conservative, especially for hydrophobic organic constituents, because these compounds are predominantly adsorbed to suspended solids and are not available for gill uptake by marine aquatic life.

As a more realistic tier of evaluation in addition to estimating effluent concentrations of constituents of concern at the edge of the ZID, areally integrated exposure concentrations within three general areas of Cook Inlet (Knik Arm, Turnagain Arm, and Upper Cook Inlet, as described in Appendix F) were estimated from modeling results. The transport and circulation model of the Upper Cook Inlet was developed to understand the transport and fate of pollutants dissolved in the water or adsorbed/adhering to suspended solids, and results are provided in Appendix F.

A.4.2 Calculation of Ecological Hazard Quotients

The potential for ecological risks to beluga food resources was estimated by calculating a hazard quotient (HQ) for each effluent-related constituent (measured or inferred). The HQ is calculated as the ratio of the estimated exposure concentration (at edge of ZID) to the TRV as follows:

$$HQ = C_w / TRV \quad (1)$$

where:

HQ = Ecological hazard quotient (unitless)
C_w = Estimated water concentration at edge of ZID (µg/L)
TRV = Toxicity reference value (µg/L)

If the estimated exposure concentration for any individual constituent exceeds its TRV, the HQ will exceed unity (one). An HQ that exceeds unity indicates that there is a potential for adverse ecological effects associated with exposure to that constituent. An HQ value less than or equal to one is considered protective of fish populations. The HQ results for constituents measured in AWWU WPCF final effluent, and emerging POC inferred to occur in the effluent, are described in the following subsections.

A.4.2.1 Evaluation of NPDES-Regulated Constituents Measured in Asplund WPCF Final Effluent

Table A-2 presents the HQs based on maximum concentrations of constituents measured during NPDES Permit monitoring of Asplund WPFC final effluent over the period of 2000 to 2009, and projected to occur at the edge of the ZID. Of the 46 constituents reported as detected at least once over this time span, only four metals have HQ values exceeding unity. These include cadmium (HQ = 3.4), copper (HQ = 5.4), silver (HQ = 2.7), and zinc (HQ = 1.1). However, it is not expected that these reflect ecologically meaningful concentrations of these metals, given the natural background levels of these occurring within Cook Inlet. These results indicate that, even under the conservative assumptions used, the constituents detected in Asplund effluent are **not likely to adversely affect** the fish species that serve as a food sources for the Cook Inlet beluga whale.

A.4.2.2 Evaluation of Hypothetical Effluent Concentrations of Emerging Parameters of Concern

Table A-4 presents the HQs based on hypothetical concentrations of emerging POC inferred from maximum reported levels in similar municipal wastewater from open literature sources. Of the 116 constituents reported with detectable concentrations in the evaluated literature sources, only one had an HQ value exceeding unity. The HQ for the antimicrobial/disinfectant triclocarban was estimated to be 2.1 at the edge of the ZID. However, this HQ is not believed to be ecologically meaningful for fish populations within Cook Inlet for the following reasons:

- This pharmaceutical is very hydrophobic, having a logarithm octanol to water partition coefficient (log K_{OW}) of 4.9. This strongly indicates that this constituent (and all such hydrophobic constituents) would be tightly adsorbed to suspended organic particulates in Asplund wastewater effluent, and would not be available for gill uptake exposure or toxicity.
- The maximum reported concentration from all evaluated literature studies was used. Actual levels detected in Asplund WPCF effluent were 14 percent of this value (see Section A.4.2.3).

- These HQs are conservatively based on projected levels at the edge of the ZID. In reality, exposure concentrations to prey species populations would be based on areally integrated levels within larger regions of Upper Cook Inlet.

These results indicate that, based on inferences made regarding hypothetical concentrations of emerging POC in Asplund WPCF effluent, these constituents are **not likely to adversely affect** the fish species that serve as a food source for the Cook Inlet beluga whale. This is confirmed by the evaluation of actual 2010 effluent data for these types of constituents, discussed in the next subsection.

A.4.2.3 Evaluation of Asplund WPCF Effluent Concentrations of Emerging Parameters of Concern

Table A-5 presents the HQs based on actual measured concentrations of emerging POC in Asplund WPCF effluent in May 2010. Of the 163 constituents reported with detectable concentrations in the final effluent, none had an HQ value exceeding unity at the edge of the ZID.

These results indicate that, based on recent measurements of actual concentrations of emerging POC in Asplund WPCF effluent, these constituents are **not likely to adversely affect** the fish species that serve as a food source for the Cook Inlet beluga whale.

A.4.3 Supporting Evidence from Whole Effluent Toxicity Results

The toxicity tests regularly conducted on whole effluent by AWWU under its NPDES program provide a very strong line of evidence in characterizing whether any of the constituents discharged at the Asplund WPCF can pose risk to marine resources present in Cook Inlet. As previously mentioned, there are no available analytical results for emerging POC in final effluent from the Asplund WPCF. However, if levels of these pollutants present are high enough to cause toxicity, the WET test results should reflect this.

Table A-6 presents the Quarterly WET test results from 2000 through 2009 for the echinoderm fertilization tests; the bivalve survival, growth, and/or larval development tests; and the topsmelt survival and growth tests. A TU_c of greater than 143 indicates a potential for toxicity at the edge of the ZID. Over the entire 10-year period evaluated, no toxicity was exhibited for any of these species, with the exception of two urchin fertilization tests conducted in 2005. However, these sporadic results were attributed to construction activities, and low clarifier performance. These conditions were subsequently mitigated, and retesting indicated non-toxic conditions.

It is important to recognize that the NPDES WET testing is designed to provide a conservative method of evaluating if there is any potential for whole effluent to cause toxicity in the receiving water. The use of notably highly sensitive tests and species, such as the sea urchin fertilization test (not a species found at Point Woronzof), is very conservative and is not likely representative of resident species. Possibly, the test species most relevant to this evaluation of beluga prey species is the top smelt test, where WET test results have indicated the absence of toxicity over the entire 10-year period evaluated.

A.5 Conclusions

Potential effects of Asplund wastewater effluent on beluga whale prey species were evaluated to determine whether beluga whale food sources could be adversely affected. Using effluent concentrations that were either measured or inferred, projected receiving water concentrations were compared with aquatic toxicological endpoint concentrations. The results indicate that none of the concentrations estimated to be discharged are at a level that would be expected to exceed toxicological endpoints for native fish species, even when considering maximum measured or inferred levels at the edge of the ZID. Supporting these results, long-term WET testing conducted as part of the AWWU NPDES compliance monitoring program has not indicated toxicity at the edge of the ZID when very sensitive test organisms are exposed to final effluent. These findings indicate that discharged levels of regulated or unregulated pollutants are not measurably harming marine resources in Cook Inlet. Considering all of the lines of evidence evaluated in this Appendix, the Asplund effluent is **not likely to adversely affect** the fish species that serve as food sources for the Cook Inlet beluga whale.

A.6 References

NMFS. 2008. Status Review and Extinction Risk Assessment of Cook Inlet Belugas (*Delphinapterus leucas*) April 2008.

NMFS. 2005. Draft Conservation Plan for the Cook Inlet Beluga Whale (*Delphinapterus leucas*) March 16, 2005.

Tables

Table A-1 Methods for the Analysis of Toxic Parameters and Pesticides for Influent, and Effluent Monitoring

Volatile Organic Compounds	Semi-Volatile Organic Compounds	Pesticides and PCBs	Inorganic Compounds
EPA 624 (Inf/Eff) Acrolein Acrylonitrile Benzene Carbon tetrachloride Chloralkyl ethers Chloroform Chlorinated benzenes Chlorinated ethanes Dichlorobenzenes 1,2-dichloroethane Dichloroethylenes Dichloropropane Dichloropropene 1,1,1-trichloroethane Ethylbenzene Halomethanes Methylene chloride Bromoform Dichlorobromomethane Toluene Tetrachloroethylene Trichloroethylene Vinyl chloride Xylenes	**EPA 625 (Inf/Eff)** Acenaphthene Benzidine Chloralkyl ethers Chlorinated ethanes Chlorinated naphthalenes Chlorinated phenols 2-chlorophenol Dichlorobenzenes Dichlorobenzidine 2,4-dichlorophenol 2,4-dimethylphenol Dinitrotoluene Diphenylhydrazine Fluoranthene Haloethers Hexachlorobutadiene Hexachlorocyclopentadiene Hexachloroethane Isophorone Naphthalene Nitrobenzene Nitrophenols Nitrosamines Polycyclic aromatic hydrocarbons (PAHs) Pentachlorophenol Phenol Phthalate esters	**EPA 614 (Inf/Eff)** Demeton Malathion Parathion Guthion **EPA 608 (Inf/Eff)** Aldrin/Diedrin Chlordane (technical mixture & metabolites) DDT & metabolites Endosulfan & metabolites Endrin & metabolites Heptachlor metabolites Hexachlorocyclohexane Polychlorinated biphenyls (PCB) Toxaphene Mirex Methoxychlor **SW 8280A (Inf/Eff)** 2,3,7,8-tetrachlorodibenzo- p-dioxin (TCDD)	**EPA 100.1/EPA 100.2 Inf/Eff)** Asbestos EPA 200.8 (Inf/Eff) Antimony Arsenic Beryllium Cadmium Chromium Copper Lead Molybdenum Nickel Silver Selenium Thallium Zinc **EPA 245.1 (Inf/Eff)** Mercury **SM 4500-CN-E (Inf/Eff)** Cyanide

Table A-2
Summary Statistics and Evaluation Results for 2000-2009 NPDES Effluent Monitoring Data

Anchorage Water and Wastewater Utility

Dilution at Edge of ZID 142.9

Chemical	CAS Number	Units (µg/L)	No. Detects	No. Samples	Detection Frequency	Minimum Nondetect	Maximum Nondetect	Mean	Minimum Detect	Maximum Detect	Maximum at Edge of ZID	Hazard Quotient at End of Pipe	Hazard Quotient at Edge of ZID	Toxicity Study Species Common Name	Test Species Type	Toxicity Endpoint	Type of Effect	Exposure Duration (Days)	Media Type	Reported Effect Level (ug/L)	Toxicity Uncertainty Factor	Adjusted Effect Level (ug/L)	Source	ECOTOX[a] Reference Number
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	1	1	100%	--	--	3.3E+00	3.3E+00	3.3E+00	2.3E-02	3.8E-03	2.6E-05	Sheepshead minnow	Fish	NOEC	Mortality	4	SW	8,800	10	880	ECOTOX, 2010	10366
1,3-Dichlorobenzene	541-73-1	µg/L	1	1	100%	--	--	9.5E+00	9.5E+00	9.5E+00	6.7E-02	2.3E-02	1.6E-04	Sheepshead minnow	Fish	NOEC	Mortality	4	SW	4,200	10	420	ECOTOX, 2010	10366
1,4-Dichlorobenzene	106-46-7	µg/L	6	13	46%	2.5E+00	5.0E+00	2.1E+00	6.8E-01	9.5E+00	6.7E-02	1.7E-02	1.2E-04	Sheepshead minnow	Fish	NOEC	Mortality	4	SW	5,600	10	560	ECOTOX, 2010	10366
3&4-Methylphenol (p&m-cresol)	1319-77-3	µg/L	2	2	100%	--	--	9.9E+01	7.8E+01	1.2E+02	8.3E-01	7.2E-01	5.0E-03	Coho salmon, silver salmon	Fish	NOEC	Mortality	3	SW	1,650	10	165	ECOTOX, 2010	14397
4,4'-DDD	72-54-8	µg/L	1	1	100%	--	--	4.7E-02	4.7E-02	4.7E-02	3.3E-04	2.4E-02	1.6E-04	Spot	Fish	EC50	Mortality	2	SW	20	10	2	ECOTOX, 2010	14574
4,4'-DDE	72-55-9	µg/L	3	3	100%	--	--	1.1E-02	8.0E-03	1.6E-02	1.1E-04	1.6E-03	1.1E-05	Spot	Fish	EC50	Mortality	2	SW	100	10	10	ECOTOX, 2010	807
4,4'-DDT	50-29-3	µg/L	1	1	100%	--	--	2.5E-01	2.5E-01	2.5E-01	1.8E-03	***6.3E+00***	4.4E-02	Atlantic silverside	Fish	LC50	Mortality	4	SW	0.4	10	0.04	ECOTOX, 2010	628
Acetone	67-64-1	µg/L	1	1	100%	--	--	1.0E+02	1.0E+02	1.0E+02	7.0E-01	2.0E-02	1.4E-04	Dolphin	Fish	NOEC	Mortality	2	SW	50,000	10	5,000	ECOTOX, 2010	112782
alpha-BHC	319-84-6	µg/L	2	3	67%	2.5E-02	2.5E-02	1.6E-02	8.2E-03	2.3E-02	1.6E-04	4.6E-05	3.2E-07	Guppy	Fish	LC10	Mortality	35	SW	500	1	500	ECOTOX, 2010	5594
Antimony	7440-36-0	µg/L	16	32	50%	2.5E-01	5.0E+00	4.7E-01	3.0E-01	6.5E-01	4.6E-03	1.0E-03	7.3E-06	Sheepshead minnow	Fish	NOEC	Mortality	4	SW	6,200	10	620	ECOTOX, 2010	10366
Arsenic	7440-38-2	µg/L	47	64	73%	1.0E+00	5.0E+00	2.1E+00	5.5E-01	4.0E+00	2.8E-02	6.3E-03	4.4E-05	Opossum shrimp	Fish	NOEC	Reproductio	29-51	SW	631	1	631	ECOTOX, 2010	11331
Benzene	71-43-2	µg/L	5	12	42%	2.5E+00	5.0E+00	1.0E+00	2.4E-01	3.3E+00	2.3E-02	2.2E-03	1.5E-05	Striped bass	Fish	NOEC	Growth	28	SW	1,500	1	1,500	ECOTOX, 2010	7832
Benzoic acid	65-85-0	µg/L	2	2	100%	--	--	1.9E+02	1.4E+02	2.4E+02	1.7E+00	1.3E-02	9.4E-05	Western mosquitofish	Fish	LC50	Mortality	4	FW	180,000	10	18,000	ECOTOX, 2010	508
Benzyl alcohol	100-51-6	µg/L	2	2	100%	--	--	2.7E+01	2.6E+01	2.8E+01	2.0E-01	1.9E-01	1.3E-03	Inland silverside	Fish	LC50	Mortality	4	SW	15,000	100	150	ECOTOX, 2010	863
Beryllium	7440-41-7	µg/L	12	64	19%	5.0E-02	5.0E-01	1.4E-01	1.0E-01	3.0E-01	2.1E-03	1.2E-02	8.4E-05	Water flea	Crustacean	NOEC	Mortality	2	FW	250	10	25	ECOTOX, 2010	5184
beta-BHC	319-85-7	µg/L	3	4	75%	2.5E-02	2.5E-02	2.9E-02	1.4E-02	3.7E-02	2.6E-04	3.4E-04	2.4E-06	Neon	Fish	LC50	Mortality	4	FW	1,100	10	110	ECOTOX, 2010	18622
Bis (2-ethylhexyl) phthalate	117-81-7	µg/L	10	10	100%	--	--	1.8E+01	1.0E+01	3.3E+01	2.3E-01	6.0E-04	4.2E-06	Sheepshead minnow	Fish	NOEC	Mortality	4	SW	550,000	10	55,000	ECOTOX, 2010	10366
Bromodichloromethane	75-27-4	µg/L	1	1	100%	--	--	3.4E-01	3.4E-01	3.4E-01	2.4E-03	1.4E-05	9.9E-08	Ciliate	Invertebrates	EC50	Growth	1		240,000	10	24,000	ECOTOX, 2010	11258
Butyl benzyl phthalate	85-68-7	µg/L	3	5	60%	5.0E+00	1.0E+01	4.8E+00	2.7E+00	7.4E+00	5.2E-02	1.5E-01	1.1E-03	Shiner perch	Fish	LC50	Mortality	7	SW	490	10	49	ECOTOX, 2010	15980
Cadmium	7440-43-9	µg/L	19	64	30%	1.0E-01	3.1E+00	5.5E-01	4.1E-02	4.9E+00	3.4E-02	***4.9E+02***	***3.4E+00***	Japanese ricefish	Fish	LOEC	Genetic	1	SW	0.1	10	0.01	ECOTOX, 2010	115837
Chloroform	67-66-3	µg/L	12	12	100%	--	--	3.3E+00	2.0E+00	4.1E+00	2.9E-02	1.5E-03	1.0E-05	Sole order	Fish	LC50	Mortality	4	SW	28,000	10	2,800	ECOTOX, 2010	19535
Chloromethane	74-87-3	µg/L	3	3	100%	--	--	1.4E+00	1.1E+00	1.7E+00	1.2E-02	6.3E-05	4.4E-07	Inland silverside	Fish	LC50	Mortality	4	SW	270,000	10	27,000	ECOTOX, 2010	863
Chromium	16065-83-1	µg/L	51	64	80%	5.0E-01	3.1E+00	2.4E+00	5.2E-01	7.0E+00	4.9E-02	1.7E-03	1.2E-05	Damselfish	Fish	LC50	Mortality	4	SW	42,000	10	4,200	ECOTOX, 2010	16999
Copper	7440-50-8	µg/L	64	64	100%	--	--	3.7E+01	1.4E+00	7.7E+01	5.4E-01	***7.7E+02***	***5.4E+00***	Japanese ricefish	Fish	LOEC	Genetic	1	SW	1	10	0.1	ECOTOX, 2010	115837
Cyanide	57-12-5	µg/L	14	33	42%	4.5E-01	5.0E+00	1.3E+01	1.9E-01	5.9E+01	4.1E-01	***2.0E+00***	1.4E-02	Sheepshead minnow	Fish	NOEC	Growth	28	SW	29	1	29	ECOTOX, 2010	14594
Dieldrin	60-57-1	µg/L	2	4	50%	1.0E-02	5.0E-02	1.6E-02	1.0E-02	2.1E-02	1.5E-04	4.2E-01	2.9E-03	Plaice, sand dab	Fish	LC50	Mortality	56	SW	0.5	10	0.05	ECOTOX, 2010	15149
Diethyl phthalate	84-66-2	µg/L	9	9	100%	--	--	8.4E+00	7.4E+00	1.0E+01	7.0E-02	4.5E-03	3.2E-05	Sheepshead minnow	Fish	NOEC	Mortality	4	SW	22,000	10	2,200	ECOTOX, 2010	10366
Di-n-butyl phthalate	84-74-2	µg/L	1	2	50%	5.0E+00	5.0E+00	1.7E+00	1.7E+00	1.7E+00	1.2E-02	1.7E-02	1.2E-04	Rainbow trout	Fish	NOEC	Growth	99	FW	100	1	100	ECOTOX, 2010	16380
Endosulfan II	33213-65-9	µg/L	2	2	100%	--	--	5.9E-02	4.2E-02	7.5E-02	5.3E-04	7.5E-01	5.3E-03	Carp	Fish	LC50	Mortality	2	SW	1	10	0.1	ECOTOX, 2010	19637
Endrin	72-20-8	µg/L	1	1	100%	--	--	1.1E-02	1.1E-02	1.1E-02	7.7E-05	***1.1E+00***	7.7E-03	Bluehead wrasse	Fish	LC50	Mortality	4	SW	0.1	10	0.01	ECOTOX, 2010	628
Endrin ketone	53494-70-5	µg/L	1	1	100%	--	--	1.2E-02	1.2E-02	1.2E-02	8.4E-05	***1.2E+00***	8.4E-03	Bluehead wrasse	Fish	LC50	Mortality	4	SW	0.1	10	0.01	ECOTOX, 2010	628
Ethylbenzene	100-41-4	µg/L	5	12	42%	2.5E+00	5.0E+00	1.2E+00	6.2E-01	2.9E+00	2.0E-02	8.8E-03	6.2E-05	Atlantic silverside	Fish	NOEC	Mortality	4	SW	3,300	10	330	ECOTOX, 2010	4189
Heptachlor	76-44-8	µg/L	5	5	100%	--	--	4.6E-01	1.5E-02	9.9E-01	6.9E-03	***1.2E+01***	8.7E-02	Bluehead wrasse	Fish	LC50	Mortality	4	SW	0.8	10	0.08	ECOTOX, 2010	628
Lead	7439-92-1	µg/L	57	64	89%	1.0E-01	5.0E-01	2.9E+00	2.3E-01	1.2E+01	8.4E-02	1.5E-02	1.1E-04	Hirame, flounder	Fish	LC50	Mortality	2	SW	8,000	10	800	ECOTOX, 2010	13279
Malathion	121-75-5	µg/L	1	3	33%	6.0E-01	6.0E-01	4.9E-01	4.9E-01	4.9E-01	3.4E-03	1.2E-01	8.6E-04	Sheepshead minnow	Fish	NOEC	Mortality	140	SW	4	1	4	ECOTOX, 2010	5074
Mercury	7487-94-7	µg/L	30	64	47%	3.0E-02	2.0E-01	1.0E-01	2.7E-02	7.0E-01	4.9E-03	7.0E-01	4.9E-03	Giant perch, White sea bass	Fish	LC16	Mortality	4	SW	10	10	1	ECOTOX, 2010	78035
Methylene Chloride	75-09-2	µg/L	12	12	100%	--	--	4.8E+00	2.6E+00	1.1E+01	7.7E-02	1.1E-03	7.9E-06	Mummichog	Fish	LC50	Mortality	2	SW	97,000	10	9,700	ECOTOX, 2010	3163
Molybdenum	7439-98-7	µg/L	25	32	78%	2.5E+00	1.0E+01	6.8E+00	4.2E+00	1.1E+01	7.7E-02	2.2E-04	1.5E-06	Rainbow trout	Fish	LOEC	Mortality	4	FW	500,000	10	50,000	ECOTOX, 2010	14367
Nickel	7440-02-0	µg/L	53	64	83%	5.0E-01	3.1E+00	3.6E+00	2.0E+00	8.0E+00	5.6E-02	***8.0E+01***	5.6E-01	Japanese Ricefish	Fish	LOEC	Genetic	1	SW	1	10	0.1	ECOTOX, 2010	115837
Phenol	108-95-2	µg/L	11	12	92%	1.0E+01	1.0E+01	2.0E+01	1.3E+01	2.5E+01	1.8E-01	***2.5E+00***	1.8E-02	Flounder	Fish	LC50	Mortality	2	SW	100	10	10	ECOTOX, 2010	5480
Selenium	7782-49-2	µg/L	9	32	28%	5.0E-01	5.0E+00	2.3E+00	4.7E-01	9.6E+00	6.7E-02	4.8E-02	3.4E-04	Sheepshead minnow	Fish	NOEC	Mortality	4	SW	2,000	10	200	ECOTOX, 2010	10366
Silver	7440-22-4	µg/L	42	64	66%	1.0E-01	1.0E+00	1.6E+00	3.0E-01	3.9E+00	2.7E-02	***3.9E+02***	***2.7E+00***	Japanese ricefish	Fish	LOEC	Genetic	1	SW	0.1	10	0.01	ECOTOX, 2010	115837
Tetrachloroethene	127-18-4	µg/L	6	11	55%	2.5E+00	5.0E+00	2.7E+00	9.4E-01	6.4E+00	4.5E-02	1.3E-02	9.0E-05	Sole order	Fish	LC50	Mortality	4	SW	5,000	10	500	ECOTOX, 2010	19535
Toluene	108-88-3	µg/L	12	12	100%	--	--	8.4E+00	4.0E+00	2.1E+01	1.5E-01	6.6E-03	4.6E-05	Sheepshead minnow	Fish	NOEC	Mortality	28	SW	3,200	1	3,200	ECOTOX, 2010	9953
Xylenes (total)	1330-20-7	µg/L	10	12	83%	5.0E+00	5.0E+00	5.2E+00	1.5E+00	2.3E+01	1.6E-01	5.8E-02	4.0E-04	Atlantic silverside	Fish	EC50	Mortality		SW	4,000	10	400	ECOTOX, 2010	14809
Zinc	7440-66-6	µg/L	64	64	100%	--	--	6.7E+01	1.1E+00	1.5E+02	1.1E+00	***1.5E+02***	***1.1E+00***	Japanese ricefish	Fish	LOEC	Genetic	1	SW	10	10	1	ECOTOX, 2010	115837

Notes:

[a] Full citations for primary sources referenced in ECOTOX or other sources are provided in the attachment to Appendix A.

na = not available
µg/L = micrograms per liter
NOEC = no observed effect level
LOEC = lowest observed effect level
EC50 = 50 percent effect concentration
LC50 = 50 percent lethal concentration
LC10 = 10 percent lethal concentration
FW = freshwater
SW = saltwater/marine

Table A-3

Emerging Parameters of Concern Reported in Literature for Primary Influent and Effluent

Y	= the compound was reported detected in that study location
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Compound Group	Compound	Study Location		
		USA	Canada	Worldwide
Pharmaceuticals and Personal Care Products	1,7-Dimethyl xanthine	Y		
	4-Epianhydrochlortetracycline (EACTC)	N		
	4-Epianhydrotetracycline (EATC)	N		
	4-Epichlortetracycline (ECTC)	N		
	4-Epioxytetracycline (EOTC)	N		
	4-Epitetracycline (ETC)	Y		
	Acetaminophen (paracetamol)	Y		Y
	Albuterol (salbutamol)	Y		
	Anhydrochlortetracycline (ACTC)	N		
	Anhydrotetracycline (ATC)	N		
	Atenolol			Y
	Azithromycin	Y		Y
	Bezafibrate		Y	Y
	Caffeine	Y		
	Carbadox	N		
	Carbamazepine	Y	Y	Y
	Cefotaxime	N		
	Chlorotetracycline	Y		
	Cimetidine	Y		
	Ciprofloxacin	Y		Y
	Clarithromycin	Y		Y
	Clinafloxacin	N		
	Clofibric acid		N	Y
	Clotrimazole			Y
	Cloxacillin	Y		
	Codeine	Y		
	Cotinine	Y		
	Cyclophosphamide		N	
	Dehydronifedipine	Y		
	Demeclocycline	N		
	Dextropropoxyphene			Y
	Diclofenac		Y	Y
	Digoxigenin	N		
	Digoxin	N		
	Diltiazem	Y		
	Diphenhydramine	Y		
	Doxycycline	Y		
	Enrofloxacin	N		
	Erythromycin	Y		Y
	Erythromycin-H2O			Y
	Fenofibrate		N	
	Fenoprofen		Y	
	Flumequine	N		
	Fluoxetine	Y		
	Gemfibrozil	Y	Y	Y
	Ibuprofen	Y	Y	Y
	Ifosfamide		N	
	Indomethacin		Y	
	Iopromide			Y
	Isochlortetracycline (ICTC)	N		
	Ketoprofen		Y	Y
	Levofloxacin			Y
	Lincomycin	Y		
	Lomefloxacin	N		
	Mefenamic acid			Y
	Metformin	Y		

Table A-3

Emerging Parameters of Concern Reported in Literature for Primary Influent and Effluent

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	Metoprolol			Y
	Miconazole	Y		
	Minocycline	Y		
	Naproxen	Y	Y	Y
	Norfloxacin	N		Y
	Norgestimate	N		
	Ofloxacin	Y		
	Ormetoprim	N		
	Oxacillin	N		
	Oxolinic Acid	N		
	Oxytetracycline	N		
	Penicillin G	N		
	Penicillin V	Y		
	Pentoxyfylline		N	
	Phenazone		N	
	Propranolol			Y
	Ranitidine	Y		
	Roxithromycin	N		Y
	Salicylic acid		Y	Y
	Sarafloxicin	N		
	Sulfachloropyridazine	N		
	Sulfadiazine	Y		
	Sulfadimethoxine	Y		
	Sulfamerazine	Y		
	Sulfamethazine	Y		Y
	Sulfamethizole	Y		
	Sulfamethoxazole	Y		Y
	Sulfanilamide	N		
	Sulfathiazole	Y		
	Tamoxifen			Y
	Tetracycline	Y		Y
	Thiabendazole	Y		
	Triclocarban	Y		
	Triclosan	Y	Y	Y
	Trimethoprim	Y		Y
	Tylosin	N		
	Virginiamycin	Y		
	Warfarin	Y		
Fragrances	Cashmeran (DPMI)		Y	
	Celestolide (ADBI)		Y	
	Galaxolide (HHCB)		Y	Y
	Musk Abrette (MA)		Y	
	Musk Ketone (MK)		Y	
	Musk Moskene (MM)		Y	
	Musk Tibetene (MT)		Y	
	Musk Xylene (MX)		Y	
	Phantolide (AHMI or AHDI)		Y	
	Tonalide (AHTN)		Y	Y
	Traseolide (ATII)		Y	
Miscellaneous Endocrine Disrupting Compounds	4-Nonylphenol	Y	Y	Y
	4-Nonylphenoxyacetic acid		Y	
	4-tert-Octylphenol	Y	Y	Y
	4-tert-Octylphenoxyacetic acid		Y	
	Bisphenol A	Y	Y	Y
	Nonylphenol diethoxylate (NP2EO)	Y		
	Nonylphenol Ethoxylates (total)		Y	
	Nonylphenol monoethoxylate (NP1EO)	Y		
Hormones and Sterols	16α-Hydroxyestrone		Y	
	17ß-Estradiol	Y	Y	Y

Table A-3
Emerging Parameters of Concern Reported in Literature for Primary Influent and Effluent

Y	= the compound was reported detected in that study location
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	= the compound was not analyzed for in that study location

	17α-Dihydroequilin	Y		
	17α-Estradiol	Y		Y
	17α-Ethinylestradiol	Y		Y
	Androstenedione	Y		
	Androsterone	Y		
	Campesterol	Y		
	Cholestanol	Y		
	Cholesterol	Y		
	Coprostanol	Y		
	Desmosterol	Y		
	Desogestrel	N		
	Epicoprostanol	Y		
	Equilenin	N		
	Equilin	Y		
	Ergosterol	Y		
	Estriol	Y		Y
	Estrone	Y	Y	Y
	Mestranol	Y		
	Norethindrone	Y		
	Norgestrel	Y		
	Progesterone	Y		
	ß-Estradiol 3-Benzoate	Y		
	ß-Sitosterol	Y		
	ß-Stigmastanol	Y		
	Stigmasterol	Y		
	Testosterone	Y	Y	Y
	α-Zearalanol	Y		
Polybrominated Diphenyl Ethers (Flame Retardant)	PBDE-28+PBDE-33	Y		
	PBDE-47	Y		
	PBDE-99	Y		
	PBDE-100	Y		
	PBDE-153	Y		
	PBDE-154	Y		
	PBDE-183	Y		
	PBDE-209	Y		
Pesticides	2,4'-DDD	Y		
	2,4'-DDE	N		
	2,4'-DDT	Y		
	4,4'-DDD	Y		
	4,4'-DDE	Y		
	4,4'-DDT	Y		
	Aldrin	N		
	Alpha-BHC	Y		
	Alpha-chlordane	Y		
	Ametryn	N		
	Atrazine	Y		
	Azinphos-methyl	N		
	Beta-BHC	N		
	Captan	N		
	Chlorothalonil	Y		
	Chlorpyriphos	Y		
	Chlorpyriphos-oxon	Y		
	Cis-Nonachlor	Y		
	Cis-Permethrin	Y		
	Cyanazine	N		
	Cypermethrins	Y		
	Dacthal	N		
	Delta-BHC	N		
	Desethyl atrazine	Y		

Table A-3

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Diazinon	Y		
Diazinon oxon	N		
Dieldrin	Y		
Disulfoton	N		
Disulfoton sulfone	Y		
Endosulfan I	Y		
Endosulfan II	N		
Endosulfan sulfate	N		
Endrin	N		
Endrin Ketone	N		
Ethyl-parathion	N		
Fenitrothion	N		
Fonofos	N		
Gamma-BHC	Y		
Gamma-chlordane	Y		
Heptachlor	Y		
Heptachlor Epoxide	Y		
Hexachlorobenzene	Y		
Hexazinone	Y		
Malathion	Y		
Methamidophos	Y		
Methoxychlor	Y		
Methyl-chlorpyriphos	Y		
Methyl-parathion	Y		
Metribuzin	N		
Mirex	N		
Octachlorostyrene	N		
Oxychlordane	N		
Pentochloronitrobenzene	N		
Permethrin	Y		
Perthane	Y		
Phorate	N		
Phosmet	N		
Pirimiphos-methyl	N		
Simazine	Y		
Tecnazene	N		
Trans-Nonachlor	Y		
Trans-Permethrin	Y		

Table A-4

Evaluation Results for Maximum Concentrations of Emerging Parameters of Concern Reported in Literature

Anchorage Water and Wastewater Utility

Dilution at Edge of ZID 142.9

Chemical	Use	CAS Number	Log Kow	Units	Maximum Reported Concentration	Source	Concentration Citation	Maximum at ZID	Hazard Quotient at End of Pipe	Hazard Quotient at Edge of ZID	Toxicity Study Species Common Name	Test Species Type	Toxicity Endpoint	Type of Effect	Exposure Duration (Days)	Media Type	Reported Effect Level (µg/L)	Toxicity Uncertainty Factor	Adjusted Effect Level (µg/L)	Source	ECOTOX^a Reference Number
1,7-Dimethyl xanthine	Antispasmodic, caffeine metabolite	611-59-6	-0.22	µg/L	6.3E+01	Influent - individual sample	USEPA (2009)	4.4E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
16α-Hydroxyestrone	Estrogen metabolite	566-76-7	na	µg/L	2.8E-02	Influent - max	Lee et al. (2004)	2.0E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
17ß-Estradiol	Sex hormone	50-28-2	4.01	µg/L	1.5E-01	Effluent - max	WERF (2006)	1.1E-03	3.0E-05	2.1E-07	Sea bass	Fish	LOEC	Developmental	200	SW	5,000	1	5,000	ECOTOX, 2010	71231
17α-Estradiol	Sex hormone	57-91-0	4.01	µg/L	1.7E-02	Influent - max	Miège et al. (2009)	1.2E-04	1.7E-06	1.2E-08	Copepod	Crustacean	EC50	Not reported	7	--	10,000	1	10,000	NCCOS, 2010	--
17α-Ethinylestradiol	Ovulation Inhibitor	57-63-6	3.67	µg/L	7.0E-02	Influent - max	Miège et al. (2009)	4.9E-04	***7.0E+00***	4.9E-02	Mummichog	Fish	NOEC	Developmental	60	SW	0.01	1	0.01	ECOTOX, 2010	73295
4-Epitetracycline (ETC)	Tetracycline degradate	23313-80-6	-1.3	µg/L	4.8E-01	Influent - individual sample	USEPA (2009)	3.3E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nonylphenol	Surfactant metabolite	25154-52-3	5.76	µg/L	3.4E+02	Effluent - max	WERF (2006)	2.4E+00	***1.2E+02***	8.3E-01	Medaka, high eyes	Fish	NOEC	Morphology	100	FW	2.9	1	2.9	ECOTOX, 2010	90077
4-Nonylphenoxyacetic acid	Surfactant metabolite	3115-49-9	5.80	µg/L	4.3E+00	Influent - max	Lee et al. (2004)	3.0E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
4-tert-Octylphenol	Nonionic detergent metabolite	140-66-9	5.28	µg/L	1.3E+01	Influent - individual sample	USEPA (2009)	9.1E-02	***4.1E+01***	2.8E-01	Zebra danio	Fish	LOEC	Mortality	6	FW	3.2	10	0.32	ECOTOX, 2010	85750
4-tert-Octylphenoxyacetic acid	Nonionic detergent metabolite	na	na	µg/L	7.1E-01	Influent - max	Lee et al. (2004)	5.0E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Acetaminophen (paracetamol)	Antipyretic, analgesic	103-90-2	0.46	µg/L	3.4E+02	Influent - individual sample	USEPA (2009)	2.4E+00	4.2E-03	2.9E-05	Fathead minnow	Fish	LC50	Mortality	4	FW	814,000	10	81,400	ECOTOX, 2010	15031/12448
Albuterol (salbutamol)	Antiasthmatic	18559-94-9	0.64	µg/L	7.6E-02	Influent - individual sample	USEPA (2009)	5.3E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Androstenedione	Anabolic agent	63-05-8	2.75	µg/L	8.6E-01	Influent - individual sample	USEPA (2009)	6.0E-03	8.6E-05	6.0E-07	Western mosquitofish	Fish	NA	Morphology	14	FW	10,000	1	10,000	ECOTOX, 2010	50414
Androsterone	Urinary steroid	53-41-8	3.69	µg/L	2.9E+00	Influent - individual sample	USEPA (2009)	2.0E-02	5.8E-02	4.1E-04	Common eel	Fish	NA	Morphology	28	FW	50	1	50	ECOTOX, 2010	60070
Atenolol	Betablocker	29122-68-7	0.16	µg/L	3.0E-02	Influent - mean	Miège et al. (2009)	2.1E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Atrazine	Trazine pesticide	1912-24-9	2.61	µg/L	8.8E-02	Influent - individual sample	USEPA (2009)	6.1E-04	2.3E-03	1.6E-05	Red drum	Fish	NOEC	Growth	9	SW	37.43	1	37.43	ECOTOX, 2010	81463
Azithromycin	Macrolide antibiotic	83905-01-5	4.02	µg/L	6.7E-01	Influent - individual sample	USEPA (2009)	4.7E-03	5.6E-05	3.9E-07	Water flea	Crustacean	EC50	Not reported	NA	FW	120,000	10	12,000	NCCOS, 2010	--
Bezafibrate	Lipid regulator	41859-67-0	4.25	µg/L	7.6E+00	Influent - max	Miège et al. (2009)	5.3E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Bisphenol A	Plasticizer	80-05-7	3.32	µg/L	2.8E+01	Influent - max	Lee et al. (2004)	2.0E-01	***1.6E+01***	1.1E-01	Brown trout	Fish	LOEC/NOEC	Reproduction	46	FW	1.75	1	1.75	ECOTOX, 2010	89713
Caffeine	Stimulant	58-08-2	-0.07	µg/L	6.8E+01	Influent - individual sample	USEPA (2009)	4.8E-01	3.4E-02	2.4E-04	Fathead minnow	Fish	LOEC	Growth	5	FW	20,000	10	2,000	ECOTOX, 2010	16432
Campesterol	Phytosterol (plant sterol)	474-62-4	9.16	µg/L	4.7E+01	Influent - individual sample	USEPA (2009)	3.3E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbamazepine	Anticonvulsant	298-46-4	2.45	µg/L	1.9E+00	Influent - max	Miège et al. (2009)	1.3E-02	7.6E-05	5.3E-07	Zebra danio	Fish	NOEC	Not reported	10	--	25,000	1	25,000	NCCOS, 2010	--
Cashmeran (DPMI)	Fragrance	33704-61-9	4.49	µg/L	1.6E-01	Influent - individual sample	Smyth et al. (2008)	1.1E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Celestolide (ADBI)	Fragrance	13171-00-1	5.93	µg/L	2.6E-01	Influent - individual sample	Smyth et al. (2008)	1.8E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorotetracycline	Tetracycline antibiotic	57-62-5	-0.62	µg/L	4.3E-01	Influent - individual sample	USEPA (2009)	3.0E-03	4.9E-05	3.5E-07	Water flea	Crustacean	EC50	--	NA	--	88,000	10	8,800	NCCOS, 2010	--
Chlorothalonil	Organochlorine pesticide	1897-45-6	3.05	µg/L	1.0E-03	Influent - individual sample	USEPA (2009)	7.3E-06	3.3E-04	2.3E-06	Spot	Fish	EC50	Mortality	2	SW	32	10	3.2	ECOTOX, 2010	14574
Chlorpyriphos	Organophosphorus pesticide	2921-88-2	4.96	µg/L	2.6E-01	Influent - individual sample	USEPA (2009)	1.8E-03	5.2E-02	3.7E-04	Ambon damselfish	Fish	NOEC	Growth	6	SW	50	10	5	ECOTOX, 2010	75183
Cholestanol	Sterol	80-97-7	8.82	µg/L	4.6E+01	Influent - individual sample	USEPA (2009)	3.2E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
Cholesterol	Plant/animal steroid	57-88-5	8.74	µg/L	7.5E+02	Influent - individual sample	USEPA (2009)	5.2E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Cimetidine	Anti-acid reflux	51481-61-9	0.40	µg/L	1.2E+01	Influent - individual sample	USEPA (2009)	8.2E-02	1.2E-04	8.2E-07	Bluegill	Fish	LC50	Mortality	NA	--	1,000,000	10	100,000	NCCOS, 2010	--
Ciprofloxacin	Quinoline antibiotic	85721-33-1	0.28	µg/L	1.5E+01	Influent - individual sample	USEPA (2009)	1.1E-01	1.5E-03	1.1E-05	Zebra danio	Fish	NOEC	Not reported	NA	--	100,000	10	10,000	NCCOS, 2010	--
Cis-Permethrin	Pyrethroid pesticide	61949-76-6	6.5	µg/L	3.1E-01	Influent - individual sample	USEPA (2009)	2.1E-03	6.1E-01	4.3E-03	Desert pupfish	Fish	LC50	Mortality	2	--	5	10	0.5	ECOTOX, 2010	699
Clarithromycin	Macrolide antibiotic	81103-11-9	3.16	µg/L	7.5E-01	Influent - individual sample	USEPA (2009)	5.2E-03	1.9E-01	1.3E-03	Water flea	Crustacean	EC50	Not reported	NA	--	40	10	4	NCCOS, 2010	--
Clofibric acid	Metabolite	882-09-7	2.57	µg/L	6.5E-01	Influent - max	Miège et al. (2009)	4.6E-03	1.2E-05	8.7E-08	Eastern mosquitofish	Fish	LC50	Mortality	4	SW	526,500	10	52,650	ECOTOX, 2010	80816
Clotrimazole	Antifongic	23593-75-1	6.26	µg/L	3.3E-02	Influent - max	Miège et al. (2009)	2.3E-04	3.3E-04	2.3E-06	Jumbo tiger prawn	Crustaceans	NOEC	Mortality	1	SW	1,000	10	100	ECOTOX, 2010	4581
Codeine	Opiate	76-57-3	1.19	µg/L	3.5E-01	Influent - individual sample	USEPA (2009)	2.4E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Coprostanol	Fecal steroid	360-68-9	8.82	µg/L	5.0E+02	Influent - individual sample	USEPA (2009)	3.5E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Cotinine	Nicotine metabolite	486-56-6	0.07	µg/L	3.0E+00	Influent - individual sample	USEPA (2009)	2.1E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cypermethrins	Pyrethroid pesticide	52315-07-8	6.06	µg/L	7.1E-02	Influent - individual sample	USEPA (2009)	4.9E-04	9.7E-01	6.8E-03	Sheepshead minnow	Fish	LC50	Mortality	4	SW	0.73	10	0.073	ECOTOX, 2010	344
Desethyl atrazine	Trazine pesticide	6190-65-4	1.51	µg/L	5.8E-02	Influent - individual sample	USEPA (2009)	4.1E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Desmosterol	Sterol	313-04-2	8.65	µg/L	1.1E+01	Influent - individual sample	USEPA (2009)	7.8E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Dextropropoxyphene	Analgesic antiinflammatory	469-62-5	4.18	µg/L	3.3E-02	Influent - max	Miège et al. (2009)	2.3E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Diazinon	Organophosphorus pesticide	333-41-5	3.81	µg/L	7.2E-02	Influent - individual sample	USEPA (2009)	5.0E-04	2.8E-01	1.9E-03	Agohaze, goby	Fish	LC50	Mortality	1	SW	3	10	0.26	ECOTOX, 2010	5767
Diclofenac	Analgesic antiinflammatory	15307-86-5	4.51	µg/L	4.1E+00	Influent - max	Miège et al. (2009)	2.9E-02	1.0E-02	7.2E-05	Zebra danio	Fish	NOEC		NA	--	4,000	10	400	NCCOS, 2010	--
Diltiazem	Antihypertensive	42399-41-7	2.7	µg/L	1.5E+00	Influent - individual sample	USEPA (2009)	1.0E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Diphenhydramine	Antihistamine	58-73-1	3.27	µg/L	1.4E+00	Influent - individual sample	USEPA (2009)	1.0E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Doxycycline	Tetracycline antibiotic	564-25-0	-0.02	µg/L	3.0E+00	Influent - individual sample	USEPA (2009)	2.1E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Epicoprostanol	Sterol	516-92-7	8.86	µg/L	2.1E+01	Influent - individual sample	USEPA (2009)	1.5E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
Equilin	Hormone replacement	474-86-2	3.35	µg/L	2.9E-02	Influent - individual sample	USEPA (2009)	2.0E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Ergosterol	Sterol	57-87-4	8.86	µg/L	4.5E+00	Influent - individual sample	USEPA (2009)	3.1E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Erythromycin	Macrolide antibiotic	114-07-8	3.06	µg/L	2.3E+00	Influent - individual sample	USEPA (2009)	1.6E-02	6.7E-05	4.7E-07	Striped bass	Fish	LC50	Mortality	4	FW	349,000	10	34,900	ECOTOX, 2010	2468
Erythromycin-H2O	macrolide antibiotic	59319-72-1	3.06	µg/L	1.2E+00	Influent - max	Miège et al. (2009)	8.4E-03	3.4E-05	2.4E-07	Striped bass	Fish	LC50	Mortality	4	FW	349,000	10	34,900	ECOTOX, 2010	2468
Estriol	Sex hormone	50-27-1	2.45	µg/L	1.0E+00	Influent - individual sample	USEPA (2009)	7.0E-03	***1.3E+01***	9.3E-02	Medaka, high eyes	Fish	NOEC	Morphology	85-110	FW	0.075	1	0.075	ECOTOX, 2010	56678
Estrone	Sex hormone	53-16-7	3.13	µg/L	6.7E-01	Influent - max	Miège et al. (2009)	4.7E-03	***6.7E+01***	4.7E-01	Cunner	Fish	NOEC	Mortality	2	SW	0.1	10	0.01	ECOTOX, 2010	90343
Fenoprofen	Antiinflammatory	31879-05-7	3.9	µg/L	9.7E+00	Influent - max	Metcalfe et al. (2003a)	6.8E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoxetine	SSRI Antidepressant	54910-89-3	4.05	µg/L	5.9E-02	Influent - individual sample	USEPA (2009)	4.1E-04	1.2E-02	8.2E-05	Medaka, high eyes	Fish	NOEC	Growth/Reproduction	28	SW	5	1	5	ECOTOX, 2010	74238
Galaxolide (HHCB)	Fragrance	1222-05-5	5.90	µg/L	4.0E+01	Influent - individual sample	Smyth et al. (2008)	2.8E-01	5.9E-01	4.1E-03	Fathead minnow	Fish	NOEC	Growth/Mortality	32	FW	68	1	68	--	--
Gemfibrozil	Antilipemic	25812-30-0	4.77	µg/L	6.6E+00	Influent - individual sample	USEPA (2009)	4.6E-02	1.3E-01	8.8E-04	Water flea	Crustacean	EC50	Not reported	NA	--	530	10	53	NCCOS, 2010	--
Hexazinone	Trazine pesticide	51235-04-2	1.85	µg/L	7.1E-03	Influent - individual sample	USEPA (2009)	5.0E-05	8.9E-05	6.3E-07	Atlantic salmon	Fish	NOEC	Growth/Morphology	21	FW	79.8	1	79.8	ECOTOX, 2010	93473
Ibuprofen	Analgesic	15687-27-1	3.97	µg/L	8.4E+01	Influent - max	Miège et al. (2009)	5.8E-01	4.8E-03	3.4E-05	Bluegill	Fish	LC50	Mortality	4	FW	173,000	10	17,300	NCCOS, 2010	--
Indomethacin	Antiinflammatory	53-86-1	4.27	µg/L	6.4E-01	Influent - max	Lishman et al. (2006)	4.5E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Iopromide	Radiopaque contrast agent	73334-07-3	-2.05	µg/L	7.5E+00	Influent - max	Miège et al. (2009)	5.3E-02	7.5E-06	5.3E-08	Zebra danio	Fish	LC50	Mortality	4	FW	10,000,000	10	1,000,000	ECOTOX, 2010	20240
Ketoprofen	Analgesic antiinflammatory	22071-15-4	3.12	µg/L	5.7E+00	Influent - max	Miège et al. (2009)	4.0E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Levofloxacin	Quinoline antibiotic	100986-85-4	na	µg/L	5.5E-04	Influent - max	Miège et al. (2009)	3.9E-06	5.5E-08	3.9E-10	Fathead minnow	Fish	NOEC	Growth/Mortality	7	FW	10,000	1	10,000	ECOTOX, 2010	80421
Lincomycin	Lincosamide antibiotic	154-21-2	0.2	µg/L	1.9E-02	Influent - individual sample	USEPA (2009)	1.3E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Malathion	Organophosphorus pesticide	121-75-5	2.36	µg/L	4.7E-01	Influent - individual sample	USEPA (2009)	3.3E-03	6.4E-02	4.5E-04	Red drum	Fish	NOEC	Growth	9	SW	7.42	1	7.42	ECOTOX, 2010	81672
Mefenamic acid	Analgesic antiinflammatory	61-68-7	5.12	µg/L	3.2E+00	Influent - max	Miège et al. (2009)	2.2E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Metformin	Antidiabetic drug	657-24-9	-2.64	µg/L	2.5E+02	Influent - individual sample	USEPA (2009)	1.7E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl-parathion	Organophosphorus pesticide	298-00-0	2.86	µg/L	9.5E-02	Influent - individual sample	USEPA (2009)	6.6E-04	***2.0E+00***	1.4E-02	Sheepshead minnow	Fish	NOEC	Mortality	5	SW	0.475	10	0.0475	ECOTOX, 2010	10123
Metoprolol	Betablocker	37350-58-6	1.88	µg/L	1.6E-01	Influent - max	Miège et al. (2009)	1.1E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Miconazole	Antifungal agent	22916-47-8	6.25	µg/L	1.1E-01	Influent - individual sample	USEPA (2009)	8.0E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Musk Abrette (MA)	Fragrance	83-66-9	4.17	µg/L	9.9E-03	Influent - individual sample	Smyth et al. (2008)	6.9E-05	--	--	--	--	--	--	--	--	--	--	--	--	--
Musk Ketone (MK)	Fragrance	81-14-1	4.60	µg/L	3.9E-01	Influent - individual sample	Smyth et al. (2008)	2.7E-03	6.9E-03	4.8E-05	Rainbow trout	Fish	NOEC	Reproduction	21	FW	56	1	56	--	--
Musk Moskene (MM)	Fragrance	116-66-5	5.39	µg/L	1.3E-02	Influent - individual sample	Smyth et al. (2008)	8.8E-05	--	--	--	--	--	--	--	--	--	--	--	--	--

Table A-4
Evaluation Results for Maximum Concentrations of Emerging Parameters of Concern Reported in Literature
Anchorage Water and Wastewater Utility
Dilution at Edge of ZID 142.9

Chemical	Use	CAS Number	Log Kow	Units	Maximum Reported Concentration	Source	Concentration Citation	Maximum at ZID	Hazard Quotient at End of Pipe	Hazard Quotient at Edge of ZID	Toxicity Study Species Common Name	Test Species Type	Toxicity Endpoint	Type of Effect	Exposure Duration (Days)	Media Type	Reported Effect Level (µg/L)	Toxicity Uncertainty Factor	Adjusted Effect Level (µg/L)	Source	ECOTOX[a] Reference Number
Musk Tibetene (MT)	Fragrance	145-39-1	5.18	µg/L	4.1E-03	Influent - individual sample	Smyth et al. (2008)	2.9E-05	--	--	--	--	--	--	--	--	--	--	--	--	--
Musk Xylene (MX)	Fragrance	81-15-2	4.45	µg/L	2.5E-01	Influent - individual sample	Smyth et al. (2008)	1.8E-03	7.6E-03	5.3E-05	Zebra danio	Fish	NOEC	Mortality	2	FW	330	10	33	ECOTOX, 2010	73327
Naproxen	Non-steroidal anti-inflammatory drug	22204-53-1	3.18	µg/L	6.1E+02	Influent - max	Miège et al. (2009)	4.3E+00	1.1E-02	7.6E-05	Bluegill	Fish	LC50	Mortality	4	FW	560,000	10	56,000	--	--
Nonylphenol diethoxylate (NP2EO)	Nonionic detergent metabolite	26027-38-2	4.21	µg/L	2.0E+02	Influent - individual sample	USEPA (2009)	1.4E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Nonylphenol Ethoxylates (total)	Nonionic detergent metabolite	26027-38-2	4.21	µg/L	8.7E-01	Influent - max	Lee et al. (2004)	6.1E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Nonylphenol monoethoxylate (NP1EO)	Surfactant metabolite	na	4.17	µg/L	1.0E+02	Influent - individual sample	USEPA (2009)	7.0E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
Norfloxacin	Quinoline antibiotic	70458-96-7	-1.03	µg/L	5.2E-01	Influent - max	Miège et al. (2009)	3.6E-03	5.2E-06	3.6E-08	Grass carp, white amur	Fish	LD50	Mortality	4	FW	1,000,000	10	100,000	ECOTOX, 2010	16685
Ofloxacin	Quinoline antibiotic	82419-36-1	-0.39	µg/L	3.2E+00	Influent - individual sample	USEPA (2009)	2.3E-02	3.2E-04	2.3E-06	Fathead minnow	Fish	NOEC	Growth/Mortality	7	FW	10,000	1	10,000	ECOTOX, 2010	80421
PBDE-100	Flame retardant	189084-64-8	na	µg/L	3.6E-02	Influent - individual sample	USEPA (2009)	2.5E-04	4.0E-03	2.8E-05	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-153	Flame retardant	68631-49-2	7.40	µg/L	1.6E-02	Influent - individual sample	USEPA (2009)	1.1E-04	1.8E-03	1.2E-05	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-154	Flame retardant	207122-15-4	na	µg/L	1.2E-02	Influent - individual sample	USEPA (2009)	8.3E-05	1.3E-03	9.4E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-183	Flame retardant	na	na	µg/L	2.2E-03	Influent - individual sample	USEPA (2009)	1.5E-05	2.4E-04	1.7E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-209	Flame retardant	1163-19-5	12.11	µg/L	2.6E-01	Influent - individual sample	USEPA (2009)	1.8E-03	2.9E-02	2.0E-04	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-28+PBDE-33	Flame retardant	41318-75-6	5.88	µg/L	4.1E-03	Influent - individual sample	USEPA (2009)	2.9E-05	4.6E-04	3.2E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-47	Flame retardant	5436-43-1	6.77	µg/L	2.0E-01	Influent - individual sample	USEPA (2009)	1.4E-03	2.2E-02	1.6E-04	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-99	Flame retardant	60348-60-9	6.84	µg/L	1.6E-01	Influent - individual sample	USEPA (2009)	1.1E-03	1.7E-02	1.2E-04	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
Permethrin	Pyrethroid pesticide	52645-53-1	6.5	µg/L	6.9E-01	Influent - individual sample	USEPA (2009)	4.8E-03	4.1E-01	2.8E-03	Sheepshead minnow	Fish	LC50	Mortality	4	SW	17	10	1.7	ECOTOX, 2010	65396
Phantolide (AHMI or AHDI)	Fragrance	15323-35-0	5.85	µg/L	3.1E-01	Influent - individual sample	Smyth et al. (2008)	2.2E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Progesterone	Sex hormone	57-83-0	3.87	µg/L	1.2E-01	Influent - individual sample	USEPA (2009)	8.3E-04	2.4E-04	1.7E-06	Rainbow trout	Fish	NA	Morphology	153	FW	500	1	500	ECOTOX, 2010	15626
Propranolol	Betablocker	525-66-6	3.48	µg/L	1.2E-01	Influent - max	Miège et al. (2009)	8.3E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Ranitidine	Anti-acid reflux	66357-35-5	0.27	µg/L	1.7E+01	Influent - individual sample	USEPA (2009)	1.2E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
Roxithromycin	Macrolide antibiotic	80214-83-1	2.75	µg/L	1.2E-01	Influent - max	Miège et al. (2009)	8.2E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Salicylic acid	Metabolite	69-72-7	2.26	µg/L	8.7E+02	Influent - max	Metcalfe et al. (2003a)	6.1E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Simazine	Trazine pesticide	122-34-9	2.18	µg/L	6.7E-03	Influent - individual sample	USEPA (2009)	4.7E-05	3.0E-05	2.1E-07	Gilthead seabream	Fish	NOEC	Mortality	3	SW	2250	10	225	ECOTOX, 2010	76270
ß-Sitosterol	Phytosterol (plant sterol)	83-46-5	9.65	µg/L	2.7E+02	Influent - individual sample	USEPA (2009)	1.9E+00	***2.7E+01***	1.9E-01	Rainbow trout	Fish	NA	Growth/Morphology	21	FW	10	1	10	ECOTOX, 2010	19329
ß-Stigmastanol	Phytosterol (plant sterol)	83-45-4	9.73	µg/L	4.6E+01	Influent - individual sample	USEPA (2009)	3.2E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
Stigmasterol	Phytosterol (plant sterol)	83-48-7	9.43	µg/L	3.7E+01	Influent - individual sample	USEPA (2009)	2.6E-01	***3.7E+00***	2.6E-02	Viviporous blenny	Fish	NA	Growth/Morphology	100	SW	10	1	10	ECOTOX, 2010	61971
Sulfadiazine	Sulfonamide antibiotic	68-35-9	-0.09	µg/L	3.1E-02	Influent - individual sample	USEPA (2009)	2.2E-04	1.6E-07	1.1E-09	Carp, hawk fish	Fish	NA	Growth	10-90	FW	200,000	1	200,000	ECOTOX, 2010	3447
Sulfamerazine	Sulfonamide antibiotic	127-79-7	0.14	µg/L	1.5E-02	Influent - individual sample	USEPA (2009)	1.1E-04	1.5E-06	1.1E-08	Striped bass	Fish	LC50	Mortality	4	FW	100,000	10	10,000	ECOTOX, 2010	2468
Sulfamethazine	Sulfonamide antibiotic	57-68-1	0.19	µg/L	6.8E-01	Influent - max	Miège et al. (2009)	4.8E-03	6.8E-05	4.8E-07	Lake trout	Fish	LC50	Mortality	2	FW	100,000	10	10,000	NCCOS, 2010	--
Sulfamethoxazole	Sulfonamide antibiotic	723-46-6	0.89	µg/L	2.6E+00	Influent - individual sample	USEPA (2009)	1.8E-02	2.6E-03	1.8E-05	Water flea	Crustacean	EC50	Not reported	2	--	10,000	10	1,000	NCCOS, 2010	--
Sulfathiazole	Sulfonamide antibiotic	72-14-0	0.05	µg/L	2.1E-01	Influent - individual sample	USEPA (2009)	1.5E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Tamoxifen	Antineoplasic,	10540-29-1	6.3	µg/L	2.2E-01	Influent - max	Miège et al. (2009)	1.5E-03	4.3E-08	3.0E-10	White sucker	Fish	NOEC	Mortality	56	FW	5,000,000	1	5,000,000	ECOTOX, 2010	62018
Testosterone	Sex hormone	58-22-0	3.32	µg/L	2.7E+00	Influent - individual sample	USEPA (2009)	1.9E-02	8.8E-04	6.2E-06	Rainbow trout	Fish	NOEC	Enzyme levels	19	FW	3000	1	3000	ECOTOX, 2010	95937
Tetracycline	Tetracycline antibiotic	60-54-8	-1.3	µg/L	7.9E-01	Influent - max	Miège et al. (2009)	5.5E-03	3.6E-05	2.5E-07	Lake trout	Fish	LC50	Mortality	4	FW	220000	10	22000	NCCOS, 2010	--
Thiabendazole	Fungicide and parasiticide	148-79-8	2.47	µg/L	3.4E-02	Influent - individual sample	USEPA (2009)	2.4E-04	6.1E-04	4.3E-06	Rainbow trout	Fish	LC50	Mortality	4	FW	560	10	56	ECOTOX, 2010	344
Tonalide (AHTN)	Fragrance	1506-02-1	5.70	µg/L	1.4E+01	Influent - individual sample	Smyth et al. (2008)	9.5E-02	3.9E-01	2.7E-03	Fathead minnow	Fish	NOEC	Early lifestage	36	FW	35	1	35	--	--
Trans-Permethrin	Pyrethroid pesticide	61949-77-7	6.5	µg/L	3.8E-01	Influent - individual sample	USEPA (2009)	2.7E-03	2.7E-01	1.9E-03	Rainbow trout	Fish	LC50	Mortality	1	FW	14	10	1.4	ECOTOX, 2010	5178
Traseolide (ATII)	Fragrance	68140-48-7	6.31	µg/L	2.0E+00	Influent - individual sample	Smyth et al. (2008)	1.4E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Triclocarban	Antimicrobial, disinfectant	101-20-2	4.90	µg/L	1.4E+01	Influent - individual sample	USEPA (2009)	9.6E-02	***3.0E+02***	***2.1E+00***	Bluegill	Fish	LOEC	Mortality	4	FW	0.46	10	0.046	ECOTOX, 2010	90733
Triclosan	Antimicrobial, disinfectant	3380-34-5	4.76	µg/L	1.2E+01	Influent - individual sample	USEPA (2009)	8.4E-02	6.9E-01	4.9E-03	Medaka, high eyes	Fish	NOEC	Morphology	21	FW	17.3	1	17.3	ECOTOX, 2010	73484
Trimethoprim	Pyrimidine antibiotic	738-70-5	0.91	µg/L	1.3E+00	Influent - max	Miège et al. (2009)	9.1E-03	1.3E-04	9.1E-07	Zebra danio	Fish	NOEC	Not reported	NA	--	100,000	10	10,000	NCCOS, 2010	--

Notes:
[a] Full citations for primary sources referenced in ECOTOX or other sources are provided in the attachment to Appendix A.
na = not available
µg/L = micrograms per liter
NOEC = no observed effect level
LOEC = lowest observed effect level
EC50 = 50 percent effect concentration
LC50 = 50 percent lethal concentration
LC10 = 10 percent lethal concentration
FW = freshwater
SW = saltwater/marine

Table A-5

Evaluation Results for Concentrations of Emerging Paramaters of Concern Detected in AWWU Primary Effluent in 2010

Anchorage Water and Wastewater Utility

Dilution at Edge of ZID 142.9

Chemical	Use	CAS Number	Log Kow[a]	Units	Detected Concentration	Qualifier	Maximum at ZID	Hazard Quotient at End of Pipe	Hazard Quotient at Edge of ZID	Toxicity Study Species Common Name	Test Species Type	Toxicity Endpoint	Type of Effect	Exposure Duration (Days)	Media Type	Reported Effect Level (µg/L)	Toxicity Uncertainty Factor	Adjusted Effect Level (µg/L)	Source	ECOTOX[b] Reference Number
1,7-Dimethyl xanthine	Antispasmodic, caffeine metabolite	611-59-6	-0.22	µg/L	5.8E+01		4.0E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
10-hydroxy-amitriptyline	Antidepressant	1159-82-6	4.92	µg/L	1.8E-02		1.2E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
17ß-Estradiol	Sex hormone	50-28-2	4.01	µg/L	3.6E-02	E	2.5E-04	7.3E-06	5.1E-08	Sea bass	Fish	LOEC	Developmental	200	SW	5,000	1	5,000	ECOTOX, 2010	71231
17α-Estradiol	Sex hormone	57-91-0	4.01	µg/L	4.3E-02	E	3.0E-04	4.3E-06	3.0E-08	Copepod	Crustacean	EC50	Not reported	7	--	10,000	1	10,000	NCCOS, 2010	--
17α-Ethinylestradiol	Ovulation Inhibitor	57-63-6	3.67	µg/L	1.4E-02	E	1.0E-04	***1.4E+00***	1.0E-02	Mummichog	Fish	NOEC	Developmental	60	SW	0.01	1	0.01	ECOTOX, 2010	73295
2,4'-DDD	Pesticide	53-19-0	5.87	µg/L	1.5E-03		1.0E-05	2.9E-03	2.0E-05	Purple sea urchin	Echinoderm	LOEC	Developmental	4	SW	5	10	0.5	ECOTOX, 2010	80422
2,4'-DDT	Pesticide	789-02-6	6.79	µg/L	3.1E-04	E	2.2E-06	1.3E-03	9.4E-06	Medaka, high eyes	Fish	LOEC	Reproduction	14	FW	0.23	1	0.23	ECOTOX, 2010	58073
2-Hydroxy-ibuprofen	Pain reliever	na	3.97	µg/L	3.8E+01		2.7E-01	2.2E-03	1.5E-05	Bluegill	Fish	LC50	Mortality	4	FW	173,000	10	17,300	NCCOS, 2010	--
4,4’-DDT	Organochlorine pesticide	50-29-3	6.91	µg/L	3.4E-04		2.4E-06	8.6E-03	6.0E-05	Atlantic silverside	Fish	LC50	Mortality	4	SW	0.4	10	0.04	ECOTOX, 2010	628
4,4'-DDD	Pesticide	72-54-8	6.02	µg/L	1.5E-04	E	1.1E-06	7.7E-05	5.4E-07	Spot	Fish	EC50	Mortality	2	SW	20	10	2	ECOTOX, 2010	14574
4,4'-DDE	Organochlorine pesticide	72-55-9	6.51	µg/L	9.7E-04		6.8E-06	9.7E-05	6.8E-07	Spot	Fish	EC50	Mortality	2	SW	100	10	10	ECOTOX, 2010	807
4-Epitetracycline (ETC)	Tetracycline degradate	23313-80-6	-1.30	µg/L	1.3E-01		9.1E-04	5.9E-06	4.1E-08	Lake trout	Fish	LC50	Mortality	4	FW	220,000	10	22,000	NCCOS, 2010	--
4-Nonylphenol ethoxylates	Nonionic detergent metabolite	26027-38-2	4.21	µg/L	6.8E+00		4.8E-02	***2.4E+00***	1.6E-02	Medaka, high eyes	Fish	NOEC	Morphology	100	FW	2.9	1	2.9	ECOTOX, 2010	90077
4-Nonylphenol monoethoxylates	Surfactant metabolite	na	4.17	µg/L	1.2E+01		8.4E-02	***4.2E+00***	2.9E-02	Medaka, high eyes	Fish	NOEC	Morphology	100	FW	2.9	1	2.9	ECOTOX, 2010	90077
4-Nonylphenols	Surfactant metabolite	25154-52-3	5.76	µg/L	2.0E+01		1.4E-01	***6.8E+00***	4.8E-02	Medaka, high eyes	Fish	NOEC	Morphology	100	FW	2.9	1	2.9	ECOTOX, 2010	90077
Acetaminophen (paracetamol)	Antipyretic, analgesic	103-90-2	0.46	µg/L	1.2E+02		8.4E-01	1.5E-03	1.0E-05	Fathead minnow	Fish	LC50	Mortality	4	FW	814,000	10	81,400	ECOTOX, 2010	15031/12448
Albuterol (salbutamol)	Antiasthmatic	18559-94-9	0.64	µg/L	2.0E-02		1.4E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Aldrin	Pesticide	309-00-2	6.50	µg/L	4.0E-05	E	2.8E-07	1.2E-04	8.5E-07	Mummichog	Fish	LC50	Mortality	10	SW	3.3	10	0.33	ECOTOX, 2010	2814
alpha-BHC	Organochlorine pesticide	319-84-6	4.14	µg/L	9.1E-05	E	6.3E-07	1.8E-07	1.3E-09	Guppy	Fish	LC10	Mortality	35	SW	500	1	500	ECOTOX, 2010	5594
alpha-Endosulfan	Pesticide	959-98-8	3.83	µg/L	1.0E-03	E	7.3E-06	2.1E-02	1.5E-04	Rainbow trout	Fish	LC50	Mortality	4	FW	0.5	10	0.05	ECOTOX, 2010	87973
Alprazolam	Antianxiety	28981-97-7	2.12	µg/L	2.8E-03		2.0E-05	--	--	--	--	--	--	--	--	--	--	--	--	--
Amitriptyline	Antidepressant	50-48-6	4.92	µg/L	7.6E-02		5.3E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Amlodipine	Antihypertensive	88150-42-9	3.00	µg/L	2.7E-02		1.9E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Amphetamine	Psychostimulant	300-62-9	1.76	µg/L	3.0E-01		2.1E-03	1.0E-04	7.3E-07	Fathead minnow	Fish	LC50	Mortality	4	FW	28,800	10	2,880	ECOTOX, 2010	12859
Androstenedione	Anabolic agent	63-05-8	2.75	µg/L	2.6E-01		1.8E-03	2.6E-05	1.8E-07	Western mosquitofish	Fish	NA	Morphology	14	FW	10,000	1	10,000	ECOTOX, 2010	50414
Androsterone	Urinary steroid	53-41-8	3.69	µg/L	2.9E+00		2.0E-02	5.7E-02	4.0E-04	Common eel	Fish	NA	Morphology	28	FW	50	1	50	ECOTOX, 2010	60070
Atenolol	Betablocker	29122-68-7	0.16	µg/L	1.8E+00		1.3E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Atorvastatin	Statin	134523-00-5	6.36	µg/L	5.7E-02		4.0E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Azithromycin	Macrolide antibiotic	83905-01-5	4.02	µg/L	1.4E-01		9.8E-04	1.2E-05	8.2E-08	Water flea	Crustacean	EC50	Not reported	NA	FW	120,000	10	12,000	NCCOS, 2010	--
Benzoylecgonine	Topical analgesic	519-09-5	-1.32	µg/L	1.9E+00		1.3E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Benztropine	Anticholinergic	86-13-5	4.28	µg/L	1.2E-03		8.7E-06	--	--	--	--	--	--	--	--	--	--	--	--	--
beta-BHC	Organochlorine pesticide	319-85-7	4.14	µg/L	1.5E-04	E	1.1E-06	1.4E-06	9.8E-09	Neon	Fish	LC50	Mortality	4	FW	1,100	10	110	ECOTOX, 2010	18622
beta-Endosulfan	Organochlorine pesticide	33213-65-9	3.83	µg/L	8.1E-04	E	5.7E-06	8.1E-03	5.7E-05	Carp	Fish	LC50	Mortality	2	SW	1	10	0.1	ECOTOX, 2010	19637
Bisphenol A	Plasticizer	80-05-7	3.32	µg/L	8.9E-01		6.2E-03	5.1E-01	3.5E-03	Brown trout	Fish	LOEC/NOEC	Reproduction	46	FW	1.75	1	1.75	ECOTOX, 2010	89713
Caffeine	Stimulant	58-08-2	-0.07	µg/L	9.8E+01		6.8E-01	4.9E-02	3.4E-04	Fathead minnow	Fish	LOEC	Growth	5	FW	20,000	10	2,000	ECOTOX, 2010	16432
Campesterol	Physiologicaltosterol (plant sterol)	474-62-4	9.16	µg/L	1.3E+01		9.3E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbamazepine	Anticonvulsant	298-46-4	2.45	µg/L	4.9E-01		3.4E-03	2.0E-05	1.4E-07	Zebra danio	Fish	NOEC	Not reported	10		25,000	1	25,000	NCCOS, 2010	--
Chlordane, alpha (cis)	Pesticide	5103-71-9	6.22	µg/L	2.1E-04	E	1.5E-06	3.0E-04	2.1E-06	Bluegill	Fish	LC50	Mortality	4	FW	7.09	10	0.709	ECOTOX, 2010	6797
Chlordane, gamma (trans)	Pesticide	5103-74-2	6.22	µg/L	2.1E-04	E	1.5E-06	4.2E-05	2.9E-07	Bluegill	Fish	LC50	Mortality	4	FW	50.5	10	5.05	ECOTOX, 2010	6797
Chlordane, oxy-	Pesticide	27304-13-8	5.48	µg/L	2.1E-04	E	1.5E-06	8.6E-04	6.0E-06	Fathead minnow	Fish	LC50	Mortality	4	FW	2.45	10	0.245	ECOTOX, 2010	17138
Chlorpyriphos	Organophosphorus pesticide	2921-88-2	4.96	µg/L	1.6E-03		1.1E-05	3.2E-04	2.2E-06	Ambon damselfish	Fish	NOEC	Growth	6	SW	50	10	5	ECOTOX, 2010	75183
Chlorpyriphos-Methyl	Pesticide	5598-13-0	4.31	µg/L	2.4E-04	E	1.7E-06	1.6E-05	1.1E-07	Spot	Fish	EC50	Mortality	1	SW	150	10	15	ECOTOX, 2010	14574
Cholestanol	Sterol	80-97-7	8.82	µg/L	1.0E+01		7.3E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cholesterol	Plant/animal steroid	57-88-5	8.74	µg/L	2.7E+02		1.9E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Ciprofloxacin	Quinoline antibiotic	85721-33-1	0.28	µg/L	7.2E-01		5.0E-03	7.2E-05	5.0E-07	Zebra danio	Fish	NOEC	Not reported	NA	--	100,000	10	10,000	NCCOS, 2010	--
Clarithromycin	Macrolide antibiotic	81103-11-9	3.16	µg/L	1.5E-01		1.1E-03	3.9E-02	2.7E-04	Water flea	Crustacean	EC50	Not reported	NA	--	40	10	4	NCCOS, 2010	--
Cocaine	CNS stimulant	50-36-2	2.30	µg/L	7.5E-01		5.3E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Codeine	Opiate	76-57-3	1.19	µg/L	1.4E-01		1.0E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Coprostanol	Fecal steroid	360-68-9	8.82	µg/L	2.0E+02		1.4E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Cotinine	Nicotine metabolite	486-56-6	0.07	µg/L	2.5E+00		1.8E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Cypermethrins	Pyrethroid pesticide	52315-07-8	6.06	µg/L	6.7E-03		4.7E-05	9.2E-02	6.4E-04	Sheepshead minnow	Fish	LC50	Mortality	4	SW	0.73	10	0.073	ECOTOX, 2010	344
Dacthal	Herbicide	1861-32-1	4.28	µg/L	1.2E-04		8.5E-07	1.2E-06	8.5E-09	Sheepshead minnow	Fish	NOEC	Mortality	2	SW	1,000	10	100	ECOTOX, 2010	14134
DEET	Insect repellent	134-62-3	2.18	µg/L	3.4E+00		2.4E-02	4.8E-04	3.4E-06	Rainbow trout	Fish	LC50	Mortality	4	FW	71,250	10	7,125	ECOTOX, 2010	344
Desmethyldiltiazem	Antihypertensive	85100-17-0	2.79	µg/L	7.6E-02		5.3E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Desmosterol	Sterol	313-04-2	8.65	µg/L	1.6E+00	E	1.1E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Desogestrel	Oral contraceptive	54024-22-5	5.65	µg/L	9.1E-02	E	6.4E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Diazepam	Antianxiety	439-14-5	2.82	µg/L	5.3E-03		3.7E-05	4.2E-06	2.9E-08	Eastern mosquitofish	Fish	LC50	Mortality	4	SW	12,700	10	1,270	ECOTOX, 2010	80816
Dieldrin	Organochlorine pesticide	60-57-1	5.20	µg/L	3.3E-04		2.3E-06	6.6E-03	4.6E-05	Sand dab	Fish	LC50	Mortality	56	SW	0.5	10	0.05	ECOTOX, 2010	15149
Digoxin	Cardiac glycoside	20830-75-5	1.26	µg/L	6.5E-02		4.6E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Diltiazem	Antihypertensive	42399-41-7	2.70	µg/L	4.1E-01		2.8E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Diphenhydramine	Antihistamine	58-73-1	3.27	µg/L	1.7E+00		1.2E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Doxycycline	Tetracycline antibiotic	564-25-0	-0.02	µg/L	2.8E-01		1.9E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Enalapril	Antihypertensive	75847-73-3	2.45	µg/L	1.2E-02		8.6E-05	--	--	--	--	--	--	--	--	--	--	--	--	--
Endosulfan Sulphate	Pesticide	1031-07-8	3.66	µg/L	3.1E-04	E	2.1E-06	3.1E-04	2.1E-06	Carp	Fish	LC50	Mortality	2	SW	10	10	1	ECOTOX, 2010	19637
Endrin	Organochlorine pesticide	72-20-8	5.20	µg/L	9.8E-05	E	6.8E-07	9.8E-03	6.8E-05	Bluehead wrasse	Fish	LC50	Mortality	4	SW	0.1	10	0.01	ECOTOX, 2010	628
Enrofloxacin	Antibiotic	93106-60-6	0.70	µg/L	5.2E-03		3.6E-05	5.2E-07	3.6E-09	Fathead minnow	Fish	NOEC	Mortality	7	FW	10,000	1	10,000	ECOTOX, 2010	80421
Epicoprostanol	Sterol	516-92-7	8.82	µg/L	5.8E+00		4.1E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Ergosterol	Sterol	57-87-4	8.86	µg/L	5.8E-01		4.1E-03	--	--	--	--	--	--	--	--	--	--	--	--	--

Table A-5

Evaluation Results for Concentrations of Emerging Paramaters of Concern Detected in AWWU Primary Effluent in 2010

Anchorage Water and Wastewater Utility

Dilution at Edge of ZID 142.9

Chemical	Use	CAS Number	Log Kow[a]	Units	Detected Concentration	Qualifier	Maximum at ZID	Hazard Quotient at End of Pipe	Hazard Quotient at Edge of ZID	Toxicity Study Species Common Name	Test Species Type	Toxicity Endpoint	Type of Effect	Exposure Duration (Days)	Media Type	Reported Effect Level (µg/L)	Toxicity Uncertainty Factor	Adjusted Effect Level (µg/L)	Source	ECOTOX[b] Reference Number
Erythromycin-H2O	macrolide antibiotic	59319-72-1	3.06	µg/L	1.7E-01		1.2E-03	4.8E-06	3.3E-08	Striped bass	Fish	LC50	Mortality	4	FW	349,000	10	34,900	ECOTOX, 2010	2468
Estriol	Sex hormone	50-27-1	2.45	µg/L	3.1E-01		2.2E-03	***4.2E+00***	2.9E-02	Medaka, high eyes	Fish	NOEC	Morphology	85-110	FW	0.075	1	0.075	ECOTOX, 2010	56678
Fluoxetine	SSRI Antidepressant	54910-89-3	4.05	µg/L	5.7E-02		4.0E-04	1.1E-02	8.0E-05	Medaka, high eyes	Fish	NOEC	Growth/Reproduction	28	SW	5	1	5	ECOTOX, 2010	74238
Furosemide	Diuretic	54-31-9	2.03	µg/L	1.9E-01		1.3E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Gemfibrozil	Antilipemic	25812-30-0	4.77	µg/L	1.3E+00		9.2E-03	2.5E-02	1.7E-04	Water flea	Crustacean	EC50	Not reported	NA		530	10	53	NCCOS, 2010	--
Glipizide	Antidiabetic drug	29094-61-9	1.91	µg/L	1.3E-02		9.2E-05	--	--	--	--	--	--	--	--	--	--	--	--	--
Glyburide	Antidiabetic drug	10238-21-8	4.79	µg/L	1.8E-02		1.3E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
HCH, gamma	Pesticide	58-89-9	4.14	µg/L	7.2E-04	E	5.0E-06	4.5E-05	3.1E-07	Mummichog	Fish	LC50	Mortality	10	SW	16	1	16	ECOTOX, 2010	2814
Heptachlor	Organochlorine pesticide	76-44-8	6.10	µg/L	5.5E-05	E	3.9E-07	6.9E-04	4.8E-06	Bluehead wrasse	Fish	LC50	Mortality	4	SW	0.8	10	0.08	ECOTOX, 2010	628
Hexachlorobenzene	Fungicide	118-74-1	5.73	µg/L	1.2E-03		8.6E-06	2.5E-02	1.7E-04	Dover sole	Fish	LC50	Mortality	4	SW	0.5	10	0.05	ECOTOX, 2010	14995
Hydrochlorothiazide	Diuretic	58-93-5	-0.07	µg/L	2.8E-01		2.0E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrocodone	Narcotic analgesic	125-29-1	2.16	µg/L	6.8E-02		4.8E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrocortisone	Antiinflammatory	50-23-7	1.61	µg/L	8.1E-01		5.7E-03	8.1E-02	5.7E-04	Water flea	Crustacean	NOEC	Mortality	6	FW	100	10	10	ECOTOX, 2010	75106
Ibuprofen	Analgesic	15687-27-1	3.97	µg/L	1.9E+01		1.3E-01	1.1E-03	7.6E-06	Bluegill	Fish	LC50	Mortality	4	FW	173,000	10	17,300	NCCOS, 2010	--
Lincomycin	Lincosamide antibiotic	154-21-2	0.20	µg/L	4.2E-02		2.9E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Meprobamate	Antianxiety	57-53-4	0.70	µg/L	3.8E-01		2.7E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Mestranol	Oral contraceptive	72-33-3	4.68	µg/L	3.1E-02	E	2.2E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Metformin	Antidiabetic drug	657-24-9	-2.64	µg/L	8.2E+01		5.7E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylprednisolone	Antiinflammatory	83-43-2	1.82	µg/L	1.1E-01		7.5E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Metoprolol	Beta-blocker	51384-51-1	1.88	µg/L	4.3E-01		3.0E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Miconazole	Antifungal agent	22916-47-8	6.25	µg/L	7.6E-02		5.3E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Naproxen	Non-steroidal anti-inflammatory	22204-53-1	3.18	µg/L	1.2E+01		8.4E-02	2.1E-04	1.5E-06	Bluegill	Fish	LC50	Mortality	4	FW	560,000	10	56,000	--	--
Norfloxacin	Antibiotic	70458-96-7	-1.03	µg/L	9.7E-02		6.8E-04	9.7E-07	6.8E-09	Grass carp, White amur	Fish	LD50	Mortality	4	FW	1,000,000	10	100,000	ECOTOX, 2010	16685
Norfluoxetine	Serotonin reuptake inhibitor	56161-73-0	4.05	µg/L	3.1E-02		2.1E-04	6.1E-03	4.3E-05	Medaka, high eyes	Fish	NOEC	Mortality	15-28	SW	5	1	5	ECOTOX, 2010	74238
Norverapamil	Calcium channel blocker	67018-85-3	3.79	µg/L	2.3E-02		1.6E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Octachlorostyrene	Byproduct of chlorine production	29082-74-4	7.46	µg/L	1.5E-04	E	1.1E-06	--	--	--	--	--	--	--	--	--	--	--	--	--
Ofloxacin	Quinoline antibiotic	82419-36-1	-0.39	µg/L	7.0E-01		4.9E-03	7.0E-05	4.9E-07	Fathead minnow	Fish	NOEC	Growth/Mortality	7	FW	10,000	1	10,000	ECOTOX, 2010	80421
Oxycodone	Opioid analgesic	76-42-6	0.66	µg/L	1.5E-01		1.1E-03	--	--	--	--	--	--	--	--	--	--	--	--	--
Paroxetine	Antidepressant	61869-08-7	3.95	µg/L	2.3E-02		1.6E-04	1.0E-04	7.2E-07	Water flea	Crustacean	NOEC	Reproduction	7-8	FW	220	1	220	ECOTOX, 2010	80408
PBDE-100	Flame retardant	189084-64-8	7.66	µg/L	1.1E-02		7.4E-05	1.2E-03	8.3E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-119+120	Flame retardant	na	7.66	µg/L	2.5E-04		1.7E-06	2.8E-05	1.9E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-12+13	Flame retardant	na	5.83	µg/L	7.6E-05		5.3E-07	8.5E-06	6.0E-08	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-137+156	Flame retardant	na	7.40	µg/L	4.5E-04		3.1E-06	5.0E-05	3.5E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-14+25	Flame retardant	na	5.88	µg/L	1.2E-03		8.7E-06	1.4E-04	9.8E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-140	Flame retardant	243982-83-4	7.40	µg/L	1.4E-04		1.0E-06	1.6E-05	1.1E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-15	Flame retardant	2050-47-7	5.83	µg/L	6.3E-05		4.4E-07	7.0E-06	4.9E-08	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-153	Flame retardant	68631-49-2	7.40	µg/L	4.7E-03		3.3E-05	5.2E-04	3.7E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-154	Flame retardant	207122-15-4	7.40	µg/L	3.8E-03		2.6E-05	4.2E-04	3.0E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-155	Flame retardant	35854-94-5	7.40	µg/L	1.9E-04	E	1.4E-06	2.2E-05	1.5E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-181	Flame retardant	na	8.27	µg/L	9.1E-05	E	6.4E-07	1.0E-05	7.2E-08	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-183	Flame retardant	na	8.27	µg/L	9.1E-04		6.4E-06	1.0E-04	7.2E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-190	Flame retardant	79682-25-0	8.27	µg/L	2.8E-04	E	2.0E-06	3.2E-05	2.2E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-203	Flame retardant	na	6.29	µg/L	1.8E-03	E	1.3E-05	2.1E-04	1.4E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-206	Flame retardant	na	6.29	µg/L	7.3E-03	E	5.1E-05	8.2E-04	5.8E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-207	Flame retardant	na	6.29	µg/L	1.4E-02	E	1.0E-04	1.6E-03	1.1E-05	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-208	Flame retardant	na	6.29	µg/L	8.5E-03	E	6.0E-05	9.6E-04	6.7E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-209	Flame retardant	1163-19-5	12.11	µg/L	6.4E-02		4.5E-04	7.1E-03	5.0E-05	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-28+PBDE-33	Flame retardant	41318-75-6	5.88	µg/L	1.7E-03		1.2E-05	1.9E-04	1.3E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-32	Flame retardant	na	5.88	µg/L	3.0E-05	E	2.1E-07	3.4E-06	2.4E-08	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-35	Flame retardant	na	5.88	µg/L	4.6E-05		3.3E-07	5.2E-06	3.7E-08	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-37	Flame retardant	na	5.88	µg/L	3.1E-05	E	2.1E-07	3.4E-06	2.4E-08	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-47	Flame retardant	5436-43-1	6.77	µg/L	5.9E-02		4.1E-04	6.6E-03	4.6E-05	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-49	Flame retardant	243982-82-3	6.77	µg/L	1.9E-03		1.3E-05	2.1E-04	1.5E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-51	Flame retardant	60044-24-8	6.77	µg/L	2.9E-04		2.0E-06	3.2E-05	2.3E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-60	Flame retardant	189084-61-5	6.77	µg/L	1.7E-03		1.2E-05	1.9E-04	1.3E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-7	Flame retardant	na	5.83	µg/L	4.0E-02		2.8E-04	4.5E-03	3.1E-05	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-71	Flame retardant	189084-62-6	6.77	µg/L	6.1E-04		4.3E-06	6.9E-05	4.8E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-75	Flame retardant	189084-63-7	6.77	µg/L	1.3E-04	E	9.4E-07	1.5E-05	1.1E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-79	Flame retardant	97038-98-7	6.77	µg/L	8.7E-04	E	6.1E-06	9.8E-05	6.9E-07	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-8+11	Flame retardant	na	5.83	µg/L	4.9E-05		3.5E-07	5.5E-06	3.9E-08	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-85	Flame retardant	182346-21-0	7.66	µg/L	2.4E-03		1.7E-05	2.7E-04	1.9E-06	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
PBDE-99	Flame retardant	60348-60-9	6.84	µg/L	5.2E-02		3.6E-04	5.8E-03	4.1E-05	Rainbow trout	Fish	NOEC	Post-hatch Growth	21	FW	8.9	1	8.9	--	--
Penicillin V	Antibiotic	87-08-1	2.09	µg/L	1.4E-02		1.0E-04	1.4E-07	1.0E-09	Daphnia magna	Crustacean	EC50	Physiological	3	FW	>1,000,000	10	100,000	ECOTOX, 2010	10197
Permethrin	Pyrethroid pesticide	52645-53-1	6.50	µg/L	6.9E-02	E	4.8E-04	4.0E-02	2.8E-04	Sheepshead minnow	Fish	LC50	Mortality	4	SW	17	10	1.7	ECOTOX, 2010	65396
PFBA	Perfluorocarbon	375-22-4	2.43	µg/L	5.1E-03		3.6E-05	1.7E-05	1.2E-07	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
PFHpA	Perfluorocarbon	375-85-9	5.33	µg/L	8.4E-03		5.9E-05	2.8E-05	2.0E-07	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
PFHxA	Perfluorocarbon	307-24-4	4.37	µg/L	2.2E-02		1.6E-04	7.5E-05	5.2E-07	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--

Table A-5

Evaluation Results for Concentrations of Emerging Paramaters of Concern Detected in AWWU Primary Effluent in 2010

Anchorage Water and Wastewater Utility

Dilution at Edge of ZID 142.9

Chemical	Use	CAS Number	Log Kow^a	Units	Detected Concentration	Qualifier	Maximum at ZID	Hazard Quotient at End of Pipe	Hazard Quotient at Edge of ZID	Toxicity Study Species Common Name	Test Species Type	Toxicity Endpoint	Type of Effect	Exposure Duration (Days)	Media Type	Reported Effect Level (µg/L)	Toxicity Uncertainty Factor	Adjusted Effect Level (µg/L)	Source	ECOTOX^b Reference Number
PFHxS	Perfluorocarbon	355-46-4	4.34	µg/L	4.0E-02		2.8E-04	1.3E-04	9.2E-07	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
PFNA	Perfluorocarbon	375-95-1	7.27	µg/L	5.5E-03		3.9E-05	1.8E-05	1.3E-07	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
PFOA	Perfluorocarbon	335-67-1	6.30	µg/L	1.7E-02		1.2E-04	3.4E-07	2.4E-09	Zebrafish	Fish	LC50	Mortality	4	FW	499,000	10	49,900	Ye et al. 2009	--
PFOS	Perfluorocarbon	1763-23-1	6.28	µg/L	2.6E-02		1.8E-04	8.7E-05	6.1E-07	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
PFPeA	Perfluorocarbon	2706-90-3	3.40	µg/L	8.7E-03		6.1E-05	2.9E-05	2.0E-07	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
Prednisone	Corticosteroid	53-03-2	1.46	µg/L	4.2E-01		2.9E-03	1.4E-03	9.8E-06	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
Promethazine	Antihistamine	60-87-7	4.81	µg/L	2.9E-03		2.0E-05	9.7E-06	6.8E-08	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
Propoxyphene	Analgesic antiinflammatory	469-62-5	4.18	µg/L	9.7E-03		6.8E-05	3.2E-05	2.3E-07	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
Propranolol	Betablocker	525-66-6	3.48	µg/L	6.1E-02		4.2E-04	2.0E-04	1.4E-06	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
Ranitidine	Anti-acid reflux	66357-35-5	0.27	µg/L	8.3E-02		5.8E-04	2.8E-04	1.9E-06	Fathead minnow	Fish	NOEC	Mortality/Growth	42	FW	300	1	300	OECD, 2002	--
Sertraline	Antidepressant	79617-96-2	5.29	µg/L	1.3E-01		9.2E-04	1.5E-02	1.0E-04	Water flea	Crustacean	NOEC	Reproduction	7-8	FW	9	1	9	ECOTOX, 2010	80408
ß-Sitosterol	Physiologicaltosterol (plant sterol)	83-46-5	9.65	µg/L	8.6E+01		6.0E-01	***8.6E+00***	6.0E-02	Rainbow trout	Fish	NA	Growth/Morphology	21	FW	10	1	10	ECOTOX, 2010	19329
ß-Stigmastanol	Physiologicaltosterol (plant sterol)	83-45-4	9.73	µg/L	6.2E+00		4.3E-02	--	--	--	--	--	--	--	--	--	--	--	--	--
Stigmasterol	Physiologicaltosterol (plant sterol)	83-48-7	9.43	µg/L	1.8E+01		1.3E-01	***1.8E+00***	1.3E-02	Viviporous blenny	Fish	NA	Growth/Morphology	100	SW	10	1	10	ECOTOX, 2010	61971
Sulfamethizole	Sulfonamide	144-82-1	0.54	µg/L	4.9E-03		3.4E-05	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfamethoxazole	Sulfonamide antibiotic	723-46-6	0.89	µg/L	1.1E+00		7.5E-03	1.1E-03	7.5E-06	Water flea	Crustacean	EC50	Not reported	2	--	10,000	10	1,000	NCCOS, 2010	--
Sulfanilamide	Antifungal	63-74-1	-0.62	µg/L	4.4E-02		3.1E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Testosterone	Sex hormone	58-22-0	3.32	µg/L	2.9E+00		2.0E-02	9.6E-04	6.7E-06	Rainbow trout	Fish	NOEC	Enzyme levels	19	FW	3,000	1	3,000	ECOTOX, 2010	95937
Tetracycline	Tetracycline antibiotic	60-54-8	-1.30	µg/L	1.7E-01		1.2E-03	7.6E-06	5.3E-08	Lake trout	Fish	LC50	Mortality	4	FW	220,000	10	22,000	NCCOS, 2010	--
TheoPhysiologicallline	Bronchodilator	58-55-9	-0.04	µg/L	4.5E+01		3.1E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
Thiabendazole	Fungicide and parasiticide	148-79-8	2.47	µg/L	2.4E-02		1.6E-04	4.2E-04	2.9E-06	Rainbow trout	Fish	LC50	Mortality	4	FW	560	10	56	ECOTOX, 2010	344
Triamterene	Diuretic	396-01-0	0.98	µg/L	9.6E-02		6.7E-04	--	--	--	--	--	--	--	--	--	--	--	--	--
Triclocarban	Antimicrobial, disinfectant	101-20-2	4.90	µg/L	2.0E+00		1.4E-02	***4.3E+01***	3.0E-01	Bluegill	Fish	LOEC	Mortality	4	FW	0.46	10	0.046	ECOTOX, 2010	90733
Triclosan	Antimicrobial, disinfectant	3380-34-5	4.76	µg/L	5.9E+00		4.1E-02	3.4E-01	2.4E-03	Medaka, high eyes	Fish	NOEC	Morphology	21	FW	17.3	1	17.3	ECOTOX, 2010	73484
Trimethoprim	Pyrimidine antibiotic	738-70-5	0.91	µg/L	7.0E-01		4.9E-03	7.0E-05	4.9E-07	Zebra danio	Fish	NOEC	Not reported	NA	--	100,000	10	10,000	NCCOS, 2010	--
Valsartan	Antihypertensive	137862-53-4	3.65	µg/L	1.5E+01		1.1E-01	--	--	--	--	--	--	--	--	--	--	--	--	--
Verapamil	Calcium-channel blocker	52-53-9	3.79	µg/L	4.9E-02		3.4E-04	7.8E-05	5.5E-07	Fairy shrimp	Crustacean	EC50	Not reported	1	FW	6,240	10	624	NCCOS, 2010	--
Warfarin	Anticoagulant	81-81-2	2.70	µg/L	5.0E-03		3.5E-05	1.5E-03	1.0E-05	Channel catfish	Fish	LC50	Mortality	4	FW	34.3	10	3.43	ECOTOX, 2010	6797

Notes:

[a] When a logKow was unavailable, values based on structurally-similar surrogates were used.

[b] Full citations for primary sources referenced in ECOTOX or other sources are provided in the attachment to Appendix A.

na = not available

µg/L = micrograms per liter

E = estimated value

NOEC = no observed effect level

LOEC = lowest observed effect level

EC50 = 50 percent effect concentration

LC50 = 50 percent lethal concentration

LC10 = 10 percent lethal concentration

FW = freshwater

SW = saltwater/marine

Table A-6
Summary of Whole Effluent Toxicity Data for Asplund WPCF

	Chronic						CHRONIC								
	Bivalve Survival			Bivalve development			Topsmelt Survival			Topsmelt Growth			Echinoderm fertilization		
Date	LOEC %	NOEC %	TUc	LOEC %	NOEC %	TUc	LOEC %	NOEC %	TUc	LOEC %	NOEC %	TUc	LOEC %	NOEC %	TUc
2/10/2003	>2.8	2.8	35.7	>2.8	2.8	35.7	NT	NT	NT	NT	NT	NT	NT	NT	NT
4/15/2003	>2.8	2.8	35.7	>2.8	2.8	35.7	NT	NT	NT	NT	NT	NT	NT	NT	NT
7/14/2003	>2.8	2.8	35.7	2.8	1.4	71.4	>2.8	2.8	35.7	>2.8	2.8	35.7	>2.8	2.8	35.7
10/20/2003	>2.8	2.8	35.7	>2.8	2.8	35.7	NT	NT	NT	NT	NT	NT	NT	NT	NT
2/3/2004	>2.8	2.8	35.7	>2.8	2.8	35.7	NT	NT	NT	NT	NT	NT	NT	NT	NT
4/362004	>2.8	2.8	35.7	>2.8	2.8	35.7	NT	NT	NT	NT	NT	NT	NT	NT	NT
7/27/2004	2.8	1.4	71.4	2.8	1.4	71.4	NT	NT	NT	NT	NT	NT	NT	NT	NT
10/24/2004	>2.8	2.8	35.7	>2.8	2.8	35.7	>2.8	2.8	35.7	>2.8	2.8	35.7	1.4	0.7	142.9
2/8/2005	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	1.4	0.7	142.9
4/6/2005	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.7	0.35	286
5/24/2005	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	>2.8	2.8	35.7
8/2/2005	2.8	1.4	71.4	1.4	0.7	142.9	>2.8	2.8	35.7	>2.8	2.8	35.7	0.175	<0.175	>571
9/7/2005	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	1.4	0.7	142.9
10/27/2005	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	>2.8	2.8	35.7
2/9/2006	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.8	1.4	71.4
4/18/2006	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	>2.8	2.8	35.7
8/16/2006	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.8	1.4	71.4
10/30/2006	>2.8	2.8	35.7	>2.8	2.8	35.7	>2.8	2.8	35.7	>2.8	2.8	35.7	1.4	0.7	142.9
1/29/2007	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.8	1.4	71.4
4/16/2007	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	>2.8	2.8	35.7
7/30/2007	2.8	1.4	71.4	>2.8	2.8	35.7	>2.8	2.8	35.7	>2.8	2.8	35.7	1.4	0.7	142.9
10/23/2007	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	>2.8	2.8	35.7
1/29/2008	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.8	1.4	71.4
4/15/2008	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.8	1.4	71.4
8/18/2008	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.8	1.4	71.4
11/4/2008	>2.8	2.8	35.7	>2.8	2.8	35.7	2.8	1.4	71.4	>2.8	2.8	35.7	2.8	1.4	71.4
1/22/2009	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.8	1.4	71.4
4/1/2009	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	1.4	0.7	142.8
8/23/2009	NT	NT	NT	NT	NT	NT	>2.8	2.8	35.7	>2.8	2.8	35.7	NT	NT	NT
9/30/2009	>2.8	2.8	35.7	>2.8	2.8	35.7	NT	NT	NT	NT	NT	NT	>2.8	2.8	35.7
10/28/2009	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	1.4	0.7	142.9

Test dulutions=0.175%, 0.35%, 0.70%, 1.4%, 2.8%

NT=not tested

7-14-2003 bivalve bioassay failed TAC, repeated September 2003

The 4/6/2005 and 8/2/2005 echinoderm test results exceeded the permit limit of 143 TUc (or 0.70% effluent NOEC), attributed to plant upsets due to construction activities, and low clarifier performance. These conditions were subsequently mitigated, and retesting indicated non-toxic conditions.

TUc =100/NOEC

Attachment A1
Aquatic Toxicology References

Attachment A1 Aquatic Toxicology References

A1.1 AQUIRE ECOTOX Database Source Documents

Reference Number: 71231
Author(s): Blazquez, M., S. Zanuy, M. Carrillo, and F. Piferrer
Publication Year: 1998
Title: Structural and Functional Effects of Early Exposure to Estradiol-17beta and 17alpha-Ethynylestradiol on the Gonads of the Gonochoristic Teleost Dicentrarchus labrax
Source: Fish Physiol.Biochem. 18:37-47

Reference Number: 73295
Author(s): Boudreau, M., S.C. Courtenay, D.L. MacLatchy, C.H. Berube, J.L. Parrott, and G.J. Van der Kraak
Publication Year: 2004
Title: Utility of Morphological Abnormalities During Early-Life Development of the Estuarine Mummichog, Fundulus heteroclitus, as an Indicator of Estrogenic and Antiestrogenic Endocrine Disruption
Source: Environ.Toxicol.Chem. 23(2):415-425

Reference Number: 12448
Author(s): Brooke, L.T., D.J. Call, D.L. Geiger, and C.E. Northcott
Publication Year: 1984
Acute Toxicities of Organic Chemicals to Fathead Minnows (Pimephales promelas), Vol. 1
Source: Center for Lake Superior Environmental Stud., Univ.of Wisconsin-Superior, Superior, WI :414 p.

Reference Number: 15031
Author(s): Broderius, S.J., M.D. Kahl, and M.D. Hoglund
Publication Year: 1995
Title: Use of Joint Toxic Response to Define the Primary Mode of Toxic Action for Diverse Industrial Organic Chemicals
Source: Environ.Toxicol.Chem. 14(9):1591-1605 (Author Communication Used)

Reference Number: 50414
Author(s): Hunsinger, R.N., and W.M. Howell
Publication Year: 1991
Title: Treatment of Fish with Hormones: Solubilization and Direct Administration of Steroids into Aquaria Water Using Acetone as a Carrier Solvent
Source: Bull.Environ.Contam.Toxicol. 47(2):272-277

Reference Number: 85750
Author(s): Cruz-Li, E.I.
Publication Year: 2004

Title: Effects of Ammonium Perchlorate, 4(Tert-Octyl)Phenol and Their Mixture on Zebrafish (Danio rerio)
Source: Ph.D.Thesis, Texas Tech Univ., Lubbock, TX :173 p.

Reference Number: 90077
Author(s): Balch, G., and C. Metcalfe
Publication Year: 2006
Title: Developmental Effects in Japanese Medaka (Oryzias latipes) Exposed to Nonylphenol Ethoxylates and Their Degradation Products
Source: Chemosphere 62(8):1214-1223

Reference Number: 4581
Author(s): Lio-Po, G.D., and E.G. Sanvictores
Publication Year: 1986
Title: Tolerance of Penaeus monodon Eggs and Larvae to Fungicides Against Lagenidium sp. and Haliphthoros philippinensis
Source: Aquaculture 51:161-168

Reference Number: 16432
Author(s): DeYoung, D.J., J.A. Bantle, M.A. Hull, and S.L. Burks
Publication Year: 1996
Title: Differences in Sensitivity to Developmental Toxicants as seen in Xenopus and Pimephales Embryos
Source: Bull.Environ.Contam.Toxicol. 56(1):143-150

Reference Number: 60070
Author(s): Peyon, P., S. Baloche, and E. Burzawa-Gerard
Publication Year: 1997
Title: Investigation into the Possible Role of Androgens in the Induction of Hepatic Vitellogenesis in the European Eel: In Vivo and In Vitro Studies
Source: Fish Physiol.Biochem. 16(2):107-118

Reference Number: 82482
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Appendix B

Assessment of Effects to Beluga Whale Through the Food Chain

Appendix B

Assessment of Effects to Beluga Whale through the Food Chain

Submitted to
U.S. Environmental Protection Agency, Region 10
Seattle, Washington

Submitted by
Anchorage Water and Wastewater Utility

Prepared by
CH2M HILL

Table of Contents

Attachments

Tables
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Acronyms and Abbreviations

ADEC	Alaska Department of Environmental Conservation
AUF	area use factor (unitless)
AWWU	Anchorage Water and Wastewater Utility
BAF	bioaccumulation factor
BE	Biological Evaluation
BE	biological evaluation
CFR	Code of Federal Regulations
CI	Cook Inlet
EPA	U.S. Environmental Protection Agency
EPOC	emerging parameters of concern
FCM	food chain multiplier
FDA	Food and Drug Administration
HQ	hazard quotient
L/kg	liters per kilogram
LOAEL	lowest observed adverse effect level
mg/kg-day	milligrams of POC per kilogram of receptor body weight per day
mg/L	milligrams per liter
MRTD	Maximum Recommended Therapeutic Dose
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbons
PBDE	polybrominated diphenyl ethers
PCB	polychlorinated biphenyls
POC	parameters of concern
SVOC	semivolatile organic compounds
TL	trophic level

TRV	toxicity reference value
UF	uncertainty factor
VOC	volatile organic compounds
WPCF	Water Pollution Control Facility
ZID	zone of initial dilution

APPENDIX B

Assessment of Effects to Beluga Whale through the Food Chain

B.1 Purpose

This appendix provides a second major line of evaluation of the potential for effects on endangered beluga whales within Cook Inlet (CI) resulting from regulated and unregulated constituents known or suspected to be discharged from the Anchorage Water and Wastewater Utility (AWWU) Asplund Water Pollution Control Facility (WPCF). It focuses on identifying whether the WPCF discharge could adversely impact the protected beluga whale through consumption of prey species that may have accumulated wastewater-related chemicals through the food chain.[1]

B.2 Evaluation Approach

To assess the plausibility that concentrations of either regulated or currently unregulated parameters of concern (POC) in Asplund WPCF effluent could affect CI beluga whales through consumption of prey species that may have accumulated wastewater-related chemicals, it is necessary to measure or estimate the concentrations of these constituents in whale prey tissues. The following primary sources of information were used to determine tissue concentrations in prey:

- Measured tissue concentrations from fish collected in CI
- Projected receiving water concentrations in CI in conjunction with bioaccumulation factors to estimate tissue concentrations

The preferred data source was measured residues in fish caught within CI because this does not rely on conservative uptake modeling or other assumptions. A disadvantage with using tissue data directly is that the measured residue levels originate from multiple sources, particularly for migratory fish such as salmonids that comprise a large portion of the beluga diet. Therefore, attributing any portion potentially originating from the Asplund WPCF is not possible. However, if the levels found in fish are below levels of concern for the beluga regardless of contaminant sources, then this measure of conservatism provides an additional level of confidence in conclusions regarding Asplund WPCF as a source.

Another limitation in using fish tissue data is that data are not available for all POCs that are the focus of this bioaccumulation evaluation. For bioaccumulative POCs without available fish tissue data, modeling approaches and additional assumptions are necessary, as described herein.

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[1] Appendix A provides an evaluation of the potential for effects on populations of aquatic organisms (e.g., fish) within CI that could serve as a food source for the endangered CI beluga whale.

B.2.1 Parameters of Potential Concern for Bioaccumulation into Whale Prey Tissues

The POCs evaluated in this appendix include those regulated and unregulated constituents with physical-chemical properties that make them sufficiently lipophilic to result in a potential for bioaccumulation. The octanol-water partition coefficient (K_{OW}) is the ratio of the concentration of a chemical in octanol and in water at equilibrium at a specified temperature. Octanol is an organic solvent that is often used as a surrogate for biological lipids to help determine the fate of chemicals in the environment and predict the extent to which organic compounds will bioaccumulate in fish.

For this BE, organic compounds with a logarithm octanol-to-water partition coefficient (Log K_{OW}) greater than or equal to 3.5 were considered to have the potential to bioaccumulate in beluga whale prey. This is consistent with Alaska Department of Environmental Conservation (ADEC, 2009) and U.S. Environmental Protection Agency (EPA, 2005) guidance. Metals with known ability to accumulate in fish tissue were included in this evaluation. A total of 77 organic compounds and 10 metals were evaluated.

B.2.2 Sources of Fish Tissue Data

Fish tissue data were obtained from the following sources:

- AWWU NPDES monitoring
- ADEC statewide fish monitoring program

As stipulated in the National Pollutant Discharge Elimination (NPDES) permit, bioaccumulation monitoring was to be performed during the fourth year after the effective date of the permit. To fulfill the permit objectives and requirements for a bioaccumulation investigation, it was proposed to EPA to perform a field bioaccumulation program utilizing a resident species from Upper CI, the Pacific cod (*Gadus macrocephalus)*. This study was approved by EPA and conducted in October 2004.

Bioaccumulation monitoring consisted of analyses for polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), pesticides, semivolatile organic compounds (SVOC), metals, and cyanide. These data were provided in Table 21 of the 2004 AWWU Monitoring Program Annual Report (http://www.awwu.biz/website/Reports/Reports_Frame.htm). Four replicates of pacific cod were collected with a beach seine near Point Woronzof and three replicates were collected at the control station near Point MacKenzie (locations are shown on Figure 3 of the AWWU 2004 Annual Report).

ADEC monitors fish from statewide locations annually in a collaborative effort with biologists from the Alaska Department of Fish and Game and the National Oceanographic and Atmospheric Administration (NOAA). The ADEC data for CI fish were provided by Robert Gerlach/ADEC. The fish from this area included 16 samples of salmon (coho and Chinook) that were analyzed for metals, pesticides, PCBs, dioxins, and polybrominated dipyhenyl ethers (PBDE). The fish tissue data provided by ADEC are found in Attachment B1.

This BE conservatively used the maximum fish tissue concentrations reported by either ADEC (salmon) or AWWU (Pacific cod) for metals, pesticides, PCBs, volatile organic compounds (VOC), SVOCs, dioxins, and PBDEs. This is anticipated to provide a representation of a reasonable high-end concentration of these constituents in the CI beluga whale diet for the purposes of exposure and hazard assessment to the whale.

B.2.3 Sources of Wastewater Concentration Data for Modeling Bioaccumulation

Wastewater concentrations of regulated and unregulated constituents were obtained from the following three sources:

- Direct concentration measurements in representative samples of Asplund WPCF effluent during normal monitoring required by the NPDES Permit.
- Concentrations inferred from reported levels in wastewater treatment facilities worldwide[2]. In general influent concentrations were used since effluent data included both primary and secondary treatment which is not representative of Asplund WPCF. The use of influent concentrations introduces conservatism in the effects analysis. Direct concentration measurements of emerging parameters of concern in Asplund WPCF effluent in 2010

Each source is described in the following subsections.

B.2.3.1 Measured Asplund WPCF Effluent Concentration Data (NPDES-Regulated)

As required in the NPDES permit, AWWU monitors for POCs in 24-hour composite effluent samples twice annually, typically once during early summer (summer dry) and once late summer (summer wet). These POCs are defined by the permit as those substances listed in 40 Code of Federal Regulations (CFR) 401.15, and are listed in Table A-1 of Appendix A. This list includes more than 130 constituents, including asbestos, VOCs, SVOCs, pesticides, PCBs, metals, and cyanide.

Of the more than 130 POCs regularly analyzed over this period, 46 have been detected. The concentration ranges and detection frequencies of these constituents are summarized in Table A-2 of Appendix A. Constituents detected at least once during Asplund WPCF NPDES effluent monitoring over the period of 2000 through 2009 were identified for evaluation in this BE.

B.2.3.2 Potential Effluent Concentrations of Emerging Constituents of Concern

Prior to 2010, there were no available analytical results for currently unregulated emerging parameters of concern (EPOC) in effluent from the Asplund WPCF. In May 2010, sampling and analysis for these constituents in Asplund WPCF effluent was conducted, as discussed in the next subsection. However, to provide a basis of comparison with levels found elsewhere in the U.S., Canada, or other locations, literature-based concentration data were also identified and evaluated.

An extensive search of available literature sources was conducted to identify levels of EPOCs that have been reported in wastewaters of municipal systems similar to that

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[2] Literature-based data were only used when concentration data from NPDES monitoring for the Asplund WPCF effluent were not available.

from the Asplund WPCF. It should be noted that many of these studies focus on EPOC concentrations in the final effluent from secondary treatment plants and in receiving waters. Because the Asplund WPCF effluent represents primary-treated wastewater, the focus of this BE is on concentrations in municipal wastewater influents.

The primary studies are listed in Appendix A. Table A-3 lists EPOCs reported to occur in influent or primary-treated effluent. Of the 212 target analytes reported in the studies reviewed, 116 constituents have been reported with detectable concentrations at least once and were included in this evaluation[3]. The maximum reported concentrations and study sources of these constituents are summarized in Table A-4 of Appendix A. The number of detected constituents on this list may not reflect what exists in the Asplund WPCF effluent, because results come from many wastewater treatment facilities and include analyses of both influent and primary effluent. The results of the 2010 sampling and analysis identified the actual number of emerging pollutants detectable in of Asplund WPCF effluent (discussed below).

B.2.3.3 Measured Asplund WPCF Effluent Concentrations of Emerging Parameters of Concern

On May 2010, AWWU collected sample results of unregulated trace contaminants in the sewage influent and final effluent, with a focus on seven distinct classes of pollutants of emerging concern and endocrine disruptors. These classes and the number of target analytes within each class are described in Appendix A, Section A.3.1.3, along with a brief summary of the sampling and analytical approaches. The reported concentrations of these constituents are summarized in Table A-5 of Appendix A. Of the 163 constituents reported with detectable concentrations in the final effluent, 103 were identified as sufficiently lipophilic to result in a potential for bioaccumulation, and were evaluated for potential exposure to beluga whales through consumption of prey species.

B.2.4 Estimation of Concentrations at Points of Exposure

The concentrations of constituents reported from the three sources provided above were assumed to occur in the Asplund WPCF effluent. As an initial step, the end-of-pipe effluent concentrations (whether measured under the NPDES program, inferred from literature sources, or measured during the 2010 sampling) were adjusted by a dilution factor to estimate the concentration at the edge of the zone of initial dilution (ZID). The Asplund WPCF NPDES permit indicates that effluent concentration at the edge of the ZID is 0.70 percent, which equates to a dilution factor of 143. Concentrations at the edge of the ZID were used as an initial conservative screening of potential bioaccumulative impacts to the beluga whale via dietary chemical intake. This is very conservative because it assumes that the prey species are constantly in residence within the ZID and thereby exposed to the associated effluent concentrations. In reality, as noted in Section 3 of this Biological Evaluation (BE), the ZID provides essentially no habitat that would attract beluga prey species to the area. Therefore, more realistic concentrations within three CI subareas were also estimated, based on the results of

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[3] Constituents already included as part of the direct NPDES Permit analyses of Asplund WPCF effluent (e.g., organochlorine pesticides) were not included in this portion of this evaluation, but are addressed in Table A-2.

the hydrodynamic model described in Appendix F. The three subareas are Knik Arm, Turnagain Arm, and Upper CI.

Concentrations used for analysis of affects were those calculated for edge of the zone of initial dilution (ZID) and beyond; Turnagain Arm, Knik Arm and Upper CI. The potential for affects on CI beluga whale from concentrations within the ZID was taken into account through a consideration of exposure resulting from; (a) frequency and travel time of beluga whales through the ZID, (b) availability and feeding within the ZID and (c) other habitat functions such as resting or calving. The CI beluga whale travel time through the ZID is calculated to be less than 25 minutes and less than 2% of time annually, assuming all CI belugas use Turnagain Arm. CI beluga whales will pass Point Woronzof as a transit corridor only and appear to have no site fidelity to this area for feeding.. The bottom within the ZID is scoured by high tidal velocities and provides little food source.

B.3 Exposure Assessment

This section uses the following two scenarios to estimate dietary exposure of CI beluga whales to POCs:

- Exposure based on directly measured fish tissue concentrations
- Exposure based on estimated fish tissue concentrations, which are in turn based on either measured or inferred water concentrations

The following subsections describe the methods and equations used to estimate potential beluga whale exposure to regulated POCs and unregulated EPOCs.

B.3.1 Exposure Estimation

Constituent concentrations in beluga prey were evaluated using the following two separate exposure estimation methodologies:

- Use of measured tissue levels from fish collected in CI
- Use of bioconcentration factors (or a bioaccumulation factor) and food-chain multipliers to estimate constituent concentrations in prey

Quantitative exposure estimates were developed using food web modeling procedures consistent with EPA guidance (EPA, 1993). These models use best available information to predict the ability of a chemical to move through the food web, in this case with ultimate uptake into the CI beluga whale. Beluga whale exposure to the POCs is estimated by using their daily food ingestion rate, body weight (BW), dietary composition, and concentrations of chemical constituents within their diet (either from measured tissue levels or estimated using bioaccumulation factors).

Exposure assessments to evaluate risks to wildlife usually express POC intake (i.e., doses) in terms of a receptor body weight-normalized daily dose, such as milligrams of POC per kilogram of receptor body weight per day (mg/kg-day). The basic exposure equation is as follows:

$$E_{diet} = \frac{DIR_{food} * C_f * AUF}{BW} \tag{1}$$

where:

E_{diet} = estimated daily dietary intake of the POC (mg/kg-day)
DIR_{food} = daily food ingestion rate (kg/day)
C_f = POC concentration in food (mg/kg)
AUF = area use factor (unitless)
BW = body weight (kg)

The AUF expresses the amount of forage the receptor receives from a geographic area, relative to their entire home range. For this BE, the AUF was conservatively assumed to be 1.0. That is, the model conservatively assumes that beluga whales receive all their forage in one of three evaluated subareas within CI. Additionally, marine mammals are assumed to obtain all of their water from their prey, as they do not ingest appreciable amounts of water (Fetcher, 1939). Therefore, the total exposure for the beluga whale is limited to POCs that have accumulated in their food and are consumed by the whale.

The POC concentration in food is represented as follows in terms of POC concentrations and a bioaccumulation factor (BAF):

$$C_f = C_m = C_w * BAF \tag{2}$$

where:

C_f = POC concentration in food (mg/kg)

C_m = measured POC concentration in fish (mg/kg)

C_w = POC in water (mg/L)

BAF = bioaccumulation factor (L/kg)

Beluga whale prey comes from different trophic levels, which in turn have different BAFs. This is particularly true for organic chemicals with large K_{OW} values, which tend to be the chemicals with the greatest potential for biomagnification. The total ingested dose a beluga receives from all of its prey is, therefore, the sum of the individual prey item ingested doses.

Biomagnification is an environmental partitioning process by which POCs are accumulated and transferred, primarily via the food web, but in reality from all sources of exposure, resulting in increasing tissue POC concentrations in organisms at succeeding trophic levels. It is a common misconception that all chemicals biomagnify.

In reality, relatively few have been demonstrated to biomagnify appreciably (Newman and Unger, 2003).

To account for different bioaccumulation rates in various prey trophic levels, the equation used to estimate exposure incorporates different BAFs prey from each trophic level to calculate the total ingested POC dose. This requires knowledge of the bioconcentration factor (BCF) or BAF values for each trophic level of the food web, as well as the proportion of the diet allocated to each prey trophic level consumed. This is represented by the following equation:

$$C_f = \sum \left[\left(C_w * BAF * Frac_{TL2} \right) + \left(C_w * BAF * Frac_{TL3} \right) \right] \tag{3}$$

where:

C_f = POC concentration in food (mg/kg)

C_w = POC concentration in water (mg/L)

BAF = bioaccumulation factor (L/kg)

$Frac_{TL2}$ = fraction of the diet consisting of trophic level 2 organisms

$Frac_{TL3}$ = fraction of the diet consisting of trophic level 3 organisms

B.3.1.1 Bioconcentration and Bioaccumulation Factors

For the modeling from water to prey, both BCFs and BAFs are necessary. The BCF relates the concentration of a POC in the tissue of an aquatic organism (mg/kg) to its concentration in water (mg/L), in situations where the organism is exposed to the POC through the water only. BCFs are an appropriate method of predicting POC concentrations in the tissues of low trophic level aquatic species. They are also appropriate for predicting tissue residues in higher trophic level organisms from the concentration in water for many metals. The BAF is the ratio of the concentration of a POC in tissue (mg/kg) to its concentration in water (mg/L), where both the organism and its prey are exposed, and is expressed as L/kg. BAFs are predicted by multiplying the BCF by the appropriate food chain multiplier (FCM).

BCFs from available literature are presented in Table B-1 for potential bioaccumulative constituents measured (NPDES-Regulated) or inferred (from Literature) in Asplund WPCF effluent, and Table B-2 for potentially bioaccumulative emerging pollutants of concern detected in AWWU Primary effluent in 2010 (tables are located at the end of this appendix). For most organic compounds, the BCFs used were those provided by EPA in the BCFBAF (v3.0) program of EPA's EPI (Estimation Programs Interface) Suite (v4.0) software tool. The BCFBAF program estimates the BCF of an organic compound using the compound's Log K_{ow} and structural features (e.g., functional groups and elemental composition). BCFs for certain super-hydrophobic chemicals (Log K_{ow} >7.0) in the EPI Suite database are adjusted based on estimates of water solubility limits (that is, when water solubility most limits uptake). For those chemicals unavailable in the BCFBAF database, BCFs were calculated from the following regression relating BCF and K_{OW} (Veith et al., 1979).

$$\text{Log BCF} = (0.85 * \text{Log } K_{OW}) - 0.70 \qquad (4)$$

or

$$\text{BCF} = 10^{(0.85 * \text{Log } K_{ow}) - 0.70} \qquad (5)$$

This regression is used in many EPA ambient water quality criteria to estimate bioconcentration factors for aquatic life. Unlike some Log BCF - Log K_{OW} regressions, the Veith et al. (1979) regression was developed with fish of known measured lipid content (7.6 percent). This information allows for adjusting the estimated BCF value to a species with any lipid content. The average lipid content of aquatic species in the United States is approximately 3 percent (EPA, 1980). Considering this, BCF values derived from the above equation were multiplied by 0.395 (the decimal fraction of 3/7.6) to obtain an average BCF for all aquatic species. Bioconcentration factors, the Log K_{OW} values used to derive the organic chemical BCFs, and the source of the BCFs and Log K_{OW} values used are presented in Tables B-1 and B-2.

For most inorganic compounds, BCFs and BAFs are assumed to be equivalent for all trophic levels (Appendix B of EPA, 1995). However, an FCM may be applicable for some metals if the organometallic form biomagnifies (EPA, 1995). To estimate a POC concentration in high trophic level aquatic species for organic chemicals, an FCM was applied to the water-to-prey BCF, as shown in the following expression:

$$C_{f\text{-}TLi} = C_w \times BAF_{TLi} = C_w \times BCF \times FCM_{TLi} \qquad (6)$$

where:

$C_{f\text{-}TLi}$ = POC concentration in prey from the i^{th} trophic level (mg/kg)

BAF_{TLi} = bioaccumulation factor for the i^{th} trophic level (L/kg)

BCF = bioconcentration factor (L/kg)

FCM_{TLi} = food chain multiplier (unitless)

C_w = POC concentration in water (mg/L)

FCM values depend on both the trophic level of the prey species and the Log K_{OW} of the chemical. The FCM values listed in the Great Lakes Water Quality Initiative (EPA, 1995) and *Toxicological Benchmarks for Wildlife* (Sample et al., 1996) were used. The food chain multipliers used are shown in Tables B-1 and B-2[4]. Table B-3 shows the constituents detected in CI fish tissue.

B.3.1.2 Wildlife Exposure Parameters

Media concentration data and exposure parameters specific to the beluga whale are needed to estimate exposure to POCs from food items. POC concentrations that serve as input to the intake equations are developed by using the approaches described above.

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[4] All BCFs and BAFs used in EPA's biological evaluation are expressed on a wet-weight basis.

The species-specific exposure parameters used for this evaluation include body weight, food intake rate, dietary composition, and area use factor. The exposure parameters and references used for the beluga whale are discussed in subsequent sections. All weight-based exposure parameters are listed on a wet-weight basis.

B.3.1.3 Body Weight

Body weight is a critical component used to estimate ingested contaminant doses. It is required to calculate exposure and is also used to estimate a daily food ingestion rate from allometric regressions. The average body weight for the beluga whale used in this evaluation is 313 kilograms, based on the average white whale weights in the north Pacific (Tamura and Ohsumi, 2000).

B.3.1.4 Allometric Conversion for Beluga Food Intake Rate

An allometric equation (Innes, 1987) was used to estimate the daily food ingestion rate (in kg/kg-body weight-day):

$$DIR_{food}\ (kg/day)\ 0.42 * BW^{0.67} \qquad (7)$$

where:

DIR_{food} = daily food ingestion rate (kg/day)
BW = body weight (kg)

B.3.1.5 Dietary Fraction Estimation

Beluga whales prey on multiple species from multiple trophic levels. The calculations in this BE assume that general food webs contain four trophic levels. Trophic level 1 (TL_1) consists of primary producers, TL_2 consists of primary consumers, mostly invertebrates but some fish species, TL_3 consists of secondary consumers, while TL_4 consists of top predators. As discussed earlier, some POCs have BCFs for organisms from higher trophic levels (e.g., 3 and 4) that are higher than the bioconcentration factors for organisms in lower trophic levels (e.g., 1 and 2). The trophic level-specific BCF or BAF and the proportion of the diet that comes from each aquatic trophic level must be known to estimate the ingested chemical dose of the aquatic-dependent wildlife receptor (in this case, the CI beluga whale).

Dietary composition information for wildlife is difficult to determine exactly and has temporal variances as a result of one or more factors. These include seasonal differences, age differences, location differences, prey availability, and health and nutritional status of both the wildlife and prey species.

Pauly et al. (1998) summarized the literature on measured dietary composition information for 97 marine mammals, including beluga whales, and apportioned their prey to one of eight prey type categories. Each prey type category was assigned a trophic level. The assigned trophic levels of the prey categories were then combined with the measured dietary composition data to calculate the trophic level of each marine mammal species.

The Pauly et al. (1998) dietary and trophic level information is expressed in terms of fractional trophic levels instead of the four discrete trophic levels utilized in this BE.

Professional judgment was used to convert the dietary composition and trophic level information in Pauly et al. (1998) into equivalent dietary fractions in each of the four trophic levels used in this BE. Based on Pauly et al. (1998), the beluga diet was assumed to be composed of 70 percent TL_3 (fish such as salmon and eulachon) and 30 percent TL_2 (invertebrates such as squid, octopus, and crab).

B.3.2 Effects Assessment

The toxicity of POCs to beluga whales as a result of potential exposure to contaminated prey in CI was identified by using literature-derived critical toxicity values. A literature review of the toxicological properties for the POCS evaluated was conducted to identify the highest exposure level considered to be without adverse ecological impact. This exposure level is called the toxicity reference value (TRV). TRVs were derived by interpreting existing literature-derived toxicological studies and adjusting the data, if necessary, to obtain values that are expected to protect the beluga whale. Available literature references generally come from toxicity studies using laboratory animals, or in some cases humans.

The primary toxicological endpoint used for development of the TRV is the chronic no observed adverse effect level (NOAEL). Derivation of wildlife TRVs for the whale is a four-step process as follows:

1. Conduct a literature search to compile data on toxicity of the POCs to surrogate (laboratory or clinical test) species.
2. Review these toxicity data to select the most appropriate values for each POC or surrogate.
3. Use uncertainty factors (UF) from the toxicology literature to derive a chronic NOAEL from other endpoints (e.g., from a subchronic lowest observed adverse effect level, or LOAEL), if necessary.
4. Calculate POC-specific TRVs by using the selected surrogate toxicity data and interspecies extrapolation to the endpoint species (the beluga whale).

B.3.2.1 Toxicological Uncertainty Factors

Uncertainty factors are applied to the literature-derived toxic level to account for any differences in the reported effect level and exposure duration. For example, if a chronic NOAEL is unavailable and only the chronic LOAEL is reported, an uncertainty factor of 5 (that is, LOAEL/5) is applied to derive the NOAEL used to calculate the TRV. The uncertainty factors applied are consistent with those recommended by EPA Region 10 (EPA, 1997). The following uncertainty factors are used in deriving chronic NOAELs for TRVs:

- Chronic NOAEL to Chronic NOAEL = 1
- Chronic LOAEL to Chronic NOAEL = 5
- Subchronic NOAEL to Chronic NOAEL = 5
- Subchronic LOAEL to Chronic NOAEL = 10

No uncertainty factors were applied for those toxicity factors based on the EPA *Ecological Soil Screening Levels* (EPA, 2005-2008). The selection scheme employed by EPA to derive these screening levels uses multiple species and multiple toxicity endpoints to determine a protective toxicity factor. The values reported are believed to be sufficiently conservative.

TRVs for laboratory species are extrapolated to TRVs for the beluga whale to account for sensitivity differences associated with body size. This conversion assumes that many physiological functions, including metabolic rate and response to toxic chemicals, are a function of body size. Given the assumption that body size can be expressed in terms of body weight, dosages for laboratory or test species can be converted to corresponding dosages in wildlife, using the following equation from Sample and Arenal (1999):

$$TRV_{wild} = TRV_{lab}\left[\frac{BW_{lab}}{BW_{wild}}\right]^{1-b} \qquad (8)$$

where:

TRV_{wild} = toxicity reference value for target receptor (mg/kg-body weight/d)

TRV_{lab} = toxicity reference value for laboratory or test species (mg/kg-body weight/d)

BW_{lab} = body weight for laboratory or test species (kg)

BW_{wild} = body weight for target endpoint species (kg)

b = allometric scaling factor (unitless); for mammals, b = 0.94

For TRVs derived from *Ecological Soil Screening Levels* (EPA, 2005-2008), which consider toxicity data from multiple species, the laboratory species body weight for a mouse was conservatively assumed. The selected literature-derived toxic level and toxicity uncertainty factors applied are provided in Table B-4.

B.3.2.2 Toxicity Data Sources

Sources used for ecological toxicity information include the following:

- NOAA Pharmaceuticals in the Environment, Information for Assessing Risk (PEIAR) database (NOAA, 2010)
- EPA Ecological Soil Screening Levels (EPA, 2005-2008)
- Department of Energy Oak Ridge National Laboratory Toxicological Benchmark Technical Reports (Sample et al., 1996)
- EPA IRIS database (EPA, 2010)
- U.S. Food and Drug Administration (FDA) Maximum Recommended Therapeutic Dose (MRTD) database (FDA, 2010)
- Agency for Toxic Substances and Disease Registry Toxicity Profile for Diazinon

- European Union Risk Assessment Reports (various dates)
- Other scientific literature (see Table B-4)

Full citations for primary sources for toxicity data are provided in Attachment B2. If a toxicity factor for a constituent was not available from a reliable source, the constituent was evaluated by comparing results to a structurally similar compound. Because surrogates generally considered to have greater toxicity were chosen, the risk estimates for these constituents are conservative.

B.3.3 Calculation of Ecological Hazard Quotients

The potential for ecological risks to beluga food resources was estimated by calculating a hazard quotient (HQ) for each effluent-related POC (measured or inferred). The HQ is calculated as the ratio of the estimated exposure E_{diet} to the TRV as follows:

$$HQ = E_{diet} / TRV \tag{9}$$

where:

HQ = ecological hazard quotient (unitless)
E_{diet} = estimated daily dietary intake of POC (mg/kg body weight-day)
TRV = toxicity reference value (mg/kg body weight-day)

If the estimated exposure concentration for any individual POC exceeds its TRV, the HQ will exceed unity (one). An HQ that exceeds unity indicates that there is a potential for adverse ecological effects associated with exposure to that POC. An HQ value less than or equal to one is considered protective of beluga whales. The HQ results for POCs measured or inferred to occur in whale prey tissue are provided in the following subsections.

B.3.3.1 Results for Constituents Measured in Fish Tissue

Table B-5 provides the HQs based on maximum detected levels in fish tissue collected from CI. Of the 33 constituents reported with detectable concentrations, none had an HQ value exceeding unity. The HQs for metals were segregated depending on whether the fish tissue sample was collected from the Point Woronzof station or from the background station. The results show that the tissue levels seen in fish from Point Woronzof (and resulting HQs) are largely attributable to naturally-occurring levels of these metals. Based on the HQs for available fish tissue data, these results indicate that these constituents are **not likely to adversely affect** the CI beluga whale.

B.3.3.2 Results for Constituents Measured (NPDES-Regulated) or Inferred (Non-Regulated) to Occur in Asplund WPCF Final Effluent

Table B-6 provides the HQs based on maximum concentrations of POCs measured during NPDES Permit monitoring of Asplund WPFC final effluent over the time period of 2000 to 2009, and based on maximum hypothetical concentrations (from literature) of unregulated POCs projected to occur at the edge of the ZID. Of the 87 constituents evaluated from these two sources, none has an HQ exceeding 1.0, even when conservatively using estimated concentrations at the edge of the ZID. When using more realistic environmental concentrations in the Knik Arm, Turnagain Arm, and the Upper

CI subareas (based on the hydrodynamic model results provided in Appendix F), the HQs are below 1.0 by several orders of magnitude. These results indicate that, even when very conservative assumptions are used, the constituents detected in Asplund effluent are **not likely to adversely affect** the CI beluga whale.

B.3.3.3 Results for Constituents Measured in Asplund WPCF Final Effluent in 2010

Table B-7 provides the HQs based on concentrations of POCs measured during the 2010 monitoring of Asplund WPFC final effluent. Concentrations detected in 2010 were generally lower than the levels previously obtained from literature sources (Table B-5). Of the 104 constituents evaluated, none has an HQ exceeding 1.0, even when conservatively using estimated concentrations at the edge of the ZID. When using more realistic environmental concentrations in the Knik Arm, Turnagain Arm, and the Upper CI subareas (based on the hydrodynamic model results provided in Appendix F), the HQs are below 1.0 by several orders of magnitude. These results confirm the results seen with literature-based concentrations that, even when very conservative assumptions are used, the constituents recently detected in 2010 in Asplund effluent are **not likely to adversely affect** the CI beluga whale.

B.4 Assumptions and Limitations

Numerous health-conservative assumptions were used to conduct the evaluation provided in this appendix. These assumptions are conservative and were intentionally selected to provide confidence in the conclusions that have been reached. The following are major assumptions used for estimating effects on the beluga whale from dietary exposure to POCs:

- Used maximum fish tissue levels reported by ADEC (salmon) and AWWU (Pacific cod) for metals, pesticides, PCBs, SVOCs, dioxins, and PBDEs
- Assumed tissue residues originated from Asplund WPCF, even though concentrations beyond the ZID are diminishingly minute and primary dietary species migrate beyond CI and accumulate from other sources
- Computed HQs using concentrations at edge of ZID and three CI subareas
- Interpolated toxicity was from studies in terrestrial mammals (using allometric scaling to account for body size differences)
- Included both NOAELs and LOAELs for the most sensitive endpoints (NOEL was used in some cases)
- Assumed beluga body weight to be 313 kilograms
- Assumed dietary composition as 70 percent fish and 30 percent invertebrates (the tissue concentration from fish was conservatively applied for both)
- Used maximum effluent levels of regulated POCs detected during AWWU NPDES compliance monitoring (2000-2009)
- Used maximum reported levels of non-regulated EPOCs from literature

- Used actual reported levels of non-regulated EPOCs detected in 2010 monitoring
- Included constituents with Log $K_{OW} \geq$ 3.5 (77 chemicals from literature reports and 103 from 2010 monitoring) and 10 metals
- Assumed no biodegradation, which is very conservative for some POCs (t½ estradiol is about 10 days; PBDE about 150 days)
- Assumed all uptake via bioconcentration from water column into beluga prey (ignoring likely sorption to suspended particulates, preventing gill uptake). 2010 monitoring indicated that a substantial fraction of total effluent concentrations were associated with solids.
- Did not account for prey residence time for uptake exposure to levels at the edge of the ZID (more appropriate for the three CI subareas evaluated)
- Estimated many BCF values using a Log K_{OW}-based model that assumes steady-state uptake levels and does not account for *in-vivo* metabolism in fish
- Used default food-chain multipliers for trophic level transfer to fish (EPA, 1995)
- Selected food ingestion rate from the most conservative of several allometric models
- Included constituents directly detected in fish tissue to provide an additional line of evidence

B.5 Conclusions

Evaluation of potential effects of Asplund wastewater on the beluga whale was conducted to determine whether discharge of wastewater POCs to CI could adversely impact the endangered beluga whale by chemical exposure through their food web. Using both measured fish tissue levels and inferred or measured effluent concentrations, modeled exposure levels were compared with toxicological threshold levels for the beluga whale. The results indicate that none of the concentrations of known or inferred POCs is at a level that exceeds toxicological thresholds for the beluga whale, even when considering the levels of conservatism associated with this evaluation. Considering the lines of evidence evaluated in this Appendix, the Asplund effluent is considered **not likely to adversely affect** the CI beluga whale via dietary exposure.

B.6 References

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Attachment B1

Fish Tissue Data Provided by Alaska Department of Environmental Conservation

Alaska Department of Environmental Conservation, Fish Tissue Testing Program
Trace Metals Concentrations in Fish from Cook Inlet

Sample#	SampleType	Length (cm)	Weight (kg)		Site	Area	Arsenic	Cadmium	Chromium	Lead	Nickel	Selenium	Methyl Mercury	Total Mercury
20024713	Chinook Salmo	64.7	3.10		Homer Spit	Cook Inlet	0.43	<MRL	<MRL	<MRL	<MRL	0.10	0.045	0.10
20024714	Chinook Salmo	89.1	8.00		Homer Spit	Cook Inlet	0.23	<MRL	<MRL	<MRL	<MRL	0.10	0.094	0.16
20024715	Chinook Salmo	49.7	1.70		Homer Spit	Cook Inlet	0.88	<MRL	<MRL	<MRL	<MRL	0.13	<MRL	0.049
20024716	Chinook Salmo	70.0	4.00		Homer Spit	Cook Inlet	0.45	<MRL	<MRL	<MRL	<MRL	0.090	0.049	0.090
20024717	Chinook Salmo	71.6	3.80		Homer Spit	Cook Inlet	0.40	<MRL	<MRL	<MRL	<MRL	0.080	0.051	0.10
20024718	Chinook Salmo	68.5	3.40		Homer Spit	Cook Inlet	0.44	<MRL	<MRL	<MRL	<MRL	0.070	0.044	0.087
20072983	Coho Salmon	51.4	2.16		Kenai River Sonar	Cook Inlet	0.37	<MRL	<MRL	<MRL	<MRL	0.24	NA	0.057
20072984	Coho Salmon	60.5	3.78		Kenai River Sonar	Cook Inlet	0.32	<MRL	NA	<MRL	NA	0.23	NA	0.046
20072985	Coho Salmon	55.0	2.54		Kenai River Sonar	Cook Inlet	0.35	<MRL	0.084	<MRL	<MRL	0.23	NA	0.039
20072986	Coho Salmon	58.2	3.31		Kenai River Sonar	Cook Inlet	0.31	<MRL	<MRL	<MRL	<MRL	0.22	NA	0.047
20072987	Coho Salmon	59.1	3.02		Kenai River Sonar	Cook Inlet	0.39	<MRL	<MRL	<MRL	<MRL	0.23	NA	0.048
20072988	Coho Salmon	54.1	2.52		Kenai River Sonar	Cook Inlet	0.40	<MRL	<MRL	<MRL	<MRL	0.21	NA	0.035
20072989	Coho Salmon	58.7	3.33		Kenai River Sonar	Cook Inlet	0.56	<MRL	0.13	<MRL	<MRL	0.23	NA	0.034
20072990	Coho Salmon	58.7	2.95		Kenai River Sonar	Cook Inlet	0.37	<MRL	<MRL	<MRL	<MRL	0.24	NA	0.032
20072991	Coho Salmon	54.2	2.77		Kenai River Sonar	Cook Inlet	0.36	<MRL	<MRL	<MRL	<MRL	0.21	NA	0.055
20072992	Coho Salmon	60.6	3.49		Kenai River Sonar	Cook Inlet	<MRL	<MRL	<MRL	<MRL	<MRL	0.21	NA	0.043
						MRL	<0.2	<0.01	<0.051	<0.05	<0.05	<0.05	<0.02	<0.025

Concentrations in micrograms/gram wet weight (parts per million)

NA not analyzed

MRL Method Reporting Limit

Alaska Department of Environmental Conservation,
Fish Tissue Testing Program
PCB Concentrations in Fish from Cook Inlet

Sample#	date	Species	Area	Congener 153	Total PCBs
20024713	7 2002	Chinook Salmon	Cook Inlet	620	8,150
20024714	7 2002	Chinook Salmon	Cook Inlet	539	6,090
20024715	7 2002	Chinook Salmon	Cook Inlet	352	5,670
20024716	7 2002	Chinook Salmon	Cook Inlet	698	8,750
20024717	7 2002	Chinook Salmon	Cook Inlet	701	8,170
20024718	7 2002	Chinook Salmon	Cook Inlet	640	7,890
20072983	8 2006	Coho Salmon	Cook Inlet	132	1,590
20072984	8 2006	Coho Salmon	Cook Inlet	109	1,730
20072985	8 2006	Coho Salmon	Cook Inlet	46	990
20072986	8 2006	Coho Salmon	Cook Inlet	115	1,880
20072987	8 2006	Coho Salmon	Cook Inlet	95	1,220
20072988	8 2006	Coho Salmon	Cook Inlet	122	1,980
20072989	8 2006	Coho Salmon	Cook Inlet	196	2,880
20072990	8 2006	Coho Salmon	Cook Inlet	92	1,340
20072991	8 2006	Coho Salmon	Cook Inlet	71	1,040
20072992	8 2006	Coho Salmon	Cook Inlet	39	556

Concentrations are in picograms/gram wet weight (parts per trillion)

Total PCBs are the sum of all identified Congeners

Alaska Department of Environmental Conservation, Fish Tissue Testing Program

Pesticide Concentrations in Fish from Cook Inlet

Sample#	Species	Area	Compound	Conc. (ppb)
20024713	Chinook Salmon	Cook Inlet	Total Chlordanes	5.04
			Total DDT	6.89
			Dieldrin	0.47
			Total HCH	0.75
			Hexachlorobenzene	1.56
			Total Toxaphene	0.00
20024714	Chinook Salmon	Cook Inlet	Total Chlordanes	1.57
			Total DDT	4.85
			Dieldrin	0.27
			Total HCH	0.36
			Hexachlorobenzene	0.90
			Total Toxaphene	0.00
20024715	Chinook Salmon	Cook Inlet	Total Chlordanes	2.32
			Total DDT	2.61
			Dieldrin	0.77
			Total HCH	3.26
			Hexachlorobenzene	1.71
			Total Toxaphene	17.70
20024716	Chinook Salmon	Cook Inlet	Total Chlordanes	5.03
			Total DDT	4.75
			Dieldrin	0.38
			Total HCH	1.93
			Hexachlorobenzene	1.58
			Total Toxaphene	0.00
20024717	Chinook Salmon	Cook Inlet	Total Chlordanes	2.86
			Total DDT	6.21
			Dieldrin	0.69
			Total HCH	1.74
			Hexachlorobenzene	1.82
			Total Toxaphene	17.00
20024718	Chinook Salmon	Cook Inlet	Total Chlordanes	2.25
			Total DDT	5.85
			Dieldrin	0.62
			Total HCH	1.38
			Hexachlorobenzene	1.47
			Total Toxaphene	10.10

Concentrations are in nanograms/gram wet weight (parts per billion)

Total Chlordanes are the sum of cis-, trans-, and oxy-chlordane, and cis- and

Total DDT is the sum of 2,4'-DDE, 4,'4-DDE, 2,4'-DDT, and 4,4'-DDT

Total HCH is the sum of Alpha-, beta-, delta-, and gamma-(lindane) HCH

Total Toxaphane is supplied as a sum by the analytical lab

Alaska Department of Environmental Conservation, Fish Tissue Testing Program
Dioxin Concentrations in Fish from Cook Inlet

Sample#	Species	Area	%Lipid	2,3,7,8-TCDD	2,3,7,8-TCDF	Total Tetra-OctaCDD	Total Tetra-OctaCDF
20024713	Chinook Salmon	Cook Inlet	5.28		0.29	0.50	0.80
20024714	Chinook Salmon	Cook Inlet	2.71		0.19	0.31	0.00
20024715	Chinook Salmon	Cook Inlet	11.10		0.21	0.31	0.30
20024716	Chinook Salmon	Cook Inlet	6.57		0.29	0.78	1.56
20024717	Chinook Salmon	Cook Inlet	7.37		0.38	0.67	1.44
20024718	Chinook Salmon	Cook Inlet	5.92		0.32	0.63	0.65
20072983	Coho Salmon	Cook Inlet	3.56			0.26	0.13
20072984	Coho Salmon	Cook Inlet	3.57			0.07	0.07
20072985	Coho Salmon	Cook Inlet	2.71			0.15	0.06
20072986	Coho Salmon	Cook Inlet	3.47			0.14	0.09
20072987	Coho Salmon	Cook Inlet	2.96			0.08	0.06
20072988	Coho Salmon	Cook Inlet	6.86		0.08	0.33	0.35
20072989	Coho Salmon	Cook Inlet	4.85		0.08	0.18	0.20
20072990	Coho Salmon	Cook Inlet	3.88			0.15	0.09
20072991	Coho Salmon	Cook Inlet	3.22			0.09	0.06
20072992	Coho Salmon	Cook Inlet	1.50			0.15	0.18

Dioxin concentrations in picograms/gram wet weight (parts per trillion)

Total concentrations are the sum of all identified Congeners within the range identified

Alaska Department of Environmental Conservation,
Fish Tissue Testing Program
PBDE Concentrations in Fish from Cook Inlet

Sample#	Species	Area	IUPAC#	Conc.
20024713	Chinook Salmon	Cook Inlet	47	243
			49	20.3
			99	102
			100	43.3
			153	18.1
			154	23.6
			Total Dominant PBDEs	450
20024714	Chinook Salmon	Cook Inlet	47	129
			49	8.91
			99	61.6
			100	23.2
			153	7.51
			154	12.0
			Total Dominant PBDEs	242
20024715	Chinook Salmon	Cook Inlet	47	118
			49	10.9
			99	29.7
			100	19.2
			153	3.90
			154	5.58
			Total Dominant PBDEs	187
20024716	Chinook Salmon	Cook Inlet	47	82.1
			49	12.0
			99	27.7
			100	11.9
			153	3.77
			154	6.20
			Total Dominant PBDEs	144
20024717	Chinook Salmon	Cook Inlet	47	188
			49	19.8
			99	96.5
			100	35.3
			153	9.41
			154	14.9
			Total Dominant PBDEs	364
20024718	Chinook Salmon	Cook Inlet	47	228
				17.6
				110
				39.7
				14.2
				18.2
			Total Dominant PBDEs	428

Alaska Department of Environmental Conservation,
Fish Tissue Testing Program
PBDE Concentrations in Fish from Cook Inlet

Sample#	Species	Area	IUPAC#	Conc.
20072983	Coho Salmon	Cook Inlet	47	25.3
			49	3.92
			99	7.79
			100	4.34
			153	1.11
			154	2.09
			Total Dominant PBDEs	45
20072984	Coho Salmon	Cook Inlet	47	16.2
			49	3.09
			99	5.19
			100	2.50
			153	1.14
			154	1.32
			Total Dominant PBDEs	29
20072985	Coho Salmon	Cook Inlet	47	14.4
			49	1.92
			99	5.35
			100	2.58
			153	0.69
			154	1.40
			Total Dominant PBDEs	26
20072986	Coho Salmon	Cook Inlet	47	18.2
			49	3.35
			99	6.51
			100	2.76
			153	0.63
			154	1.52
			Total Dominant PBDEs	33
20072987	Coho Salmon	Cook Inlet	47	26.2
			49	2.94
			99	7.38
			100	4.14
			153	0.95
			154	2.06
			Total Dominant PBDEs	44
20072988	Coho Salmon	Cook Inlet	47	25.6
			49	4.28
			99	6.78
			100	4.37
			153	0.80
			154	1.93
			Total Dominant PBDEs	44
20072989	Coho Salmon	Cook Inlet	47	27.3
			49	5.45
			99	6.72
			100	5.31
			153	1.07
			154	2.84
			Total Dominant PBDEs	49

Alaska Department of Environmental Conservation,
Fish Tissue Testing Program
PBDE Concentrations in Fish from Cook Inlet

Sample#	Species	Area	IUPAC#	Conc.
20072990	Coho Salmon	Cook Inlet	47	21.7
			49	2.69
			99	6.79
			100	3.44
			153	0.84
			154	1.30
			Total Dominant PBDEs	37
20072991	Coho Salmon	Cook Inlet	47	17.6
			49	2.72
			99	6.37
			100	3.42
			153	0.73
			154	1.24
			Total Dominant PBDEs	32
20072992	Coho Salmon	Cook Inlet	47	12.8
			49	1.49
			99	5.82
			100	2.91
			153	0.69
			154	0.93
			Total Dominant PBDEs	25

Concentrations are in picograms/gram wet weight (parts per trillion)
Dominant PBDEs are the sum of Congeners 47, 49, 99, 100, 153, 154

Attachment B2
Mammalian Toxicology References

Attachment B2 Mammalian Toxicology References

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Table B-1

Potentially Bioaccumulative Constituents Measured (NPDES-Regulated) or Inferred (from Literature) in Asplund WPCF Effluent

Anchorage Water and Wastewater Facility Biological Evaluation

Dilution Factor	142.9	1,223	9,385	2,189

Chemical	CAS Number	Use	Log Kow[a]	Log Kow Source	BCF	Source	Trophic Level 2	Trophic Level 3	Trophic Level 4	Max Detected Concentration (ug/L)	Max Detected Concentration (mg/L)	Maximum at Edge of ZID (mg/L)	Estimated Conc. in Knik Arm (mg/L)	Estimated Conc. in Turnagain Arm (mg/L)	Estimated Conc. in Mid Upper CI (mg/L)
1,3- Dichlorobenzene	541-73-1	Semivolatile organic	3.5	b	99	EPA EPI Suite v. 4.0, 2011	1	1.083	1.019	9.5	0.0095	6.65E-05	7.77E-06	1.01E-06	4.34E-06
16α-Hydroxyestrone	566-76-7	Estrogen metabolite	4.0	17a-Estra	206	17a-Estradiol as surrogate	1	1.202	1.054	0.03	0.000028	1.96E-07	2.29E-08	2.98E-09	1.28E-08
17a-Estradiol	57-91-0	Sex hormone	4.0	b	206	EPA EPI Suite v. 4.0, 2011	1	1.202	1.054	0.02	0.0000172	1.20E-07	1.41E-08	1.83E-09	7.86E-09
17a-Ethynyl Estradiol (EE2)	57-63-6	Ovulation inhibitor	3.7	b	123	EPA EPI Suite v. 4.0, 2011	1	1.128	1.033	0.07	0.00007	4.90E-07	5.72E-08	7.46E-09	3.20E-08
17b-Estradiol (E2)	50-28-2	Sex hormone	4.0	b	206	EPA EPI Suite v. 4.0, 2011	1	1.253	1.072	0.15	0.00015	1.05E-06	1.23E-07	1.60E-08	6.85E-08
4,4'- DDD	72-54-8	Organochlorine pesticide	6.0	b	4,355	EPA EPI Suite v. 4.0, 2011	1	10.556	15.996	0.047	0.000047	3.29E-07	3.84E-08	5.01E-09	2.15E-08
4,4'- DDE	72-55-9	Organochlorine pesticide	6.5	b	9,168	EPA EPI Suite v. 4.0, 2011	1	13.662	24.604	0.016	0.000016	1.12E-07	1.31E-08	1.70E-09	7.31E-09
4,4’- DDT	50-29-3	Organochlorine pesticide	6.9	b	16,840	EPA EPI Suite v. 4.0, 2011	1	14.388	26.669	0.25	0.00025	1.75E-06	2.04E-07	2.66E-08	1.14E-07
4-Nonylphenol	25154-52-3	Surfactant metabolite	5.8	b	124	EPA EPI Suite v. 4.0, 2011	1	10.556	15.996	343	0.343	2.40E-03	2.80E-04	3.65E-05	1.57E-04
4-Nonylphenoxyacetic acid	3115-49-9	Nonionic detergent metabolite	5.8	b	10	EPA EPI Suite v. 4.0, 2011	1	8.841	12.05	4.30	0.0043	3.01E-05	3.52E-06	4.58E-07	1.96E-06
4-tert-Octylphenol	140-66-9	Nonionic detergent metabolite	5.3	b	1,406	EPA EPI Suite v. 4.0, 2011	1	4.803	4.742	13.00	0.013	9.10E-05	1.06E-05	1.39E-06	5.94E-06
4-tert-Octylphenoldiethoxylate	na	Nonionic detergent metabolite	5.3	4-tert-octy	1,406	4-tert-octylphenol as surroga	1	1.315	1.096	0.71	0.00071	4.97E-06	5.80E-07	7.57E-08	3.24E-07
alpha-BHC	319-84-6	Organochlorine pesticide	4.1	b	250	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	0.023	0.000023	1.61E-07	1.88E-08	2.45E-09	1.05E-08
Androsterone	53-41-8	Urinary steroid	3.7	b	126	EPA EPI Suite v. 4.0, 2011	1	1.128	1.033	2.91	0.00291	2.04E-05	2.38E-06	3.10E-07	1.33E-06
Antimony	7440-36-0	Metal	na	na	1	EPA 2002	1	1	1	0.65	0.00065	4.55E-06	5.31E-07	6.93E-08	2.97E-07
Arsenic	7440-38-2	Metal	na	na	44	EPA 2002	1	1	1	4	0.004	2.80E-05	3.27E-06	4.26E-07	1.83E-06
Azithromycin	83905-01-5	Macrolide antibiotic	4.0	b	209	EPA EPI Suite v. 4.0, 2011	1	1.253	1.072	0.67	0.000669	4.68E-06	5.47E-07	7.13E-08	3.06E-07
Beryllium	7440-41-7	Metal	na	na	19	EPA 2002	1	1	1	0.3	0.0003	2.10E-06	2.45E-07	3.20E-08	1.37E-07
beta-BHC	319-85-7	Organochlorine pesticide	4.1	b	250	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	0.037	0.000037	2.59E-07	3.02E-08	3.94E-09	1.69E-08
beta-Sitosterol	83-46-5	Phytosterol (plant sterol)	9.7	b	671	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	271	0.271	1.90E-03	2.22E-04	2.89E-05	1.24E-04
beta-Stigmastanol	83-45-4	Phytosterol (plant sterol)	9.7	b	610	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	46.0	0.046	3.22E-04	3.76E-05	4.90E-06	2.10E-05
Bezafibrate	41859-67-0	Lipid regulator	4.3	b	3	EPA EPI Suite v. 4.0, 2011	1	1.491	1.178	7.60	0.0076	5.32E-05	6.21E-06	8.10E-07	3.47E-06
Bis (2-ethylhexyl) phthalate	117-81-7	Plasticizer	7.6	b	1,712	EPA EPI Suite v. 4.0, 2011	1	11.708	16.749	33	0.033	2.31E-04	2.70E-05	3.52E-06	1.51E-05
Butyl benzyl phthalate	85-68-7	Plasticizer	4.7	b	614	EPA EPI Suite v. 4.0, 2011	1	2.175	1.633	7.4	0.0074	5.18E-05	6.05E-06	7.88E-07	3.38E-06
Cadmium	7440-43-9	Metal	na	na	38	ODEQ 2003	1	1	1	4.9	0.0049	3.43E-05	4.01E-06	5.22E-07	2.24E-06
Campesterol	474-62-4	Phytosterol (plant sterol)	9.2	b	1,168	EPA EPI Suite v. 4.0, 2011F	1	1.493	0.226	46.6	0.0466	3.26E-04	3.81E-05	4.97E-06	2.13E-05
Cashmeran (DPMI)	33704-61-9	Fragrance	4.5	b	426	EPA EPI Suite v. 4.0, 2011	1	1.766	1.334	0.16	0.000163	1.14E-06	1.33E-07	1.74E-08	7.45E-08
Celestolide (ADBI)	13171-00-1	Fragrance	5.9	b	984	EPA EPI Suite v. 4.0, 2011	1	9.716	13.964	0.26	0.000259	1.81E-06	2.12E-07	2.76E-08	1.18E-07
Chlorpyriphos	2921-88-2	Organophosphorus pesticide	4.96	b	870	EPA EPI Suite v. 4.0, 2011	1	3.181	2.612	0.26	0.000262	1.83E-06	2.14E-07	2.79E-08	1.20E-07
Cholestanol	80-97-7	Sterol	8.8	b	1,699	EPA EPI Suite v. 4.0, 2011	1	2.246	0.521	45.7	0.0457	3.20E-04	3.74E-05	4.87E-06	2.09E-05
Cholesterol	57-88-5	Plant/animal steroid	8.7	b	1,871	EPA EPI Suite v. 4.0, 2011	1	2.732	0.778	745	0.745	5.22E-03	6.09E-04	7.94E-05	3.40E-04
Chromium	7440-47-3	Metal	na	na	16	EPA 2002	1	1	1	7	0.007	4.90E-05	5.72E-06	7.46E-07	3.20E-06
Cis-Permethrin	61949-76-6	Pyrethroid pesticide	6.5	b	497	EPA EPI Suite v. 4.0, 2011	1	12.987	21.038	0.31	0.000306	2.14E-06	2.50E-07	3.26E-08	1.40E-07
Clotrimazole	23593-75-1	Antifongic	6.26	b	6,297	EPA EPI Suite v. 4.0, 2011	1	12.691	21.667	0.033	0.000033	2.31E-07	2.70E-08	3.52E-09	1.51E-08
Copper	7440-50-8	Metal	na	na	36	EPA 2002	1	1	1	77	0.077	5.39E-04	6.29E-05	8.20E-06	3.52E-05
Coprostanol	360-68-9	Fecal steroid	8.8	b	1,699	EPA EPI Suite v. 4.0, 2011	1	2.246	0.521	496	0.496	3.47E-03	4.05E-04	5.28E-05	2.27E-04
Cypermethrins	52315-07-8	Pyrethroid pesticide	6.6	b	255	EPA EPI Suite v. 4.0, 2011	1	13.98	25.645	0.071	0.0000705	4.94E-07	5.76E-08	7.51E-09	3.22E-08
Desmosterol	313-04-2	Sterol	8.7	b	2,060	EPA EPI Suite v. 4.0, 2011	1	2.732	0.778	11.1	0.0111	7.77E-05	9.07E-06	1.18E-06	5.07E-06
Dextropropoxyphene	469-62-5	Analgesic antiinflammatory	4.2	b	266	EPA EPI Suite v. 4.0, 2011	1	1.38	1.13	0.03	0.000033	2.31E-07	2.70E-08	3.52E-09	1.51E-08
Diazinon	333-41-5	Organophosphorus pesticide	3.81	b	152	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	0.072	0.0000719	5.03E-07	5.88E-08	7.66E-09	3.29E-08
Diclofenac	15307-86-5	Antiinflammatory	4.51	b	3	EPA EPI Suite v. 4.0, 2011	1	1.766	1.334	4.11	0.00411	2.88E-05	3.36E-06	4.38E-07	1.88E-06
Dieldrin	60-57-1	Organochlorine pesticide	5.2	b	1,253	EPA EPI Suite v. 4.0, 2011	1	5.502	5.821	0.021	0.000021	1.47E-07	1.72E-08	2.24E-09	9.60E-09
Di-n-butyl phthalate	84-74-2	Plasticizer	4.5	b	433	EPA EPI Suite v. 4.0, 2011	1	1.766	1.334	1.7	0.0017	1.19E-05	1.39E-06	1.81E-07	7.77E-07
Endosulfan II	33213-65-9	Organochlorine pesticide	3.8	b	156	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	0.075	0.000075	5.25E-07	6.13E-08	7.99E-09	3.43E-08
Endrin	72-20-8	Organochlorine pesticide	5.2	b	1,253	EPA EPI Suite v. 4.0, 2011	1	4.188	3.873	0.011	0.000011	7.70E-08	8.99E-09	1.17E-09	5.03E-09
Endrin ketone	53494-70-5	Organochlorine pesticide	5.0	b	906	EPA EPI Suite v. 4.0, 2011	1	3.181	2.612	0.012	0.000012	8.40E-08	9.81E-09	1.28E-09	5.48E-09
Epicoprostanol	516-92-7	Sterol	8.82	b	1,699	EPA EPI Suite v. 4.0, 2011	1	2.246	0.521	21.4	0.0214	1.50E-04	1.75E-05	2.28E-06	9.78E-06
Ergosterol	57-87-4	Sterol	8.86	b	1,639	EPA EPI Suite v. 4.0, 2011	1	2.246	0.521	4.49	0.00449	3.14E-05	3.67E-06	4.78E-07	2.05E-06
Fenoprofen	31879-05-7	Antiinflammatory	3.9	b	3	EPA EPI Suite v. 4.0, 2011	1	1.202	1.054	9.70	0.0097	6.79E-05	7.93E-06	1.03E-06	4.43E-06
Fluoxetine	54910-89-3	SSRI Antidepressant	4.1	b	218	EPA EPI Suite v. 4.0, 2011	1	1.315	1.096	0.06	0.0000587	4.11E-07	4.80E-08	6.25E-09	2.68E-08

Table B-1

Potentially Bioaccumulative Constituents Measured (NPDES-Regulated) or Inferred (from Literature) in Asplund WPCF Effluent

Anchorage Water and Wastewater Facility Biological Evaluation

											Dilution Factor	142.9	1,223	9,385	2,189
Chemical	**CAS Number**	**Use**	**Log Kow[a]**	**Log Kow Source**	**BCF**	**Source**	**Trophic Level 2**	**Trophic Level 3**	**Trophic Level 4**	**Max Detected Concentration (ug/L)**	**Max Detected Concentration (mg/L)**	**Maximum at Edge of ZID (mg/L)**	**Estimated Conc. in Knik Arm (mg/L)**	**Estimated Conc. in Turnagain Arm (mg/L)**	**Estimated Conc. in Mid Upper CI (mg/L)**
Galaxolide (HHCB)	1222-05-5	Fragrance	5.9	b	3,629	EPA EPI Suite v. 4.0, 2011	1	12.691	21.677	40.3	0.0403	2.82E-04	3.29E-05	4.29E-06	1.84E-05
Gemfibrozil	25812-30-0	Antilipemic	4.8	b	3	EPA EPI Suite v. 4.0, 2011	1	2.452	1.871	6.63	0.00663	4.64E-05	5.42E-06	7.06E-07	3.03E-06
Heptachlor	76-44-8	Organochlorine pesticide	6.1	b	4,918	EPA EPI Suite v. 4.0, 2011	1	11.337	17.783	0.99	0.00099	6.93E-06	8.09E-07	1.05E-07	4.52E-07
Ibuprofen	15687-27-1	Analgesic	4.0	b	3	EPA EPI Suite v. 4.0, 2011	1	1.253	1.072	83.5	0.0835	5.85E-04	6.83E-05	8.90E-06	3.82E-05
Indomethacin	53-86-1	Antiinflammatory	4.27	b	3	EPA EPI Suite v. 4.0, 2011	1	1.491	1.178	0.64	0.00064	4.48E-06	5.23E-07	6.82E-08	2.92E-07
Mefenamic acid	61-68-7	Analgesic antiinflammatory	5.1	b	10	EPA EPI Suite v. 4.0, 2011	1	3.643	3.162	3.20	0.0032	2.24E-05	2.62E-06	3.41E-07	1.46E-06
Mercury	na	Metal	na	na	27,900	EPA 1995	1	27,900	140,000	0.7	0.0007	4.90E-06	5.72E-07	7.46E-08	3.20E-07
Miconazole	22916-47-8	Antifungal agent	6.3	b	6,192	EPA EPI Suite v. 4.0, 2011	1	12.691	21.677	0.11	0.000114	7.98E-07	9.32E-08	1.21E-08	5.21E-08
Molybdenum	7439-98-7	Metal	na	na	1	default	1	1	1	11	0.011	7.70E-05	8.99E-06	1.17E-06	5.03E-06
Musk Abrette (MA)	83-66-9	Fragrance	4.2	b	261	EPA EPI Suite v. 4.0, 2011	1	1.38	1.13	0.01	0.00000988	6.92E-08	8.08E-09	1.05E-09	4.51E-09
Musk Ketone (MK)	81-14-1	Fragrance	4.6	b	131	EPA EPI Suite v. 4.0, 2011	1	1.491	1.178	0.39	0.000385	2.70E-06	3.15E-07	4.10E-08	1.76E-07
Musk Moskene (MM)	116-66-5	Fragrance	5.4	b	1,675	EPA EPI Suite v. 4.0, 2011	1	5.502	5.821	0.01	0.0000126	8.82E-08	1.03E-08	1.34E-09	5.76E-09
Musk Tibetene (MT)	145-39-1	Fragrance	5.2	b	1,215	EPA EPI Suite v. 4.0, 2011	1	4.188	3.873	0.004	0.0000041	2.87E-08	3.35E-09	4.37E-10	1.87E-09
Musk Xylene (MX)	81-15-2	Fragrance	4.5	b	401	EPA EPI Suite v. 4.0, 2011	1	1.766	1.334	0.25	0.000252	1.76E-06	2.06E-07	2.69E-08	1.15E-07
Nickel	7440-02-0	Metal	na	na	47	EPA 2002	1	1	1	8	0.008	5.60E-05	6.54E-06	8.52E-07	3.66E-06
Nonylphenol diethoxylate	26027-38-2	Nonionic detergent metabolite	4.21	a	299	Veith et al. 1979	1	1.38	1.13	200	0.2	1.40E-03	1.64E-04	2.13E-05	9.14E-05
Nonylphenol Ethoxylates (total)	26027-38-2	Nonionic detergent metabolite	4.21	a	299	Veith et al. 1979	1	1.38	1.13	0.87	0.000868	6.08E-06	7.10E-07	9.25E-08	3.97E-07
Nonylphenol monoethoxylate	na	Surfactant metabolite	4.17	a	276	Veith et al. 1979	1	1.38	1.13	100	0.1	7.00E-04	8.18E-05	1.07E-05	4.57E-05
PBDE-100	32534-81-9	flame retardant	6.8	b	15,140	EPA EPI Suite v. 4.0, 2011	1	10.914	14.388	0.036	0.0000358	2.51E-07	2.93E-08	3.81E-09	1.64E-08
PBDE-153	68631-49-2	flame retardant	7.4	b	5,640	EU 2000	1	12.987	21.038	0.016	0.0000158	1.11E-07	1.29E-08	1.68E-09	7.22E-09
PBDE-154	36483-60-0	flame retardant	8.6	b	2,316	EPA EPI Suite v. 4.0, 2011	1	3.296	1.146	0.012	0.0000119	8.33E-08	9.73E-09	1.27E-09	5.44E-09
PBDE-183	32536-52-0	flame retardant	10.3	b	311	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	0.0022	0.00000216	1.51E-08	1.77E-09	2.30E-10	9.87E-10
PBDE-209	1163-19-5	flame retardant	12.1	b	42	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	0.26	0.00026	1.82E-06	2.13E-07	2.77E-08	1.19E-07
PBDE-28+PBDE-33	49690-94-0	flame retardant	5.9	b	3,519	EPA EPI Suite v. 4.0, 2011	1	9.716	13.964	0.0041	0.00000408	2.86E-08	3.34E-09	4.35E-10	1.86E-09
PBDE-47	5436-43-1	flame retardant	6.8	b	13,600	EPA EPI Suite v. 4.0, 2011	1	14.355	26.669	0.20	0.0002	1.40E-06	1.64E-07	2.13E-08	9.14E-08
PBDE-99	60348-60-9	flame retardant	6.8	b	15,140	EPA EPI Suite v. 4.0, 2011	1	10.914	14.388	0.16	0.000155	1.09E-06	1.27E-07	1.65E-08	7.08E-08
Permethrin	52645-53-1	Pyrethroid pesticide	6.5	b	497	EPA EPI Suite v. 4.0, 2011	1	13.662	24.604	0.69	0.000689	4.82E-06	5.63E-07	7.34E-08	3.15E-07
Phantolide (AHMI or AHDI)	15323-35-0	Fragrance	5.9	b	880	EPA EPI Suite v. 4.0, 2011	1	9.716	13.964	0.31	0.00031	2.17E-06	2.53E-07	3.30E-08	1.42E-07
Progesterone	57-83-0	Sex hormone	3.87	b	166	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	0.12	0.000118	8.26E-07	9.65E-08	1.26E-08	5.39E-08
Stigmasterol	83-48-7	Phytosterol (plant sterol)	9.43	b	855	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	37.2	0.0372	2.60E-04	3.04E-05	3.96E-06	1.70E-05
Tamoxifen	10540-29-1	Antineoplastic	6.3	b	6,689	EPA EPI Suite v. 4.0, 2011	1	12.691	21.677	0.22	0.000215	1.51E-06	1.76E-07	2.29E-08	9.82E-08
Tonalide (AHTN)	1506-02-1	Fragrance	5.7	b	696	EPA EPI Suite v. 4.0, 2011	1	13.228	23.281	13.6	0.0136	9.52E-05	1.11E-05	1.45E-06	6.21E-06
Trans-Permethrin	61949-77-7	Pyrethroid pesticide	6.5	b	497	EPA EPI Suite v. 4.0, 2011	1	12.987	21.038	0.38	0.000383	2.68E-06	3.13E-07	4.08E-08	1.75E-07
Traseolide (ATII)	68140-48-7	Fragrance	6.3	b	1,757	EPA EPI Suite v. 4.0, 2011	1	12.691	21.677	2.03	0.00203	1.42E-05	1.66E-06	2.16E-07	9.28E-07
Triclocarban	101-20-2	antimicrobial, disinfectant	4.9	b	797	EPA EPI Suite v. 4.0, 2011	1	2.78	2.193	13.7	0.0137	9.59E-05	1.12E-05	1.46E-06	6.26E-06
Triclosan	3380-34-5	antimicrobial, disinfectant	4.8	b	642	EPA EPI Suite v. 4.0, 2011	1	2.452	1.871	12.0	0.012	8.40E-05	9.81E-06	1.28E-06	5.48E-06
Zinc	7440-66-6	Metal	na	na	47	EPA 2002	1	1	1	150	0.15	1.05E-03	1.23E-04	1.60E-05	6.85E-05

Notes:

a. When a Log Kow was unavailable, values based on structurally-similar surrogates were used.

b. EPA's EPI Suite (v. 4.0) BCFBAF Database (EPA 2011)

na = not applicable

BCF = bioconcentration factor

Table B-2

Potentially Bioaccumulative Emerging Parameters of Concern Detected in AWWU Primary Effluent in 2010

Anchorage Water and Wastewater Facility Biological Evaluation

Chemical	CAS Number	Use	Log Kow[a]	Log Kow Source	BCF	Source	Trophic Level 2	Trophic Level 3	Trophic Level 4	Max Detected Concentration (ug/L)	Data Qualifier	Max Detected Concentration (mg/L)	Maximum at Edge of ZID (mg/L)	Estimated Conc. in Knik Arm (mg/L)	Estimated Conc. in Turnagain Arm (mg/L)	Estimated Conc. in Mid Upper CI (mg/L)
												Dilution Factor	142.9	1,223	9,385	2,189
10-hydroxy-amitriptyline	1159-82-6	Antidepressant	4.92	b	819	EPA EPI Suite v. 4.0, 2011	1	2.78	2.193	1.76E-02		1.76E-05	1.23E-07	1.44E-08	1.87E-09	8.02E-09
17ß-Estradiol	50-28-2	Sex hormone	4.01	b	206	EPA EPI Suite v. 4.0, 2011	1	1.253	1.072	3.63E-02	E	3.63E-05	2.54E-07	2.97E-08	3.87E-09	1.66E-08
17α-Estradiol	57-91-0	Sex hormone	4.01	b	206	EPA EPI Suite v. 4.0, 2011	1	1.202	1.054	4.26E-02	E	4.26E-05	2.98E-07	3.48E-08	4.54E-09	1.95E-08
17α-Ethinylestradiol	57-63-6	Ovulation inhibitor	3.67	b	123	EPA EPI Suite v. 4.0, 2011	1	1.128	1.033	1.45E-02	E	1.45E-05	1.01E-07	1.19E-08	1.54E-09	6.62E-09
2,4'-DDD	53-19-0	Pesticide	5.87	b	3,486	EPA EPI Suite v. 4.0, 2011	1	9.716	13.964	1.45E-03		1.45E-06	1.02E-08	1.19E-09	1.55E-10	6.64E-10
2,4'-DDT	789-02-6	Pesticide	6.79	b	14,130	EPA EPI Suite v. 4.0, 2011	1	14.355	26.699	3.10E-04	E	3.10E-07	2.17E-09	2.53E-10	3.30E-11	1.42E-10
2-Hydroxy-ibuprofen	na	Pain reliever	3.97	b	3	EPA EPI Suite v. 4.0, 2011	1	1.253	1.072	3.79E+01		3.79E-02	2.65E-04	3.10E-05	4.04E-06	1.73E-05
4,4'- DDE	72-55-9	Organochlorine pesticide	6.51	b	9,168	EPA EPI Suite v. 4.0, 2011	1	13.662	24.604	3.43E-04		3.43E-07	2.40E-09	2.80E-10	3.65E-11	1.57E-10
4,4’- DDT	50-29-3	Organochlorine pesticide	6.91	b	16,840	EPA EPI Suite v. 4.0, 2011	1	14.388	26.669	9.68E-04		9.68E-07	6.78E-09	7.91E-10	1.03E-10	4.42E-10
4,4'-DDD	72-54-8	Pesticide	6.02	b	4,355	EPA EPI Suite v. 4.0, 2011	1	10.556	15.996	1.55E-04	E	1.55E-07	1.09E-09	1.27E-10	1.65E-11	7.08E-11
4-Nonylphenol ethoxylates	26027-38-2	Nonionic detergent metabolite	4.21	b	278	EPA EPI Suite v. 4.0, 2011	1	1.38	1.13	6.82E+00		6.82E-03	4.78E-05	5.58E-06	7.27E-07	3.12E-06
4-Nonylphenol monoethoxylates	na	Surfactant metabolite	4.17	b	262	EPA EPI Suite v. 4.0, 2011	1	1.38	1.13	1.20E+01		1.20E-02	8.43E-05	9.85E-06	1.28E-06	5.50E-06
4-Nonylphenols	25154-52-3	Surfactant metabolite	5.99	b	124	EPA EPI Suite v. 4.0, 2011	1	10.556	15.996	1.98E+01		1.98E-02	1.38E-04	1.62E-05	2.11E-06	9.03E-06
Aldrin	309-00-2	Pesticide	6.50	b	9,030	EPA EPI Suite v. 4.0, 2011	1	13.662	24.604	4.00E-05	E	4.00E-08	2.80E-10	3.27E-11	4.26E-12	1.83E-11
alpha-BHC	319-84-6	Organochlorine pesticide	3.80	b	250	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	9.05E-05	E	9.05E-08	6.34E-10	7.40E-11	9.64E-12	4.14E-11
alpha-Endosulfan	959-98-8	Pesticide	3.83	b	156	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	1.05E-03	E	1.05E-06	7.34E-09	8.57E-10	1.12E-10	4.79E-10
Amitriptyline	50-48-6	Antidepressant	4.92	b	819	EPA EPI Suite v. 4.0, 2011	1	2.78	2.193	7.62E-02		7.62E-05	5.33E-07	6.23E-08	8.12E-09	3.48E-08
Androsterone	53-41-8	Urinary steroid	3.69	b	126	EPA EPI Suite v. 4.0, 2011	1	1.128	1.033	2.86E+00		2.86E-03	2.00E-05	2.34E-06	3.05E-07	1.31E-06
Atorvastatin	134523-00-5	Statin	6.36	b	56	EPA EPI Suite v. 4.0, 2011	1	13.228	23.281	5.73E-02		5.73E-05	4.01E-07	4.68E-08	6.10E-09	2.62E-08
Azithromycin	83905-01-5	Macrolide antibiotic	4.02	b	209	EPA EPI Suite v. 4.0, 2011	1	1.253	1.072	1.41E-01		1.41E-04	9.84E-07	1.15E-07	1.50E-08	6.42E-08
beta-BHC	319-85-7	Organochlorine pesticide	3.78	b	250	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	1.55E-04	E	1.55E-07	1.08E-09	1.26E-10	1.65E-11	7.06E-11
beta-Endosulfan	33213-65-9	Organochlorine pesticide	3.83	b	156	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	8.10E-04	E	8.10E-07	5.67E-09	6.62E-10	8.63E-11	3.70E-10
Campesterol	474-62-4	Phytosterol (plant sterol)	9.16	b	1,168	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	1.33E+01		1.33E-02	9.31E-05	1.09E-05	1.42E-06	6.08E-06
Chlordane, alpha (cis)	5103-71-9	Pesticide	6.10	b	5,901	EPA EPI Suite v. 4.0, 2011	1	11.337	17.783	2.11E-04	E	2.11E-07	1.48E-09	1.72E-10	2.25E-11	9.64E-11
Chlordane, gamma (trans)	5103-74-2	Pesticide	7.00	b	5,901	EPA EPI Suite v. 4.0, 2011	1	14.305	26.242	2.11E-04	E	2.11E-07	1.48E-09	1.72E-10	2.25E-11	9.64E-11
Chlordane, oxy-	27304-13-8	Pesticide	5.48	b	1,931	EPA EPI Suite v. 4.0, 2011	1	6.266	7.079	2.10E-04	E	2.10E-07	1.47E-09	1.71E-10	2.23E-11	9.57E-11
Chlorpyriphos	2921-88-2	Organophosphorus pesticide	4.96	b	870	EPA EPI Suite v. 4.0, 2011	1	3.181	2.612	1.59E-03		1.59E-06	1.11E-08	1.30E-09	1.70E-10	7.27E-10
Chlorpyriphos-Methyl	5598-13-0	Pesticide	4.31	b	324	EPA EPI Suite v. 4.0, 2011	1	1.491	1.178	2.37E-04	E	2.37E-07	1.66E-09	1.93E-10	2.52E-11	1.08E-10
Cholestanol	80-97-7	Sterol	8.82	b	1,699	EPA EPI Suite v. 4.0, 2011	1	2.246	0.521	1.04E+01		1.04E-02	7.30E-05	8.53E-06	1.11E-06	4.77E-06
Cholesterol	57-88-5	Plant/animal steroid	8.74	b	1,871	EPA EPI Suite v. 4.0, 2011	1	2.732	0.778	2.67E+02		2.67E-01	1.87E-03	2.18E-04	2.84E-05	1.22E-04
Coprostanol	360-68-9	Fecal steroid	8.82	b	1,699	EPA EPI Suite v. 4.0, 2011	1	2.246	0.521	2.04E+02		2.04E-01	1.43E-03	1.67E-04	2.18E-05	9.33E-05
Cypermethrins	52315-07-8	Pyrethroid pesticide	6.60	b	255	EPA EPI Suite v. 4.0, 2011	1	13.98	25.645	6.70E-03		6.70E-06	4.69E-08	5.47E-09	7.13E-10	3.06E-09
Dacthal	1861-32-1	Herbicide	4.28	b	310	EPA EPI Suite v. 4.0, 2011	1	1.491	1.178	1.22E-04		1.22E-07	8.51E-10	9.94E-11	1.30E-11	5.56E-11
Desmosterol	313-04-2	Sterol	8.65	b	2,060	EPA EPI Suite v. 4.0, 2011	1	2.732	0.778	1.62E+00	E	1.62E-03	1.14E-05	1.33E-06	1.73E-07	7.42E-07
Desogestrel	54024-22-5	Oral contraceptive	5.65	b	2,489	EPA EPI Suite v. 4.0, 2011	1	7.962	10.209	9.07E-02	E	9.07E-05	6.35E-07	7.42E-08	9.67E-09	4.15E-08
Dieldrin	60-57-1	Organochlorine pesticide	5.40	b	1,253	EPA EPI Suite v. 4.0, 2011	1	5.502	5.821	3.28E-04		3.28E-07	2.29E-09	2.68E-10	3.49E-11	1.50E-10
Endosulfan Sulphate	1031-07-8	Pesticide	3.66	b	103	EPA EPI Suite v. 4.0, 2011	1	1.128	1.033	3.07E-04	E	3.07E-07	2.15E-09	2.51E-10	3.27E-11	1.40E-10
Endrin	72-20-8	Organochlorine pesticide	5.20	b	1,253	EPA EPI Suite v. 4.0, 2011	1	4.188	3.873	9.75E-05	E	9.75E-08	6.83E-10	7.97E-11	1.04E-11	4.45E-11
Epicoprostanol	516-92-7	Sterol	8.82	b	1,699	EPA EPI Suite v. 4.0, 2011	1	2.246	0.521	5.85E+00		5.85E-03	4.09E-05	4.78E-06	6.23E-07	2.67E-06
Ergosterol	57-87-4	Sterol	8.86	b	1,639	EPA EPI Suite v. 4.0, 2011	1	2.246	0.521	5.85E-01		5.85E-04	4.09E-06	4.78E-07	6.23E-08	2.67E-07
Fluoxetine	54910-89-3	SSRI Antidepressant	4.05	b	218	EPA EPI Suite v. 4.0, 2011	1	1.315	1.096	5.70E-02		5.70E-05	3.99E-07	4.66E-08	6.07E-09	2.60E-08
Gemfibrozil	25812-30-0	Antilipemic	4.77	b	3	EPA EPI Suite v. 4.0, 2011	1	2.452	1.871	1.32E+00		1.32E-03	9.25E-06	1.08E-06	1.41E-07	6.04E-07
Glyburide	10238-21-8	Antidiabetic drug	4.79	b	672	EPA EPI Suite v. 4.0, 2011	1	2.452	1.871	1.79E-02		1.79E-05	1.25E-07	1.47E-08	1.91E-09	8.19E-09
HCH, gamma (Lindane)	58-89-9	Pesticide	4.14	b	250	EPA EPI Suite v. 4.0, 2011	1	1.128	1.033	7.18E-04	E	7.18E-07	5.02E-09	5.87E-10	7.65E-11	3.28E-10
Heptachlor	76-44-8	Organochlorine pesticide	6.10	b	4,918	EPA EPI Suite v. 4.0, 2011	1	11.337	17.783	5.52E-05	E	5.52E-08	3.86E-10	4.51E-11	5.88E-12	2.52E-11
Hexachlorobenzene	118-74-1	Fungicide	5.73	b	2,803	EPA EPI Suite v. 4.0, 2011	1	7.962	10.209	1.23E-03		1.23E-06	8.61E-09	1.01E-09	1.31E-10	5.62E-10
Ibuprofen	15687-27-1	Analgesic	3.97	b	3	EPA EPI Suite v. 4.0, 2011	1	1.253	1.072	1.87E+01		1.87E-02	1.31E-04	1.53E-05	1.99E-06	8.54E-06
Mestranol	72-33-3	Oral contraceptive	4.68	b	566	EPA EPI Suite v. 4.0, 2011	1	2.175	1.633	3.11E-02	E	3.11E-05	2.18E-07	2.54E-08	3.32E-09	1.42E-08
Miconazole	22916-47-8	Antifungal agent	6.25	b	6,192	EPA EPI Suite v. 4.0, 2011	1	12.691	21.677	7.60E-02		7.60E-05	5.32E-07	6.21E-08	8.10E-09	3.47E-08

Table B-2

Potentially Bioaccumulative Emerging Parameters of Concern Detected in AWWU Primary Effluent in 2010

Anchorage Water and Wastewater Facility Biological Evaluation

Chemical	CAS Number	Use	Log Kow[a]	Log Kow Source	BCF	Source	Trophic Level 2	Trophic Level 3	Trophic Level 4	Max Detected Concentration (ug/L)	Data Qualifier	Max Detected Concentration (mg/L)	Maximum at Edge of ZID (mg/L)	Estimated Conc. in Knik Arm (mg/L)	Estimated Conc. in Turnagain Arm (mg/L)	Estimated Conc. in Mid Upper CI (mg/L)
												Dilution Factor	142.9	1,223	9,385	2,189
Norfluoxetine	56161-73-0	Serotonin reuptake inhibitor	4.05	b	218	Fluoxetine as surrogate	1	1.315	1.096	3.07E-02		3.07E-05	2.15E-07	2.51E-08	3.27E-09	1.40E-08
Norverapamil	67018-85-3	Calcium channel blocker	3.79	b	6,564	Verapamil as surrogate	1	1.161	1.042	2.26E-02		2.26E-05	1.58E-07	1.85E-08	2.41E-09	1.03E-08
Octachlorostyrene	29082-74-4	production	7.46	b	7,921	EPA EPI Suite v. 4.0, 2011	1	12.517	18.967	1.54E-04	E	1.54E-07	1.08E-09	1.26E-10	1.64E-11	7.02E-11
Paroxetine	61869-08-7	Antidepressant	3.95	b	189	EPA EPI Suite v. 4.0, 2011	1	1.253	1.072	2.26E-02		2.26E-05	1.58E-07	1.85E-08	2.41E-09	1.03E-08
PBDE-100	189084-64-8	Flame retardant	7.66	c	15,140	PBDE-99 as surrogate	1	13.98	25.645	1.05E-02		1.05E-05	7.37E-08	8.61E-09	1.12E-09	4.81E-09
PBDE-119+120	na	Flame retardant	7.66	c	15,140	PBDE-99 as surrogate	1	13.98	25.645	2.47E-04		2.47E-07	1.73E-09	2.02E-10	2.63E-11	1.13E-10
PBDE-12+13	na	Flame retardant	5.83	b	3,260	PBDE-15 as surrogate	1	8.841	12.050	7.57E-06		7.57E-09	5.30E-11	6.19E-12	8.07E-13	3.46E-12
PBDE-137+156	na	Flame retardant	7.40	c	5,640	PBDE-153 as surrogate	1	12.987	21.038	4.47E-04		4.47E-07	3.13E-09	3.65E-10	4.76E-11	2.04E-10
PBDE-14+25	na	Flame retardant	5.88	b	3,519	EPA EPI Suite v. 4.0, 2011	1	9.716	13.964	1.25E-03		1.25E-06	8.72E-09	1.02E-09	1.33E-10	5.69E-10
PBDE-140	243982-83-4	Flame retardant	7.40	c	5,640	PBDE-153 as surrogate	1	12.987	21.038	1.43E-04		1.43E-07	1.00E-09	1.17E-10	1.53E-11	6.55E-11
PBDE-15	2050-47-7	Flame retardant	5.83	b	3,260	EPA EPI Suite v. 4.0, 2011	1	8.841	12.05	6.25E-05		6.25E-08	4.38E-10	5.11E-11	6.66E-12	2.86E-11
PBDE-153	68631-49-2	Flame retardant	7.40	c	5,640	EU 2000	1	12.987	21.038	4.65E-03		4.65E-06	3.26E-08	3.80E-09	4.95E-10	2.12E-09
PBDE-154	207122-15-4	Flame retardant	7.40	c	5,640	PBDE-153 as surrogate	1	12.987	21.038	3.77E-03		3.77E-06	2.64E-08	3.08E-09	4.02E-10	1.72E-09
PBDE-155	35854-94-5	Flame retardant	7.40	c	5,640	PBDE-153 as surrogate	1	12.987	21.038	1.93E-04	E	1.93E-07	1.35E-09	1.58E-10	2.06E-11	8.84E-11
PBDE-181	na	Flame retardant	8.27	c	5,640	PBDE-153 as surrogate	1	5.489	3.311	9.11E-05	E	9.11E-08	6.37E-10	7.44E-11	9.70E-12	4.16E-11
PBDE-183	na	Flame retardant	8.27	c	5,640	PBDE-153 as surrogate	1	5.489	3.311	9.10E-04		9.10E-07	6.37E-09	7.44E-10	9.69E-11	4.16E-10
PBDE-190	79682-25-0	Flame retardant	8.27	c	5,640	PBDE-153 as surrogate	1	5.489	3.311	2.85E-04	E	2.85E-07	1.99E-09	2.33E-10	3.03E-11	1.30E-10
PBDE-203	na	Flame retardant	6.29	c	6,554	PBDE-209 as surrogate	1	12.691	21.677	1.84E-03	E	1.84E-06	1.29E-08	1.50E-09	1.96E-10	8.41E-10
PBDE-206	na	Flame retardant	6.29	c	6,554	PBDE-209 as surrogate	1	12.691	21.677	7.33E-03	E	7.33E-06	5.13E-08	5.99E-09	7.81E-10	3.35E-09
PBDE-207	na	Flame retardant	6.29	c	6,554	PBDE-209 as surrogate	1	12.691	21.677	1.44E-02	E	1.44E-05	1.01E-07	1.18E-08	1.54E-09	6.58E-09
PBDE-208	na	Flame retardant	6.29	c	6,554	PBDE-209 as surrogate	1	12.691	21.677	8.55E-03	E	8.55E-06	5.98E-08	6.99E-09	9.10E-10	3.90E-09
PBDE-209	1163-19-5	Flame retardant	12.11	c	42	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	6.36E-02		6.36E-05	4.45E-07	5.20E-08	6.78E-09	2.91E-08
PBDE-28+PBDE-33	41318-75-6	Flame retardant	5.88	b	3,519	EPA EPI Suite v. 4.0, 2011	1	9.716	13.964	1.69E-03		1.69E-06	1.18E-08	1.38E-09	1.80E-10	7.72E-10
PBDE-32	na	Flame retardant	5.88	b	3,519	EPA EPI Suite v. 4.0, 2011	1	9.716	13.964	3.01E-05		3.01E-08	2.11E-10	2.46E-11	3.21E-12	1.38E-11
PBDE-35	na	Flame retardant	5.88	b	3,519	EPA EPI Suite v. 4.0, 2011	1	9.716	13.964	4.65E-05		4.65E-08	3.26E-10	3.80E-11	4.95E-12	2.12E-11
PBDE-37	na	Flame retardant	5.88	b	3,519	EPA EPI Suite v. 4.0, 2011	1	9.716	13.964	3.07E-05		3.07E-08	2.15E-10	2.51E-11	3.27E-12	1.40E-11
PBDE-47	5436-43-1	Flame retardant	6.77	c	13,600	EPA EPI Suite v. 4.0, 2011	1	14.355	26.669	5.87E-02		5.87E-05	4.11E-07	4.79E-08	6.25E-09	2.68E-08
PBDE-49	243982-82-3	Flame retardant	6.77	c	13,600	PBDE-47 as surrogate	1	14.355	26.669	1.89E-03		1.89E-06	1.32E-08	1.55E-09	2.01E-10	8.64E-10
PBDE-51	60044-24-8	Flame retardant	6.77	c	13,600	PBDE-47 as surrogate	1	14.355	26.669	2.89E-04		2.89E-07	2.02E-09	2.36E-10	3.08E-11	1.32E-10
PBDE-60	189084-61-5	Flame retardant	6.77	c	13,600	PBDE-47 as surrogate	1	14.355	26.669	1.71E-03		1.71E-06	1.20E-08	1.40E-09	1.82E-10	7.82E-10
PBDE-7	na	Flame retardant	5.83	b	3,260	PBDE-15 as surrogate	1	8.841	12.050	4.00E-02		4.00E-05	2.80E-07	3.27E-08	4.26E-09	1.83E-08
PBDE-71	189084-62-6	Flame retardant	6.77	c	13,600	PBDE-47 as surrogate	1	14.355	26.669	6.11E-04		6.11E-07	4.28E-09	4.99E-10	6.51E-11	2.79E-10
PBDE-75	189084-63-7	Flame retardant	6.77	c	13,600	PBDE-47 as surrogate	1	14.355	26.669	1.35E-04	E	1.35E-07	9.44E-10	1.10E-10	1.44E-11	6.16E-11
PBDE-79	97038-98-7	Flame retardant	6.77	c	13,600	PBDE-47 as surrogate	1	14.355	26.669	8.73E-04	E	8.73E-07	6.11E-09	7.14E-10	9.31E-11	3.99E-10
PBDE-8+11	na	Flame retardant	5.83	b	3,260	PBDE-15 as surrogate	1	8.841	12.050	4.94E-05		4.94E-08	3.46E-10	4.04E-11	5.26E-12	2.26E-11
PBDE-85	182346-21-0	Flame retardant	6.57	c	6,320	EPA EPI Suite v. 4.0, 2011	1	13.98	25.645	2.43E-03		2.43E-06	1.70E-08	1.99E-09	2.59E-10	1.11E-09
PBDE-99	60348-60-9	Flame retardant	7.66	c	15,140	EPA EPI Suite v. 4.0, 2011	1	10.914	14.388	5.18E-02		5.18E-05	3.63E-07	4.23E-08	5.52E-09	2.37E-08
Permethrin	52645-53-1	Pyrethroid pesticide	6.50	b	497	EPA EPI Suite v. 4.0, 2011	1	13.662	24.604	6.88E-02	E	6.88E-05	4.82E-07	5.62E-08	7.33E-09	3.14E-08
PFHpA	375-85-9	Perfluorocarbon	5.33	b	10	EPA EPI Suite v. 4.0, 2011	1	4.803	4.742	8.40E-03		8.40E-06	5.88E-08	6.87E-09	8.96E-10	3.84E-09
PFHxA	307-24-4	Perfluorocarbon	4.37	b	3	EPA EPI Suite v. 4.0, 2011	1	1.614	1.242	2.25E-02		2.25E-05	1.57E-07	1.84E-08	2.40E-09	1.03E-08
PFHxS	355-46-4	Perfluorocarbon	4.34	b	3	EPA EPI Suite v. 4.0, 2011	1	1.491	1.178	3.96E-02		3.96E-05	2.77E-07	3.24E-08	4.22E-09	1.81E-08
PFNA	375-95-1	Perfluorocarbon	7.27	b	56	EPA EPI Suite v. 4.0, 2011	1	13.474	22.856	5.51E-03		5.51E-06	3.86E-08	4.50E-09	5.87E-10	2.52E-09
PFOA	335-67-1	Perfluorocarbon	6.30	b	56	EPA EPI Suite v. 4.0, 2011	1	12.691	21.677	1.68E-02		1.68E-05	1.18E-07	1.38E-08	1.79E-09	7.69E-09
PFOS	1763-23-1	Perfluorocarbon	6.28	b	56	EPA EPI Suite v. 4.0, 2011	1	12.691	21.677	2.62E-02		2.62E-05	1.83E-07	2.14E-08	2.79E-09	1.20E-08
PFPeA	2706-90-3	Perfluorocarbon	3.40	b	3	EPA EPI Suite v. 4.0, 2011	1	1.067	1.014	8.74E-03		8.74E-06	6.12E-08	7.15E-09	9.32E-10	4.00E-09
Promethazine	60-87-7	Antihistamine	4.81	b	693	EPA EPI Suite v. 4.0, 2011	1	2.452	1.871	2.90E-03		2.90E-06	2.03E-08	2.37E-09	3.09E-10	1.33E-09
Propoxyphene	469-62-5	Analgesic antiinflammatory	4.18	b	266	EPA EPI Suite v. 4.0, 2011	1	1.38	1.13	9.66E-03		9.66E-06	6.76E-08	7.90E-09	1.03E-09	4.41E-09
Sertraline	79617-96-2	Antidepressant	5.29	b	1,429	EPA EPI Suite v. 4.0, 2011	1	4.803	4.742	1.31E-01		1.31E-04	9.15E-07	1.07E-07	1.39E-08	5.97E-08
ß-Sitosterol	83-46-5	Phytosterol (plant sterol)	9.65	b	671	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	8.55E+01		8.55E-02	5.99E-04	6.99E-05	9.11E-06	3.91E-05

Table B-2
Potentially Bioaccumulative Emerging Parameters of Concern Detected in AWWU Primary Effluent in 2010
Anchorage Water and Wastewater Facility Biological Evaluation

													Dilution Factor	142.9	1,223	9,385	2,189
Chemical	**CAS Number**	**Use**	**Log Kow[a]**	**Log Kow Source**	**BCF**	**Source**	**Trophic Level 2**	**Trophic Level 3**	**Trophic Level 4**	**Max Detected Concentration (ug/L)**	**Data Qualifier**		**Max Detected Concentration (mg/L)**	**Maximum at Edge of ZID (mg/L)**	**Estimated Conc. in Knik Arm (mg/L)**	**Estimated Conc. in Turnagain Arm (mg/L)**	**Estimated Conc. in Mid Upper CI (mg/L)**
ß-Stigmastanol	83-45-4	Phytosterol (plant sterol)	9.73	b	610	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	6.18E+00			6.18E-03	4.33E-05	5.05E-06	6.58E-07	2.82E-06
Stigmasterol	83-48-7	Phytosterol (plant sterol)	9.43	b	855	EPA EPI Suite v. 4.0, 2011	1	1.493	0.226	1.79E+01			1.79E-02	1.25E-04	1.46E-05	1.91E-06	8.18E-06
Triclocarban	101-20-2	antimicrobial, disinfectant	4.90	b	797	EPA EPI Suite v. 4.0, 2011	1	2.78	2.193	1.97E+00			1.97E-03	1.38E-05	1.61E-06	2.10E-07	9.00E-07
Triclosan	3380-34-5	antimicrobial, disinfectant	4.76	b	642	EPA EPI Suite v. 4.0, 2011	1	2.452	1.871	5.88E+00			5.88E-03	4.12E-05	4.81E-06	6.27E-07	2.69E-06
Valsartan	137862-53-4	Antihypertensive	3.65	b	100	Veith et al. 1979	1	1.128	1.033	1.52E+01			1.52E-02	1.07E-04	1.24E-05	1.62E-06	6.95E-06
Verapamil	52-53-9	Calcium-channel blocker	3.79	b	147	EPA EPI Suite v. 4.0, 2011	1	1.161	1.042	4.89E-02			4.89E-05	3.42E-07	4.00E-08	5.21E-09	2.23E-08

Notes:
a. When a Log Kow was unavailable, values based on structurally-similar surrogates were used.
b. EPA's EPI Suite (v. 4.0) BCFBAF Database (EPA 2011)
c. ATSDR Toxicological Profile for Polybrominated Biphenyls and Polybrominated Diphenyl Ethers (PBBs and PBDEs). Sept 2004.
na = not applicable
BCF = bioconcentration factor
E = estimated value

Table B-3
Constituents Detected in Cook Inlet Fish Tissue
Anchorage Water and Wastewater Facility Biological Evaluation

				Cook Inlet Data from ADEC[a]		AWWU NPDES Data 10/1/2004		Maximum Detected Conc. (mg/kg)	Maximum Detected Background Conc. (mg/kg)
Chemical	**Class**	**CAS Number**	**Units**	**Max Detect**	**Sample Type**	**Max Detect**	**Sample Type**		
2,3,7,8-TCDF	Dioxins	51207-31-9	mg/kg	3.80E-07	Chinook Salmon	na	na	3.80E-07	na
Total Tetra-OctaCDD	Dioxins	3268-87-9	mg/kg	7.80E-07	Chinook Salmon	na	na	7.80E-07	na
Total Tetra-OctaCDF	Dioxins	na	mg/kg	1.56E-06	Chinook Salmon	na	na	1.56E-06	na
PBDE 47	PBDEs	5436-43-1	mg/kg	2.43E-04	Chinook Salmon	na	na	2.43E-04	na
PBDE 49	PBDEs	na	mg/kg	2.03E-05	Chinook Salmon	na	na	2.03E-05	na
PBDE 99	PBDEs	60348-60-9	mg/kg	1.10E-04	Chinook Salmon	na	na	1.10E-04	na
PBDE 100	PBDEs	na	mg/kg	4.33E-05	Chinook Salmon	na	na	4.33E-05	na
PBDE 153	PBDEs	68631-49-2	mg/kg	1.81E-05	Chinook Salmon	na	na	1.81E-05	na
PBDE 154	PBDEs	na	mg/kg	2.36E-05	Chinook Salmon	na	na	2.36E-05	na
Total Dominant PBDEs	PBDEs	na	mg/kg	4.50E-04	Chinook Salmon	na	na	4.50E-04	na
PCB Congener 153	PCBs	na	mg/kg	7.01E-04	Chinook Salmon	na	na	7.01E-04	na
Total PCBs	PCBs	1336-36-3	mg/kg	8.75E-03	Chinook Salmon	na	na	8.75E-03	na
2,4'-DDE	Pesticides	72-55-9	mg/kg	na	na	1.10E-04	Pacific cod	1.10E-04	na
2,4'-DDT	Pesticides	789-02-6	mg/kg	na	na	8.10E-04	Pacific cod	8.10E-04	na
4,4'-DDE	Pesticides	72-55-9	mg/kg	na	na	1.40E-03	Pacific cod	1.40E-03	na
Alpha-Chlordane	Pesticides	57-74-9	mg/kg	na	na	6.30E-04	Pacific cod	6.30E-04	na
Beta-BHC	Pesticides	319-85-7	mg/kg	na	na	4.20E-04	Pacific cod	4.20E-04	na
Chlorpyrifos	Pesticides	2921-88-2	mg/kg	na	na	4.50E-04	Pacific cod	4.50E-04	na
Cis-Nonachlor	Pesticides	3734-49-4	mg/kg	na	na	7.20E-04	Pacific cod	7.20E-04	na
Dieldrin	Pesticides	60-57-1	mg/kg	7.70E-04	Chinook Salmon	9.00E-04	Pacific cod	9.00E-04	na
Endosulfan I	Pesticides	115-29-7	mg/kg	na	na	4.40E-04	Pacific cod	4.40E-04	na
Endosulfan II	Pesticides	115-29-7	mg/kg	na	na	3.70E-04	Pacific cod	3.70E-04	na
Gamma-BHC (Lindane)	Pesticides	58-89-9	mg/kg	na	na	5.00E-04	Pacific cod	5.00E-04	na
Hexachlorobenzene	Pesticides	118-74-1	mg/kg	1.82E-03	Chinook Salmon	8.80E-04	Pacific cod	1.82E-03	na
Methoxychlor	Pesticides	72-43-5	mg/kg	na	na	4.80E-03	Pacific cod	4.80E-03	na
Total Chlordanes	Pesticides	57-74-9	mg/kg	5.04E-03	Chinook Salmon	na	na	5.04E-03	na
Total DDT	Pesticides	50-29-3	mg/kg	6.89E-03	Chinook Salmon	na	na	6.89E-03	na
Total HCH	Pesticides	608-73-1	mg/kg	3.26E-03	Chinook Salmon	na	na	3.26E-03	na
Total Toxaphene	Pesticides	8001-35-2	mg/kg	1.77E-02	Chinook Salmon	na	na	1.77E-02	na
Trans-Nonachlor	Pesticides	3734-49-4	mg/kg	na	na	8.30E-04	Pacific cod	8.30E-04	na
2,4,6-Trichlorophenol	Semi-Volatiles & PAHs	88-06-2	mg/kg	na	na	6.80E-01	Pacific cod	6.80E-01	na
Butyl Benzyl Phthalate	Semi-Volatiles & PAHs	85-68-7	mg/kg	na	na	2.10E+00	Pacific cod	2.10E+00	na
Pentachlorophenol	Semi-Volatiles & PAHs	87-86-5	mg/kg	na	na	1.00E+00	Pacific cod	1.00E+00	na
Arsenic	Trace Metals	7440-38-2	mg/kg	8.80E-01	Chinook Salmon	7.74E+00	Pacific cod	7.74E+00	4.21E+00
Chromium	Trace Metals	7440-47-3	mg/kg	1.30E-01	Coho Salmon	ND	na	1.30E-01	ND
Copper	Trace Metals	7440-50-8	mg/kg	na	na	1.67E+00	Pacific cod	1.67E+00	1.40E+00
Methyl Mercury	Trace Metals	22967-92-6	mg/kg	9.40E-02	Chinook Salmon	na	na	9.40E-02	na
Selenium	Trace Metals	7782-49-2	mg/kg	2.40E-01	Coho Salmon	1.35E+00	Pacific cod	1.35E+00	1.11E+00
Total Mercury	Trace Metals	7439-97-6	mg/kg	1.60E-01	Chinook Salmon	8.30E-02	Pacific cod	1.60E-01	3.10E-02
Zinc	Trace Metals	7440-66-6	mg/kg	na	na	1.30E+01	Pacific cod	1.30E+01	1.33E+01

Notes:

a. Alaska Statewide Fish Monitoring Program data provided by Robert Gerlach of Alaska Department of Environmental Conservation in March 2010.

na = not available

ND = not detected

Table B-4

Mammalian Toxicity Factors for Emerging Parameters of Concern Detected or Inferred in AWWU Primary Effluent

Anchorage Water and Wastewater Facility Biological Evaluation

Chemical	Source	Test Species	Measured Effect	Toxicity Endpoint	Body Weight (kg)	NOAEL-Based Dose (mg/kg-bw-day)	Adjusted NOAEL-Based Dose (mg/kg-bw-day)
1,3-Dichlorobenzene	Surrogate 1,2 DCB from NTP, 1985 in IRIS, USEPA	Mice	Renal, survival	NOAEL	0.03	85.7	4.92E+01
10-hydroxy-amitriptyline	Surrogate Amitriptyline	Human adults	FDA-MRTD/100	NOAEL	70	0.05	4.57E-02
16α-Hydroxyestrone	na	na	na	na	na	na	na
17ß-Estradiol	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.00005	4.57E-05
17α-Estradiol	Surrogate 17ß-Estradiol	Human adults	FDA-MRTD/100	NOAEL	70	0.00005	4.57E-05
17α-Ethinylestradiol	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.000005	4.57E-06
2,3,7,8-TCDF	Sample et al., 1996	Rats	Reproduction	Chronic NOAEL	0.35	0.00001	6.65E-06
2,4,6-Trichlorophenol	EPA	Rats	Liver and kidney pathology	Chronic NOAEL	0.35	1,000	6.65E+02
2,4'-DDD	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.147	8.44E-02
2,4'-DDT	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.147	8.44E-02
2-Hydroxy-ibuprofen	Surrogate Ibupropen	Human adults	Lowest therapeutic dose	NOAEL	70	0.11	1.01E-01
4,4'- DDD	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.147	8.44E-02
4,4'- DDE	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.147	8.44E-02
4,4'- DDT	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.147	8.44E-02
4-Nonylphenol ethoxylates	Surrogate 4-Nonylphenol	Rats	Reproduction (oestrous cycle length)	NOAEL	0.35	15	9.98E+00
4-Nonylphenol monoethoxylates	Surrogate 4-Nonylphenol	Rats	Reproduction (oestrous cycle length)	NOAEL	0.35	15	9.98E+00
4-Nonylphenols	EU, 2004	Rats	Reproduction (oestrous cycle length)	NOAEL	0.35	15	9.98E+00
4-Nonylphenoxyacetic acid	na	na	na	na	na	na	na
4-tert-Octylphenol	na	na	na	na	na	na	na
4-tert-Octylphenoldiethoxylate	na	na	na	na	na	na	na
Aldrin	Surrogate Dieldrin	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.015	8.61E-03
alpha-BHC	Surrogate Beta-BHC	Rats	Growth, blood chemistry, organ histology	Converted from Subchronic NOAEL (divided by UF of 5)	0.35	0.8	5.32E-01
alpha-Endosulfan (Endosulfan I)	Sample et al., 1996	Rats	Reproduction, blood chemistry	Converted from Subchronic NOAEL (divided by UF of 5)	0.35	0.3	2.00E-01
Amitriptyline	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.05	4.57E-02
Androsterone	na	na	na	na	na	na	na
Antimony	USEPA Eco SSL, 2005	Multiple species	Reproduction, growth, and survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.059	3.39E-02
Arsenic	USEPA Eco SSL, 2005	Multiple species	Reproduction, growth, and survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	1.04	5.97E-01
Atorvastatin	Walsh and Rothwell. 1999	Beagles	Liver toxicity	Chronic NOAEL	10	10	8.13E+00
Azithromycin	na	na	na	na	na	na	na
Beryllium	USEPA Eco SSL, 2005	Multiple species	Reproduction, growth, and survival	Highest bounded NOAEL	0.03	0.532	3.05E-01
Beta-BHC	Sample et al., 1996	Rats	Growth, blood chemistry, organ histology	Converted from Subchronic NOAEL (divided by UF of 5)	0.35	0.8	5.32E-01
beta-Endosulfan (Endosulfan II)	Sample et al., 1996	Rats	Reproduction, blood chemistry	Converted from Subchronic NOAEL (divided by UF of 5)	0.35	0.3	2.00E-01
beta-Sitosterol	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	1	9.14E-01
beta-Stigmastanol	na	na	na	na	na	na	na
Bezafibrate	na	na	na	na	na	na	na
Bis (2-ethylhexyl) phthalate	Sample et al., 1996	Mice	Reproduction	Chronic NOAEL	0.03	18.3	1.05E+01
Butyl Benzyl Phthalate	Sample et al., 1996	Mice	Reproduction	Chronic NOAEL	0.03	550	3.16E+02
Cadmium	USEPA Eco SSL, 2005	Multiple species	Reproduction, growth, and survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.77	4.42E-01
Campesterol	na	na	na	na	na	na	na
Cashmeran (DPMI)	na	na	na	na	na	na	na
Celestolide (ADBI)	na	na	na	na	na	na	na
Chlordane, alpha (cis)	WHO, 1984 in Sample et al., 1996	Mice	Reproduction	Chronic NOAEL	0.03	4.6	2.64E+00
Chlordane, oxy-	Sample et al., 1996	Mice	Reproduction	Chronic NOAEL	0.03	4.6	2.64E+00
Chlorpyriphos	Dow Chemical, 1971, in IRIS, USEPA	Rats	Reproduction	Chronic NOAEL	0.35	1.0	6.65E-01
Chlorpyriphos-Methyl	Surrogate Chlorpyrifos	Rats	Reproduction	Chronic NOAEL	0.35	1.0	6.65E-01
Cholestanol	na	na	na	na	na	na	na
Cholesterol	na	na	na	na	na	na	na
Chromium	USEPA Eco SSL, 2008	Multiple species	Growth and reproduction	Geometric mean of the NOAEL values	0.03	2.4	1.38E+00
Cis-Nonachlor	Surrogate Trans-Nonachlor	Mink	Reproduction	Converted from Chronic LOAEL (divided by UF of 5)	1	0.2	1.42E-01
Cis-Permethrin	FMC Corp., 1977 in IRIS, USEPA	Rats	Liver	Chronic NOAEL	0.35	5.0	3.33E+00
Clotrimazole	na	na	na	na	na	na	na
Copper	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	5.6	3.21E+00
Coprostanol	na	na	na	na	na	na	na
Cypermethrins	ICI Americas, Inc. 1982 in IRIS, USEPA	Beagles	Gastrointestinal	Chronic NOAEL	10	1.0	8.13E-01
Dacthal	ISK Biotech Corp., 1993 in IRIS, USEPA	Rats	Lungs, liver, kidney, thyroid	Chronic NOAEL	0.35	1.0	6.65E-01
Desmosterol	na	na	na	na	na	na	na
Desogestrel	Surrogate 3-Keto-desogestrel, in FDA, 2003	Rats	Reproduction	Converted from Subchronic LOAEL (divided by UF of 10x10 for study quality)	0.35	0.04	2.66E-02
Dextropropoxyphene	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.065	5.94E-02
Diazinon	Rudzki et al. 1991 in ATSDR 2008	Beagles	Depressed body weight	Chronic NOAEL	10	0.015	1.22E-02
Diclofenac	na	na	na	na	na	na	na
Dieldrin	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.015	8.61E-03
Di-n-butyl phthalate	Sample et al., 1996	Mice	Reproduction	Chronic NOAEL	0.03	550	3.16E+02
Endosulfan Sulphate	Surrogate Endosulfan, Hoechst Celanese Corp., 1989 in IRIS, USEPA	Rats	Reduced growth	Chronic NOAEL	0.35	0.6	3.99E-01
Endrin	Velsicol Chemical Corporation, 1969 in IRIS, USEPA	Dogs	Tremors, liver histopathology	Chronic NOAEL	10	0.025	2.03E-02
Endrin ketone	Surrogate Endrin	Dogs	Tremors, liver histopathology	Chronic NOAEL	10	0.025	2.03E-02
Epicoprostanol	na	na	na	na	na	na	na
Ergosterol	na	na	na	na	na	na	na
Fenoprofen	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.5	4.57E-01
Fluoxetine	Schwab et al., 2005	Human adults	Lowest therapeutic dose	NOAEL	70	0.0029	2.65E-03
Galaxolide (HHCB)	EU, 2008a	Rats	Peri/postnatal toxicity	NOAEL	0.35	20	1.33E+01

Table B-4
Mammalian Toxicity Factors for Emerging Parameters of Concern Detected or Inferred in AWWU Primary Effluent
Anchorage Water and Wastewater Facility Biological Evaluation

Chemical	Source	Test Species	Measured Effect	Toxicity Endpoint	Body Weight (kg)	NOAEL-Based Dose (mg/kg-bw-day)	Adjusted NOAEL-Based Dose (mg/kg-bw-day)
Gemfibrozil	Schwab et al., 2005	Human adults	Lowest therapeutic dose	NOAEL	70	0.055	5.03E-02
Glyburide	na	na	na	na	na	na	na
HCH, gamma (Lindane)	Sample et al., 1996	Rats	Reproduction	Chronic NOAEL	0.35	8	5.32E+00
Heptachlor	Velsicol Chemical, 1955 in IRIS, USEPA	Rats	Hepatic lesions, weight	NOAEL	0.35	0.15	9.98E-02
Hexachlorobenzene	Arnold et al., 1985 in IRIS, USEPA	Rats	Liver effects	Chronic NOAEL	0.35	0.08	5.32E-02
Ibuprofen	Schwab et al., 2005	Human adults	Lowest therapeutic dose	NOAEL	70	0.11	1.01E-01
Indomethacin	na	na	na	na	na	na	na
Mefenamic acid	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.208	1.90E-01
Mercury	Sample et al., 1996	Mink	Reproduction	Chronic NOAEL	1	1	7.08E-01
Mestranol	Kwapian et al., 1980	Beagles	Mammary tumors	Chronic NOEC (divided by UF of 5 for study quality)	10	0.002	1.63E-03
Methoxychlor	Sample et al., 1996	Rat	Reproduction	Chronic NOAEL	0.35	4	2.66E+00
Methyl Mercury	Sample et al., 1996	Mink	Mortality, weight loss, ataxia	Converted from Subchronic NOAEL (divided by UF of 5)	1	0.03	2.13E-02
Miconazole	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.60	5.48E-01
Molybdenum	Koval'skiy et al., 1961 in IRIS, USEPA	Human adults	Elevated uric acid	Converted from chronic LOAEL (divided by UF of 5)	70	0.028	2.56E-02
Musk Abrette (MA)	na	na	na	na	na	na	na
Musk Ketone (MK)	EU, 2005a	Rats	Peri/postnatal toxicity	NOAEL	0.35	2.5	1.66E+00
Musk Moskene (MM)	na	na	na	na	na	na	#VALUE!
Musk Tibetene (MT)	na	na	na	na	na	na	#VALUE!
Musk Xylene (MX)	EU, 2005b	Rats	Peri/postnatal toxicity	NOAEL	0.35	7.5	4.99E+00
Nickel	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	1.7	9.76E-01
Norfluoxetine	Surrogate Fluoxetine	Human adults	FDA-MRTD/100	NOAEL	70	0.0133	1.22E-02
Norverapamil	na	na	na	na	na	na	na
Octachlorostyrene	Chu et al., 1986	Rats	Thyroid histological effects	Chronic NOAEL	0.35	0.003	2.00E-03
Paroxetine	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.00833	7.61E-03
PBDE-100	Surrogate PBDE-99	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.058	3.33E-02
PBDE-119+120	Surrogate PBDE-99	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.058	3.33E-02
PBDE-12+13	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-137+156	Surrogate PBDE-153	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.09	5.17E-02
PBDE-14+25	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-140	Surrogate PBDE-153	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.09	5.17E-02
PBDE-15	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-153	Viberg et al., 2003a in IRIS, USEPA	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.09	5.17E-02
PBDE-154	Surrogate PBDE-153	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.09	5.17E-02
PBDE-155	Surrogate PBDE-153	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.09	5.17E-02
PBDE-181	Surrogate PBDE-153	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.09	5.17E-02
PBDE-183	Surrogate PBDE-153	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.09	5.17E-02
PBDE-190	Surrogate PBDE-153	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.09	5.17E-02
PBDE-203	Octabromodiphenylether mixture, Carlson, 1980 in IRIS, USEPA	Mice	Liver effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.35	0.50	3.34E-01
PBDE-206	Surrogate Octabromodiphenylether mixture	Mice	Liver effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.35	0.50	3.34E-01
PBDE-207	Surrogate Octabromodiphenylether mixture	Mice	Liver effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.35	0.50	3.34E-01
PBDE-208	Surrogate Octabromodiphenylether mixture	Mice	Liver effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.35	0.50	3.34E-01
PBDE-209	Viberg et al. 2003b in IRIS, USEPA	Mice	Motor behavior	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.44	2.55E-01
PBDE-28+PBDE-33	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-32	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-35	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-37	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-47	Eriksson et al., 2001 in IRIS, USEPA	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-49	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-51	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-60	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-7	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-71	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-75	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-79	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-8+11	Surrogate PBDE-47	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.14	8.04E-02
PBDE-85	Surrogate PBDE-99	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.058	3.33E-02
PBDE-99	Viberg et al., 2004 in IRIS, USEPA	Mice	Neurobehavioral effects	Converted from Subchronic NOAEL (divided by UF of 5)	0.03	0.058	3.33E-02
Pentachlorophenol	USEPA Eco SSL, 2007	Multiple species	Growth and reproduction	Geometric mean of the NOAEL values	0.03	8.42	4.83E+00
Permethrin	FMC Corp., 1977 in IRIS, USEPA	Rats	Liver	Chronic NOAEL	0.35	5	3.33E+00
PFHpA	Surrogate PFOa	Mice	Maternal liver weight	Benchmark dose (BMD$_{10}$)	0.03	0.46	2.64E-01
PFHxA	Surrogate PFOa	Mice	Maternal liver weight	Benchmark dose (BMD$_{10}$)	0.03	0.46	2.64E-01
PFHxS	Surrogate PFOS	Monkeys	↑ TSH, ↓T3 and HDL	NOAEL	3	0.03	2.27E-02
PFNA	Surrogate PFOa	Mice	Maternal liver weight	Benchmark dose (BMD$_{10}$)	0.03	0.46	2.64E-01
PFOA	Lau et al. 2006 in USEPA 2009	Mice	Maternal liver weight	Benchmark dose (BMD$_{10}$)	0.03	0.46	2.64E-01
PFOS	Seacat et al., 2002 in USEPA 2009	Monkeys	↑ TSH, ↓T3 and HDL	NOAEL	3	0.03	2.27E-02
PFPeA	Surrogate PFOa	Mice	Maternal liver weight	Benchmark dose (BMD$_{10}$)	0.03	0.46	2.64E-01
Phantolide (AHMI or AHDI)	na	na	na	na	na	na	na
Progesterone	FAO/WHO, 1999	Human adults	Changes in the uterus	NOAEL	70	3.3	3.02E+00
Promethazine	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.0167	1.53E-02
Propoxyphene	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.065	5.94E-02

Table B-4
Mammalian Toxicity Factors for Emerging Parameters of Concern Detected or Inferred in AWWU Primary Effluent
Anchorage Water and Wastewater Facility Biological Evaluation

Chemical	Source	Test Species	Measured Effect	Toxicity Endpoint	Body Weight (kg)	NOAEL-Based Dose (mg/kg-bw-day)	Adjusted NOAEL Based Dose (mg/kg-bw-day)
Selenium	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.143	8.21E-02
Sertraline	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.0333	3.04E-02
Stigmasterol	na	na	na	na	na	na	na
Tamoxifen	na	na	na	na	na	na	na
TCDD TEQ	Sample et al., 1996	Rats	Reproduction	chronic NOAEL	0.35	0.000001	1.00E-06
Tonalide (AHTN)	EU, 2008b	Rats	Hematological and biochemistry effects	NOAEL	0.35	5	3.33E+00
Total Chlordanes	Sample et al., 1996	Mice	Reproduction	Chronic NOAEL	0.03	4.6	2.64E+00
Total DDT	USEPA Eco SSL, 2007	Multiple species	Reproduction, growth, or survival	Highest bounded NOAEL below the lowest bounded LOAEL	0.03	0.147	8.44E-02
Total Dominant PBDEs	Surrogate PBDE-99	Mice	Neurobehavioral effects	NOAEL	0.03	0.4	2.30E-01
Total HCH	Surrogate Lindane	Rats	Reproduction	Chronic NOAEL	0.35	8	5.32E+00
Total PCBs	Aulerich and Ringer 1977 in Sample et al., 1996	Mink	Reproduction	Chronic NOAEL	1	0.14	9.92E-02
Total Tetra-OctaCDD	Sample et al., 1996	Rats	Reproduction	Chronic NOAEL	0.35	0.0033	2.22E-03
Total Tetra-OctaCDF	Sample et al., 1996	Rats	Reproduction	Chronic NOAEL	0.35	0.0033	2.22E-03
Total Toxaphene	Sample et al., 1996	Rats	Reproduction	Chronic NOAEL	0.35	8	5.32E+00
Trans-Nonachlor	Crum 1993 in Sample et al., 1996	Mink	Reproduction	Converted from Chronic LOAEL (divided by UF of 5)	1	0.2	1.42E-01
Trans-Permethrin	Surrogate Permethrin	Rats	Liver	Chronic NOAEL	0.35	5	3.33E+00
Traseolide (ATII)	na	na	na	na	na	na	na
Triclocarban	na	na	na	na	na	na	na
Triclosan	USEPA, 2008	Baboons	Clinical toxicity (vomiting, diarrhea, failure to e	NOAEL	5	30	2.34E+01
Valsartan	FDA MRTD Database, 2008	Human adults	FDA-MRTD/100	NOAEL	70	0.0533	4.87E-02
Verapamil	na	na	na	na	na	na	na
Zinc	USEPA Eco SSL, 2007	Multiple species	Growth and reproduction	Geometric mean of the NOAEL values	0.03	75.4	4.33E+01

Notes:
a. Full citations for primary sources referenced are provided in Attachment B-2.
na = not available
µg/L = micrograms per liter
NOAEL = no observed adverse effect level
LOAEL = lowest observed adverse effect level
BMD10 = Benchmark dose 10 percent
MRTD = maximum recommended therapeutic dose
UF = uncertainty factor

Table B-5

Beluga Whale Hazard Quotients for Constituents Detected in Cook Inlet Fish Tissue

Anchorage Water and Wastewater Facility Biological Evaluation

Chemical	NOAEL-based HQ	LOAEL-based HQ	NOAEL-based HQ (Background)	LOAEL-based HQ (Background)
Arsenic	0.8	0.5	0.4	0.3
Chromium	0.006	0.005	ND	ND
Copper	0.03	0.03	0.03	0.02
Methyl Mercury	0.3	0.2	na	na
Selenium	1.0	1.0	0.9	0.8
Total Mercury	0.01	na	0.01	na
Zinc	0.02	0.02	0.02	0.02
2,3,7,8-TCDF	0.004	0.0004		
Total Tetra-OctaCDD	0.00002	0.000001		
Total Tetra-OctaCDF	0.00004	0.000004		
Total Dominant PBDEs	0.0001	0.001		
Total PCBs	0.006	0.001		
2,4'-DDE	0.00008	0.00004		
2,4'-DDT	0.0006	0.0003		
4,4'-DDE	0.001	0.0006		
Alpha-Chlordane	0.00002	0.000008		
Beta-BHC	0.00005	0.00001		
Chlorpyrifos	0.00004	na		
Cis-Nonachlor	0.0003	0.00006		
Dieldrin	0.007	0.003		
Endosulfan I	0.0001	na		
Endosulfan II	0.0001	na		
Gamma-BHC	0.000006	na		
Hexachlorobenzene	0.002	na		
Methoxychlor	0.0001	0.00002		
Total Chlordanes	0.0001	0.00006		
Total DDT	0.005	0.003		
Total HCH	0.00004	na		
Total Toxaphene	0.0002	na		
Trans-Nonachlor	0.0004	0.00007		
2,4,6-Trichlorophenol	0.00006	0.00002		
Butyl Benzyl Phthalate	0.0004	na		
Pentachlorophenol	0.01	0.01		

Notes:
HQ = hazard quotient
na = not available
ND = not detected

Table B-6
Beluga Whale Hazard Quotients for Constituents Measured (NPDES-Regulated) or Inferred (from Literature) in Asplund WPCF Effluent
Anchorage Water and Wastewater Facility

		Dilution Factor	142.9	1,223	9,385	2,189
Chemical	**CAS Number**	**NOAEL-based HQ End of Pipe**	**NOAEL-based HQ Edge of ZID**	**NOAEL-based HQ for Knik Arm**	**NOAEL-based HQ for Turnagain Arm**	**NOAEL-based HQ for Mid Upper Cook Inlet**
1,3- Dichlorobenzene	541-73-1	1.28E-03	8.94E-06	1.04E-06	1.36E-07	5.83E-07
16α-Hydroxyestrone	566-76-7	na	na	na	na	na
17a-Estradiol	57-91-0	***5.57E+00***	3.90E-02	4.55E-03	5.93E-04	2.54E-03
17a-Ethynyl Estradiol (EE2)	57-63-6	***1.29E+02***	9.03E-01	1.05E-01	1.37E-02	5.89E-02
17b-Estradiol (E2)	50-28-2	***5.01E+01***	3.50E-01	4.09E-02	5.33E-03	2.29E-02
4,4'- DDD	72-54-8	***1.18E+00***	8.23E-03	9.62E-04	1.25E-04	5.37E-04
4,4'- DDE	72-55-9	***1.08E+00***	7.57E-03	8.84E-04	1.15E-04	4.94E-04
4,4'- DDT	50-29-3	***3.26E+01***	2.28E-01	2.67E-02	3.48E-03	1.49E-02
4-Nonylphenol	25154-52-3	***2.07E+00***	1.45E-02	1.69E-03	2.20E-04	9.44E-04
4-Nonylphenoxyacetic acid	3115-49-9	na	na	na	na	na
4-tert-Octylphenol	140-66-9	na	na	na	na	na
4-tert-Octylphenoldiethoxylate	na	na	na	na	na	na
alpha-BHC	319-84-6	1.84E-03	1.29E-05	1.50E-06	1.96E-07	8.41E-07
Androsterone	53-41-8	na	na	na	na	na
Antimony	7440-36-0	1.21E-03	8.47E-06	9.89E-07	1.29E-07	5.53E-07
Arsenic	7440-38-2	1.86E-02	1.30E-04	1.52E-05	1.98E-06	8.49E-06
Azithromycin	83905-01-5	na	na	na	na	na
Beryllium	7440-41-7	1.18E-03	8.24E-06	9.62E-07	1.25E-07	5.38E-07
beta-BHC	319-85-7	1.22E-03	8.55E-06	9.99E-07	1.30E-07	5.58E-07
beta-Sitosterol	83-46-5	***1.69E+01***	1.18E-01	1.38E-02	1.80E-03	7.71E-03
beta-Stigmastanol	83-45-4	na	na	na	na	na
Bezafibrate	41859-67-0	na	na	na	na	na
Bis (2-ethylhexyl) phthalate	117-81-7	***2.88E+00***	2.02E-02	2.36E-03	3.07E-04	1.32E-03
Butyl benzyl phthalate	85-68-7	1.65E-03	1.16E-05	1.35E-06	1.76E-07	7.55E-07
Cadmium	7440-43-9	2.66E-02	1.86E-04	2.17E-05	2.83E-06	1.21E-05
Campesterol	474-62-4	na	na	na	na	na
Cashmeran (DPMI)	33704-61-9	na	na	na	na	na
Celestolide (ADBI)	13171-00-1	na	na	na	na	na
Chlorpyriphos	2921-88-2	5.46E-02	3.82E-04	4.46E-05	5.82E-06	2.50E-05
Cholestanol	80-97-7	na	na	na	na	na
Cholesterol	57-88-5	na	na	na	na	na
Chromium	7440-47-3	5.13E-03	3.59E-05	4.19E-06	5.46E-07	2.34E-06
Cis-Permethrin	61949-76-6	2.71E-02	1.90E-04	2.22E-05	2.89E-06	1.24E-05
Clotrimazole	23593-75-1	na	na	na	na	na
Copper	7440-50-8	5.44E-02	3.81E-04	4.45E-05	5.79E-06	2.48E-05
Coprostanol	360-68-9	na	na	na	na	na
Cypermethrins	52315-07-8	1.41E-02	9.84E-05	1.15E-05	1.50E-06	6.42E-06
Desmosterol	313-04-2	na	na	na	na	na
Dextropropoxyphene	469-62-5	1.18E-02	8.26E-05	6.75E-08	7.19E-12	3.29E-15
Diazinon	333-41-5	6.27E-02	4.39E-04	3.59E-07	3.82E-11	1.75E-14
Diclofenac	15307-86-5	na	na	na	na	na
Dieldrin	60-57-1	8.00E-01	5.60E-03	4.58E-06	4.88E-10	2.23E-13
Di-n-butyl phthalate	84-74-2	2.26E-04	1.58E-06	1.29E-09	1.38E-13	6.29E-17
Endosulfan II	33213-65-9	4.12E-03	2.89E-05	2.36E-08	2.51E-12	1.15E-15
Endrin	72-20-8	1.38E-01	9.67E-04	7.90E-07	8.42E-11	3.85E-14
Endrin ketone	53494-70-5	8.52E-02	5.96E-04	4.87E-07	5.19E-11	2.37E-14
Epicoprostanol	516-92-7	na	na	na	na	na

Table B-6

Beluga Whale Hazard Quotients for Constituents Measured (NPDES-Regulated) or Inferred (from Literature) in Asplund WPCF Effluent

Anchorage Water and Wastewater Facility

		Dilution Factor	142.9	1,223	9,385	2,189
Chemical	**CAS Number**	**NOAEL-based HQ End of Pipe**	**NOAEL-based HQ Edge of ZID**	**NOAEL-based HQ for Knik Arm**	**NOAEL-based HQ for Turnagain Arm**	**NOAEL-based HQ for Mid Upper Cook Inlet**
Ergosterol	57-87-4	na	na	na	na	na
Fenoprofen	31879-05-7	4.83E-03	3.38E-05	2.76E-08	2.95E-12	1.35E-15
Fluoxetine	54910-89-3	3.72E-01	2.61E-03	2.13E-06	2.27E-10	1.04E-13
Galaxolide (HHCB)	1222-05-5	***6.37E+00***	4.46E-02	3.64E-05	3.88E-09	1.77E-12
Gemfibrozil	25812-30-0	5.30E-02	3.71E-04	3.03E-07	3.23E-11	1.48E-14
Heptachlor	76-44-8	***2.53E+01***	1.77E-01	1.45E-04	1.55E-08	7.06E-12
Ibuprofen	15687-27-1	1.95E-01	1.36E-03	1.12E-06	1.19E-10	5.43E-14
Indomethacin	53-86-1	na	na	na	na	na
Mefenamic acid	61-68-7	3.02E-02	2.12E-04	1.73E-07	1.84E-11	8.43E-15
Mercury	na	***1.74E+00***	1.22E-02	9.95E-06	1.06E-09	4.84E-13
Miconazole	22916-47-8	7.45E-01	5.22E-03	4.27E-06	4.54E-10	2.08E-13
Molybdenum	7439-98-7	2.71E-02	1.90E-04	1.55E-07	1.65E-11	7.55E-15
Musk Abrette (MA)	83-66-9	na	na	na	na	na
Musk Ketone (MK)	81-14-1	2.57E-03	1.80E-05	1.47E-08	1.57E-12	7.15E-16
Musk Moskene (MM)	116-66-5	na	na	na	na	na
Musk Tibetene (MT)	145-39-1	na	na	na	na	na
Musk Xylene (MX)	81-15-2	1.96E-03	1.37E-05	1.12E-08	1.20E-12	5.47E-16
Nickel	7440-02-0	2.43E-02	1.70E-04	1.39E-07	1.48E-11	6.77E-15
Nonylphenol diethoxylate	26027-38-2	4.78E-01	3.34E-03	2.73E-06	2.91E-10	1.33E-13
Nonylphenol Ethoxylates (total)	26027-38-2	2.07E-03	1.45E-05	1.19E-08	1.26E-12	5.78E-16
Nonylphenol monoethoxylate	na	2.21E-01	1.55E-03	1.26E-06	1.35E-10	6.16E-14
PBDE-100	32534-81-9	***1.18E+00***	8.27E-03	6.76E-06	7.21E-10	3.29E-13
PBDE-153	68631-49-2	2.04E-01	1.43E-03	1.17E-06	1.25E-10	5.69E-14
PBDE-154	36483-60-0	1.75E-02	1.23E-04	1.00E-07	1.07E-11	4.89E-15
PBDE-183	32536-52-0	2.20E-04	1.54E-06	1.26E-09	1.34E-13	6.14E-17
PBDE-209	1163-19-5	7.22E-04	5.05E-06	4.13E-09	4.40E-13	2.01E-16
PBDE-28+PBDE-33	49690-94-0	1.60E-02	1.12E-04	9.16E-08	9.76E-12	4.46E-15
PBDE-47	5436-43-1	***4.42E+00***	3.09E-02	2.53E-05	2.69E-09	1.23E-12
PBDE-99	60348-60-9	***2.92E+00***	2.05E-02	1.67E-05	1.78E-09	8.15E-13
Permethrin	52645-53-1	6.41E-02	4.49E-04	3.67E-07	3.91E-11	1.79E-14
Phantolide (AHMI or AHDI)	15323-35-0	na	na	na	na	na
Progesterone	57-83-0	4.56E-04	3.19E-06	2.61E-09	2.78E-13	1.27E-16
Stigmasterol	83-48-7	na	na	na	na	na
Tamoxifen	10540-29-1	na	na	na	na	na
Tonalide (AHTN)	1506-02-1	***1.72E+00***	1.20E-02	9.82E-06	1.05E-09	4.78E-13
Trans-Permethrin	61949-77-7	3.39E-02	2.37E-04	1.94E-07	2.07E-11	9.45E-15
Traseolide (ATII)	68140-48-7	na	na	na	na	na
Triclocarban	101-20-2	na	na	na	na	na
Triclosan	3380-34-5	4.19E-02	2.93E-04	2.40E-07	2.55E-11	1.17E-14
Zinc	7440-66-6	1.03E-02	7.19E-05	5.88E-08	6.26E-12	2.86E-15

Notes:

Bold = hazard quotient exceeds unity

na = not available

NOAEL = no observed adverse effect level

HQ = hazard quotient

Table B-7
Beluga Whale Hazard Quotients (HQs) for Emerging Parameters of Concern Detected in AWWU Primary Effluent in 2010
Anchorage Water and Wastewater Facility

		Dilution Factor	142.9	1,223	9,385	2,189
Chemical	**CAS Number**	**NOAEL-based HQ End of Pipe**	**NOAEL-based HQ Edge of ZID**	**NOAEL-based HQ for Knik Arm**	**NOAEL-based HQ for Turnagain Arm**	**NOAEL-based HQ for Mid Upper Cook Inlet**
10-hydroxy-amitriptyline	1159-82-6	4.46E-02	3.12E-04	3.64E-05	4.75E-06	2.04E-05
17ß-Estradiol	50-28-2	***1.21E+01***	8.48E-02	9.91E-03	1.29E-03	5.54E-03
17α-Estradiol	57-91-0	***1.38E+01***	9.65E-02	1.13E-02	1.47E-03	6.30E-03
17α-Ethinylestradiol	57-63-6	***2.67E+01***	1.87E-01	2.18E-02	2.85E-03	1.22E-02
2,4'-DDD	53-19-0	2.69E-02	1.88E-04	2.20E-05	2.87E-06	1.23E-05
2,4'-DDT	789-02-6	3.39E-02	2.37E-04	2.77E-05	3.61E-06	1.55E-05
2-Hydroxy-ibuprofen	na	8.84E-02	6.19E-04	7.23E-05	9.42E-06	4.04E-05
4,4'- DDE	72-55-9	2.32E-02	1.62E-04	1.89E-05	2.47E-06	1.06E-05
4,4’- DDT	50-29-3	1.26E-01	8.84E-04	1.03E-04	1.35E-05	5.77E-05
4,4'-DDD	72-54-8	3.88E-03	2.72E-05	3.17E-06	4.13E-07	1.77E-06
4-Nonylphenol ethoxylates	26027-38-2	1.52E-02	1.06E-04	1.24E-05	1.62E-06	6.93E-06
4-Nonylphenol monoethoxylates	na	2.52E-02	1.77E-04	2.06E-05	2.69E-06	1.15E-05
4-Nonylphenols	25154-52-3	1.19E-01	8.33E-04	9.73E-05	1.27E-05	5.44E-05
Aldrin	309-00-2	2.61E-02	1.82E-04	2.13E-05	2.78E-06	1.19E-05
alpha-BHC	319-84-6	2.99E-06	2.09E-08	2.44E-09	3.18E-10	1.37E-09
alpha-Endosulfan	959-98-8	5.76E-05	4.03E-07	4.71E-08	6.14E-09	2.63E-08
Amitriptyline	50-48-6	1.93E-01	1.35E-03	1.58E-04	2.06E-05	8.84E-05
Androsterone	53-41-8	na	na	na	na	na
Atorvastatin	134523-00-5	2.39E-04	1.67E-06	1.95E-07	2.54E-08	1.09E-07
Azithromycin	83905-01-5	na	na	na	na	na
beta-BHC	319-85-7	5.10E-06	3.57E-08	4.17E-09	5.44E-10	2.33E-09
beta-Endosulfan	33213-65-9	4.45E-05	3.11E-07	3.64E-08	4.74E-09	2.03E-08
Campesterol	474-62-4	na	na	na	na	na
Chlordane, alpha (cis)	5103-71-9	2.45E-04	1.71E-06	2.00E-07	2.61E-08	1.12E-07
Chlordane, gamma (trans)	5103-74-2	3.07E-04	2.15E-06	2.51E-07	3.27E-08	1.40E-07
Chlordane, oxy-	27304-13-8	4.53E-05	3.17E-07	3.70E-08	4.82E-09	2.07E-08
Chlorpyriphos	2921-88-2	3.32E-04	2.32E-06	2.71E-07	3.53E-08	1.52E-07
Chlorpyriphos-Methyl	5598-13-0	9.76E-06	6.83E-08	7.98E-09	1.04E-09	4.46E-09
Cholestanol	80-97-7	na	na	na	na	na
Cholesterol	57-88-5	na	na	na	na	na
Coprostanol	360-68-9	na	na	na	na	na
Cypermethrins	52315-07-8	1.33E-03	9.34E-06	1.09E-06	1.42E-07	6.10E-07
Dacthal	1861-32-1	4.80E-06	3.36E-08	3.92E-09	5.11E-10	2.19E-09
Desmosterol	313-04-2	na	na	na	na	na
Desogestrel	54024-22-5	***3.14E+00***	2.20E-02	2.57E-03	3.35E-04	1.44E-03
Dieldrin	60-57-1	1.25E-02	8.74E-05	1.02E-05	1.33E-06	5.70E-06
Endosulfan Sulphate	1031-07-8	5.42E-06	3.79E-08	4.43E-09	5.77E-10	2.48E-09
Endrin	72-20-8	1.22E-03	8.57E-06	1.00E-06	1.30E-07	5.59E-07
Epicoprostanol	516-92-7	na	na	na	na	na
Ergosterol	57-87-4	na	na	na	na	na
Fluoxetine	54910-89-3	3.61E-01	2.53E-03	2.95E-04	3.85E-05	1.65E-04
Gemfibrozil	25812-30-0	1.06E-02	7.40E-05	8.64E-06	1.13E-06	4.83E-06
Glyburide	10238-21-8	na	na	na	na	na
HCH, gamma	58-89-9	2.32E-06	1.62E-08	1.90E-09	2.47E-10	1.06E-09
Heptachlor	76-44-8	1.41E-03	9.89E-06	1.16E-06	1.51E-07	6.46E-07
Hexachlorobenzene	118-74-1	2.40E-02	1.68E-04	1.96E-05	2.56E-06	1.10E-05
Ibuprofen	15687-27-1	4.36E-02	3.05E-04	3.57E-05	4.65E-06	1.99E-05
Mestranol	72-33-3	***1.24E+00***	8.71E-03	1.02E-03	1.33E-04	5.69E-04
Miconazole	22916-47-8	4.97E-01	3.48E-03	4.06E-04	5.29E-05	2.27E-04
Norfluoxetine	56161-73-0	4.24E-02	2.97E-04	3.47E-05	4.52E-06	1.94E-05
Norverapamil	67018-85-3	na	na	na	na	na
Octachlorostyrene	29082-74-4	3.49E-01	2.44E-03	2.85E-04	3.71E-05	1.59E-04
Paroxetine	61869-08-7	4.15E-02	2.91E-04	3.40E-05	4.43E-06	1.90E-05
PBDE-100	189084-64-8	***3.05E+00***	2.13E-02	2.49E-03	3.25E-04	1.39E-03
PBDE-119+120	na	7.15E-02	5.00E-04	5.84E-05	7.61E-06	3.26E-05
PBDE-12+13	na	1.26E-04	8.80E-07	1.03E-07	1.34E-08	5.74E-08
PBDE-137+156	na	3.08E-03	2.15E-05	2.52E-06	3.28E-07	1.41E-06
PBDE-14+25	na	2.44E-02	1.71E-04	2.00E-05	2.60E-06	1.12E-05
PBDE-140	243982-83-4	9.26E-03	6.49E-05	7.57E-06	9.87E-07	4.23E-06
PBDE-15	2050-47-7	1.04E-03	7.26E-06	8.48E-07	1.11E-07	4.74E-07
PBDE-153	68631-49-2	3.01E-01	2.10E-03	2.46E-04	3.20E-05	1.37E-04
PBDE-154	207122-15-4	2.44E-01	1.71E-03	1.99E-04	2.60E-05	1.11E-04
PBDE-155	35854-94-5	1.25E-02	8.76E-05	1.02E-05	1.33E-06	5.71E-06
PBDE-181	na	2.60E-03	1.82E-05	2.12E-06	2.77E-07	1.19E-06
PBDE-183	na	2.59E-02	1.82E-04	2.12E-05	2.76E-06	1.19E-05
PBDE-190	79682-25-0	8.12E-03	5.68E-05	6.64E-06	8.65E-07	3.71E-06
PBDE-203	na	2.09E-02	1.46E-04	1.71E-05	2.23E-06	9.56E-06
PBDE-206	na	8.33E-02	5.83E-04	6.81E-05	8.88E-06	3.81E-05
PBDE-207	na	1.64E-01	1.15E-03	1.34E-04	1.75E-05	7.48E-05
PBDE-208	na	9.71E-02	6.80E-04	7.94E-05	1.03E-05	4.44E-05
PBDE-209	1163-19-5	8.83E-04	6.18E-06	7.22E-07	9.41E-08	4.03E-07
PBDE-28+PBDE-33	41318-75-6	3.31E-02	2.32E-04	2.71E-05	3.53E-06	1.51E-05
PBDE-32	na	5.90E-04	4.13E-06	4.83E-07	6.29E-08	2.70E-07
PBDE-35	na	9.12E-04	6.38E-06	7.45E-07	9.72E-08	4.17E-07
PBDE-37	na	6.02E-04	4.21E-06	4.92E-07	6.41E-08	2.75E-07
PBDE-47	5436-43-1	***6.48E+00***	4.53E-02	5.30E-03	6.90E-04	2.96E-03
PBDE-49	243982-82-3	2.09E-01	1.46E-03	1.71E-04	2.23E-05	9.54E-05
PBDE-51	60044-24-8	3.19E-02	2.23E-04	2.61E-05	3.40E-06	1.46E-05
PBDE-60	189084-61-5	1.89E-01	1.32E-03	1.55E-04	2.02E-05	8.64E-05
PBDE-7	na	6.64E-01	4.65E-03	5.43E-04	7.07E-05	3.03E-04
PBDE-71	189084-62-6	6.75E-02	4.72E-04	5.52E-05	7.19E-06	3.08E-05
PBDE-75	189084-63-7	1.49E-02	1.04E-04	1.22E-05	1.59E-06	6.80E-06
PBDE-79	97038-98-7	9.64E-02	6.75E-04	7.88E-05	1.03E-05	4.41E-05
PBDE-8+11	na	8.20E-04	5.74E-06	6.70E-07	8.74E-08	3.75E-07
PBDE-85	182346-21-0	2.93E-01	2.05E-03	2.40E-04	3.13E-05	1.34E-04
PBDE-99	60348-60-9	***1.18E+01***	8.26E-02	9.64E-03	1.26E-03	5.39E-03
Permethrin	52645-53-1	6.40E-03	4.48E-05	5.23E-06	6.82E-07	2.92E-06
PFHpA	375-85-9	7.35E-05	5.15E-07	6.01E-08	7.83E-09	3.36E-08
PFHxA	307-24-4	2.43E-05	1.70E-07	1.99E-08	2.59E-09	1.11E-08
PFHxS	355-46-4	4.68E-04	3.27E-06	3.82E-07	4.98E-08	2.14E-07
PFNA	375-95-1	7.20E-04	5.04E-06	5.89E-07	7.67E-08	3.29E-07
PFOA	335-67-1	2.08E-03	1.45E-05	1.70E-06	2.21E-07	9.49E-07
PFOS	1763-23-1	3.75E-02	2.63E-04	3.07E-05	4.00E-06	1.72E-05
PFPeA	2706-90-3	6.91E-06	4.84E-08	5.65E-09	7.37E-10	3.16E-09
Promethazine	60-87-7	1.68E-02	1.17E-04	1.37E-05	1.79E-06	7.66E-06
Propoxyphene	469-62-5	3.45E-03	2.42E-05	2.82E-06	3.68E-07	1.58E-06
Sertraline	79617-96-2	***1.42E+00***	9.92E-03	1.16E-03	1.51E-04	6.48E-04
ß-Sitosterol	83-46-5	***5.32E+00***	3.73E-02	4.35E-03	5.67E-04	2.43E-03
ß-Stigmastanol	83-45-4	na	na	na	na	na
Stigmasterol	83-48-7	na	na	na	na	na
Triclocarban	101-20-2	na	na	na	na	na

Table B-7
Beluga Whale Hazard Quotients (HQs) for Emerging Parameters of Concern Detected in AWWU Primary Effluent in 2010
Anchorage Water and Wastewater Facility

		Dilution Factor	142.9	1,223	9,385	2,189
Chemical	**CAS Number**	**NOAEL-based HQ End of Pipe**	**NOAEL-based HQ Edge of ZID**	**NOAEL-based HQ for Knik Arm**	**NOAEL-based HQ for Turnagain Arm**	**NOAEL-based HQ for Mid Upper Cook Inlet**
Triclosan	3380-34-5	2.05E-02	1.44E-04	1.68E-05	2.19E-06	9.37E-06
Valsartan	137862-53-4	***2.14E+00***	1.50E-02	1.75E-03	2.28E-04	9.79E-04
Verapamil	52-53-9	na	na	na	na	na

Notes:
Bold = hazard quotient exceeds unity
na = not available
NOAEL = no observed adverse effect level
HQ = hazard quotient

Appendix C

Literature Review: Summary of Available Data on Marine Mammals and Contaminants

APPENDIX C

Literature Review – Summary of Available Data on Marine Mammals and Contaminants

A literature review of available studies on the effects of various contaminants on marine mammals was conducted. This review was not intended to be an exhaustive review of all available literature, but rather a summary review to identify whether there are any clear established thresholds of adverse effects for various contaminants on beluga whales and, secondarily, other marine mammals. Although the available literature is extensive, it is difficult to unequivocally establish a cause-effect relationship between contaminant concentrations and specific adverse effects among marine mammals. This is largely due to the difficulties in studying wild marine mammals, or even captive marine mammals, under controlled conditions with reliable baseline controls and sufficient sample sizes. Among these difficulties is that marine mammals are legally protected from harm and harassment in many countries, including the U.S. and Canada.

A limited number of blubber and internal organ tissue samples have been collected from harvested or stranded Cook Inlet beluga whales as summarized in Becker (2000) and in Tables C-1 through C-3. Known reported contaminant levels in Cook Inlet beluga whales are relatively low compared to other beluga populations (e.g., from the St. Lawrence and Arctic). At this time, there are no specific studies linking contaminant levels with adverse effects on Cook Inlet beluga whales.

The literature review indicates that the accumulating “weight of evidence” implies that contaminants such as persistent organic pollutants (POP), polychlorinated biphenyls (PCB), polybrominated diphenyl ethers (PBDE), mercury, and compounds with dioxin-like properties, are associated with increased incidents of endocrine and immune dysfunction, reproductive impairment, and developmental abnormalities in a number of marine mammal species. Table C-4 summarizes some of these studies. To avoid interpreting these results, selected quotations from the original papers and their sources are included in Table C-4. Some of the relatively well documented species and populations of marine mammals relative to effects of contaminants include the St. Lawrence Estuary beluga whales, the Pacific Northwest and British Columbia killer whales and harbor seals, and harbor and gray seals in the North Atlantic Ocean, and the populations in Baltic, North, and Dutch Wadden Seas.

A few studies correlate contaminants and associated thresholds with specific adverse effects to marine mammals in the wild or in semi-captive or captive conditions. Some of the strongest evidence among marine mammals has been collected in controlled captive conditions with harbor seals, though the sample sizes have been small. These studies have linked contaminants with adverse effects such as reproductive impairment and immunotoxicity. Thresholds have been reported for the effects of PCBs and other contaminants on harbor seals through controlled laboratory conditions on small sample sizes. Correlations have also frequently been derived through stranding samples and field observations; however, these conditions necessarily limit substantiation because of the inability to control other variables that may cause or contribute to the observed symptoms. Evidence from the field comes, in part, from observations of abnormalities in marine mammal populations inhabiting contaminated coastal regions, including skeletal malformations, adrenal lesions, and reproductive impairment.

Among odontocetes (toothed whales, dolphins, and porpoises), a number of studies have provided “weight of evidence” strongly suggesting that some of these long-lived species have been adversely affected by exposure to contaminants through the food chain. However, there are no direct causal data on effects or specific thresholds for odontocetes, unlike for pinnipeds (e.g., seals and sea lions).

Table C-1. Concentrations of PCB, DDT, Toxaphene, and Chlordane in Blubber of Cook Inlet Belugas Compared with Belugas from Other North American Locations (values [mg/kg wet mass] are mean ±1 standard deviation)

Location (Date)	Gender	n	Age (yr)	PCBs	DDT	Toxaphene	Chlordane	Source
Cook Inlet, AK (1992–97)	M	10	9.2 ± 0.96	1.49 ± 0.70	1.35 ± 0.73	2.40 ± 1.06	0.56 ± 0.25	3, 4
	F	10	9.9 ± 5.66	0.79 ± 0.56	0.59 ± 0.45	2.02 ± 0.46	0.30 ± 0.22	3, 4
West Greenland (1989–90) Nuussuaq/ Disko Bugt	M	71		5.38 ± 2.27	4.06 ± 2.50	3.69 ± 1.46	2.41 ± 1.08	1
	F	67		3.74 ± 2.31	2.60 ± 1.94	3.01 ± 1.62	1.79 ± 1.11	1
Cumberland Sound (1983) Pangnirtung	M	6	7.3 ± 6.5	4.91 ± 0.25	6.83 ± 1.89	5.78 ± 5.39	2.38 ± 0.40	2
	F	6	8.1 ± 7.3	1.15 ± 0.41	0.93 ± 0.55	1.77 ± 1.76	0.62 ± 0.15	2
St. Lawrence (1986–87) Estuary	M	4	17.5 ± 9.1	75.8 ± 15.3	101 ± 32.6	14.7 ± 2.46	7.43 ± 0.63	2
	F	5	15.6 ± 10.4	37.3 ± 22.0	23.0 ± 17.3	6.34 ± 3.51	3.55 ± 1.99	2
E. Hudson Bay (1984–85) Nastapoka	M	6	15.6 ± 10.4	2.77 ± 0.51	2.27 ± 0.68	4.13 ± 0.82	1.86 ± 0.35	2
	F	6	17.0 ± 6.3	1.23 ± 0.84	0.98 ± 0.73	1.99 ± 1.10	0.87 ± 0.58	2
W. Hudson Bay (1986) Eskimo Point	M	4	13.0 ± 4.8	3.12 ± 0.34	3.13 ± 0.20	5.10 ± 0.42	2.33 ± 0.26	2
	F	4	10.3 ± 4.1	0.96 ± 1.00	0.85 ± 0.96	1.77 ± 1.41	0.85 ± 0.80	2
Jones Sound (1986) Grise Fjord	M	8	4.4± 2.2	2.53 ± 0.57	1.96 ± 0.32	4.25 ± 1.02	1.87 ± 0.44	2
	F	7	4.6 ± 2.9	2.46 ± 1.98	2.19 ± 1.69	3.74 ± 2.12	1.84 ± 1.13	2
Beaufort Sea (1983, 1987, 1989) Mackenzie River & Point Hope	M	10	17.03	3.33 ± 0.85	2.20 ± 0.83	3.83 ± 1.16	1.75 ± 0.41	2
	F	4	10.2 ± 7.04	1.80 ± 0.77	0.95 ± 0.38	2.22 ± 1.05	0.99 ± 0.46	2, 3, 4
E. Chukchi Sea (1990,1996) Point Lay, AK	M	11	12.2 ± 4.55	5.20 ± 0.90	3.63 ± 0.90	3.93 ± 1.16	2.42 ± 0.46	3, 4
	F	8	16.4 ± 7.5	1.50 ± 1.12	0.93 ± 0.85	2.62 ± 2.07	0.79 ± 0.61	3, 4

Source: Becker, 2000

PCBs for the Beaufort Sea, eastern Chukchi Sea, and Cook Inlet animals are from Krahn et al. (1999). For the other beluga whale stocks, PCBs are from Muir et al. (1990b). Chlordane is the sum of the concentrations of heptachlor, heptachlor epoxide, cis-chlordane, trans-chlordane, trans-nonachlor, cis-nonachlor, oxychlordane, and nonachlor III. DDT is the sum of the concentrations of 2,4′-DDT, 4,4′-DDT, 2,4′-DDD, 4,4′-DDD, 2,4′-DDE, and 4,4′-DDE.

1 = Stern et al. (1994); 2 = Muir et al. (1990b); 3 = Becker et al. (1995b); 4 = Krahn et al. (1999).

Table C-2. Concentrations of Dieldrin, HCB, HCH, and Mirex in Blubber of Cook Inlet Belugas Compared with Belugas from Other North American Locations (values [mg/kg wet mass] are ± 1 Standard Deviation)

Location (Date)	Gender	*n*	Age (yr)	Dieldrin	HCB	HCH1	Mirex	Source
Cook Inlet, AK (1992–97)	M	10	9.2 ± 0.96	0.09 ± 0.05	0.22 ± 0.09	0.21 ± 0.07	0.01 ± 0.01	3, 4
	F	10	9.9 ± 5.66	0.06 ± 0.05	0.15 ± 0.13	0.17 ± 0.05	0.01 ± 0.00	3, 4
Cumberland Sound (1983) Pangnirtung	M	6	7.3 ± 6.5	0.91 ± 0.26	0.96 ± 0.18	0.39 ± 0.11	0.01 ± 0.01	2
	F	6	8.1 ± 7.3	0.20 ± 0.33	0.18 ± 0.04	0.24 ± 0.06	0.01 ± 0.00	2
St. Lawrence (1986–87) Estuary	M	4	17.5 ± 9.1	0.93 ± 0.12	1.34 ± 0.44	0.37 ± 0.11	1.00 ± 0.64	2
	F	5	15.6 ± 10.4	0.56 ± 0.31	0.60 ± 0.43	0.24 ± 0.10	1.11 ± 0.99	2
E. Hudson Bay (1984–85) Nastapoka	M	6	15.6 ± 3.0	0.28 ± 0.09	0.30 ± 0.19	0.21 ± 0.06	0.02 ± 0.01	2
	F	6	17.0 ± 6.3	0.14 ± 0.10	0.14 ± 0.12	0.15 ± 0.04	0.01 ± 0.01	2
W. Hudson Bay (1986) Eskimo Point	M	4	13.0 ± 4.8	0.36 ± 0.07	0.61 ± 0.05	0.24 ± 0.07	0.36 ± 0.07	2
	F	4	10.3 ± 4.1	0.14 ± 0.12	0.19 ± 0.18	0.15 ± 0.04	0.14 ± 0.12	2
Jones Sound (1986) Grise Fjord	M	8	4.4 ± 2.2	0.34 ± 0.11	0.50 ± 0.21	0.19 ± 0.09	0.01 ± 0.00	2
	F	7	4.6 ± 2.9	0.33 ± 0.23	0.39 ± 0.21	0.16 ± 0.08	0.01 ± 0.01	2
Beaufort Sea (1983, 1987, 1989) Mackenzie River & Point Hope	M	10	17.03	0.23 ± 0.05	0.59 ± 0.13	0.23 ± 0.06	0.04 ± 0.01	2
	F	4	10.2 ± 7.04	0.16 ± 0.08	0.42 ± 0.29	0.27 ± 0.12	0.02 ± 0.01	2, 3, 4
E. Chukchi Sea (1990,1996) Point Lay, AK	M	11	12.2 ± 4.55	0.39 ± 0.09	0.81 ± 0.12	0.33 ± 0.76	0.06 ± 0.02	3, 4
	F	8	16.4 ± 7.5	0.12 ± 0.10	0.23 ± 0.28	0.25 ± 0.12	0.02 ± 0.01	3, 4

Source: Becker, 2000)

1 = Stern et al. (1994); 2 = Muir et al. (1990b); 3 = Becker et al. (1995b); 4 = Krahn et al. (1999).

Table C-3. Concentrations of Cu, Cd, Hg, Se, and Zn in Livers of Cook Inlet Belugas Compared Belugas from Other North American Locations (values [mg/kg dry mass] are given as mean ± 1 standard deviation)

Location (Date)	n	Age (yr)	Cu	Cd	Hg	Se	Zn	Source
Cook Inlet, AK (1992–95)	10	9.6 ± 3.76	162 ± 130	2.397	16.3 ± 13.0	14.3 ± 7.0	102 ±10.7	6
West Greenland (1980-87)	40	not analyzed	8.84 (median)	10.5 ± 13.02	14.8 (median)	114 (median)	1, 2	
Cumberland S., Pangnirtung (1984)	11	11.2 ± 3.7	60.7 ± 36.0	23.5 ± 23.9	18.7 ± 16.8	10.31 ± 5.57	101 ± 25.9	3
St. Lawrence estuary (1982–86)	30	17.4 ± 8.5	37.3 ± 34.5	0.58 ± 0.41	126 ±161	79.2 ± 110	98.4 ±41.8	3
E. Hudson Bay, Nastapoka R. (1984)	15	13.2 ± 7.7	150 ± 200	18.9 ± 9.88	38.4 ± 48	16.7 ± 7.97	93.2 ± 9.99	3
W. Hudson Bay, Eskimo Pt (1984)	23	11.2 ± 6.7	117 ± 250	25.0 ± 22.9	24.9 ± 25.2	15.7 ± 8.78	90.4 ± 31.4	3
W. Hudson Bay, S.E. Baffin I. (1984-94)	139	11.9 ± 6.0	76.8 ± 131	26.0 ± 19.5	33.6 ± 33.0	21.4 ± 12.7	115 ± 32.2	4
Jones Sound, Grise Fjord (1984)	17	5.6 ± 4.8	39.1 ± 21.1	12.2 ± 14.1	8.27 ± 7.71	9.21 ± 4.74	93.6 ± 18.8	3
E. Beaufort, Mackenzie R. (1981, 84)	43	13.9 ± 5.5	50.3 ± 49.0	8.52 ± 5.42	44.1 ± 45.53	23.3 ±19.7	92.0 ± 15.5	3
E. Beaufort, Mackenzie R. (1993–94)	77	19.3 ± 6.6	45.2 ± 28.4	9.08 ± 4.16	108 ± 98.8	75.2 ± 55.6	112 ± 20.0	4
E. Beaufort, Point Hope, AK (1989)	4	7.0 ± 2.5	48.0 ± 6.08	4.47 ± 2.50	18.8 ± 13.0	30.0 ± 15.0	120 ± 29.6	3
E. Chukchi Sea, Point Lay, AK (1990)	10	14.1 ± 6.8 4	61.6 ± 42.3	9.38 ± 3.39	179 ± 78.65	97.2 ± 76.7	96.0 ± 11.5	5

Source: Becker 2000

1 = Dietz et al. (1990); 2 = Hansen et al. (1990); 3 = Wagemann et al. (1990); 4 = Wagemann et al. (1996); 5 = Becker et al. (1995b); 6 = NIST (this paper).

Table C-4. Selected Summary of Literature Review of the Effects of Contaminants on Marine Mammals

Species	Population	Contaminant of Concern	Excerpts from Publications	Source
Beluga	Cook Inlet		"The Cook Inlet belugas had the lowest concentrations of all (PCBs averaged 1.49 ± 0.70 and 0.79 ± 0.56 mg/kg wet mass, and DDT averaged 1.35 ± 0.73 and 0.59 ± 0.45 mg/kg in males and females, respectively). Concentrations in the blubber of the Cook Inlet males were significantly lower than those found in the males of the Arctic Alaska belugas (PCBs and DDT were about half). The lower levels in the Cook Inlet animals might be due to differences in contaminant sources, food web differences, or different age distributions among the animals sampled…Due to the lower concentrations in the Cook Inlet belugas, the effects of PCBs and chlorinated pesticides on animal health may be of less significance for the Cook Inlet animals than for belugas from other locations. However, very little is known about the role that multiple stressors play in the health of individual animals and populations."	Becker 2000[a]
Beluga	St. Lawrence Estuary	POPs	"A lack of recovery in the contaminated St. Lawrence beluga whales (since the 1962 protection of this population), in combination with observations of disease-associated mortalities, has been partly attributed to POPs and other environmental contaminants" (De Guise et al., 1995; Lebeuf et al., 2004).	Martineau 2001
Beluga	St. Lawrence Estuary	POPs	"Thirty-seven percent of all the tumors reported in cetaceans were observed in the St. Lawrence beluga whales. This could be explained by two different mechanisms: high exposure to environmental carcinogens and suppression of immunosurveillance against tumors. Overall, St. Lawrence belugas might well represent the risk associated with long-term exposure to pollutants present in their environment."	De Guise et al., 1995
Beluga	St. Lawrence Estuary	Organochlorines	"The reduced proliferation of beluga cells exposed in vitro to mixtures of organochlorines at concentrations in the range of those observed in tissues of St. Lawrence belugas might provide a basis to support the hypothesis that contaminants induce immunosuppression in these animals."	DeGuise 1998
Beluga	St. Lawrence Estuary	PAHs	"A population of approximately 650 beluga (Delphinapterus leucas) inhabits a short segment of the St. Lawrence Estuary (SLE). Over 17 years (1983–1999), we have examined 129 (or 49%) of 263 SLE beluga carcasses reported stranded. The major primary causes of death were respiratory and gastrointestinal infections with metazoan parasites (22%), cancer (18%), and bacterial, viral, and protozoan infections (17%). We observed cancer in 27% of examined adult animals found dead, a percentage similar to that found in humans. SLE beluga and their environment are contaminated by polycyclic aromatic hydrocarbons (PAHs) produced by the local aluminum smelters."	Martineau 2001

Table C-4. Selected Summary of Literature Review of the Effects of Contaminants on Marine Mammals

Species	Population	Contaminant of Concern	Excerpts from Publications	Source
Beluga	St. Lawrence Estuary	PCBs	"Different threshold values above which mean PCB concentration would be potentially higher in belugas dead from infectious diseases were examined. None of the animal groups with PCB contamination above the threshold values led to significantly higher mean concentration of PCBs in animals that died from infections."	Lebeuf 2009
Beluga	Arctic (Beaufort Sea)	Mercury	"Mercury (Hg) has long been known as a neurotoxin, and is emerging as a critical contaminant issue in the Arctic for belugas and ringed seals that have exhibited increasing Hg concentrations during the past two decades. Studies show that belugas bioaccumulate mercury to levels that would probably cause effects in many species" (Lockhart et al., 2005).	Stern 2009 (p.1)
Beluga and White-sided dolphin	St. Lawrence Estuary	DDT	"Two types of lesions affected the adrenal cortex of St. Lawrence belugas: hyperplastic nodules and serous cysts...similar lesions were reported in female white-sided dolphins (*Lagenorhynchus acutus*) (Geraci et al., 1978). These lesions presumably reflect a functional alteration of the physiology of the adrenal cortex. The pathophysiology proposed for the development of cysts in the adrenal cortex of beluga whales involving hydropic degeneration of clusters of adrenocortical cells, could correspond to an exaggeration of the adrenocorticolytic process as described under DDT metabolite exposure."	DeGuise et al., 1993 (p. 74)
Killer whale	British Columbia	PCBs	"…PCB concentrations in northern resident, southern resident, and transient killer whales readily exceed established thresholds for effects of PCBs on reproduction in harbour seals (25 mg• kg-1)(Boon et al., 1987) and river otters (*Lontra canadensis*) (7.5 mg• kg-1)(Kihlstrom et al., 1992), immune function in harbour seals (17 mg• kg-1)(De Swart et al., 1994; Ross et al., 1995), and endocrine effects (thyroid hormone and vitamin A) in river otters (4 mg• kg-1)(Smit et al., 1996) and harbour seals (17 mg• kg-1)(De Swart et al., 1994; Ross et al., 1995). Extrapolation and a weight of evidence approach therefore imply a significant health risk associated with current PCB burdens in British Columbia's killer whale communities."	Ross 2006 (p. 229)
White-sided dolphin	Atlantic Ocean	Organochlorines	"Serous cysts have apparently never been described in domestic animals, but similar lesions were reported in female white-sided dolphins (*Lagenorhynchus acutus*) (Geraci et al., 1978). These lesions presumably reflect a functional alteration of the physiology of the adrenal cortex."	DeGuise et al., 1993 (p. 74)
Dall's Porpoise	NW Pacific	PCBs, DDEs	"Dall's porpoises (*Phocoenoides dalli*) from the northwestern North Pacific showed reduced testosterone levels in relation with high PCB and DDE concentrations."	DeGuise et al., 993 (p.74)

Table C-4. Selected Summary of Literature Review of the Effects of Contaminants on Marine Mammals

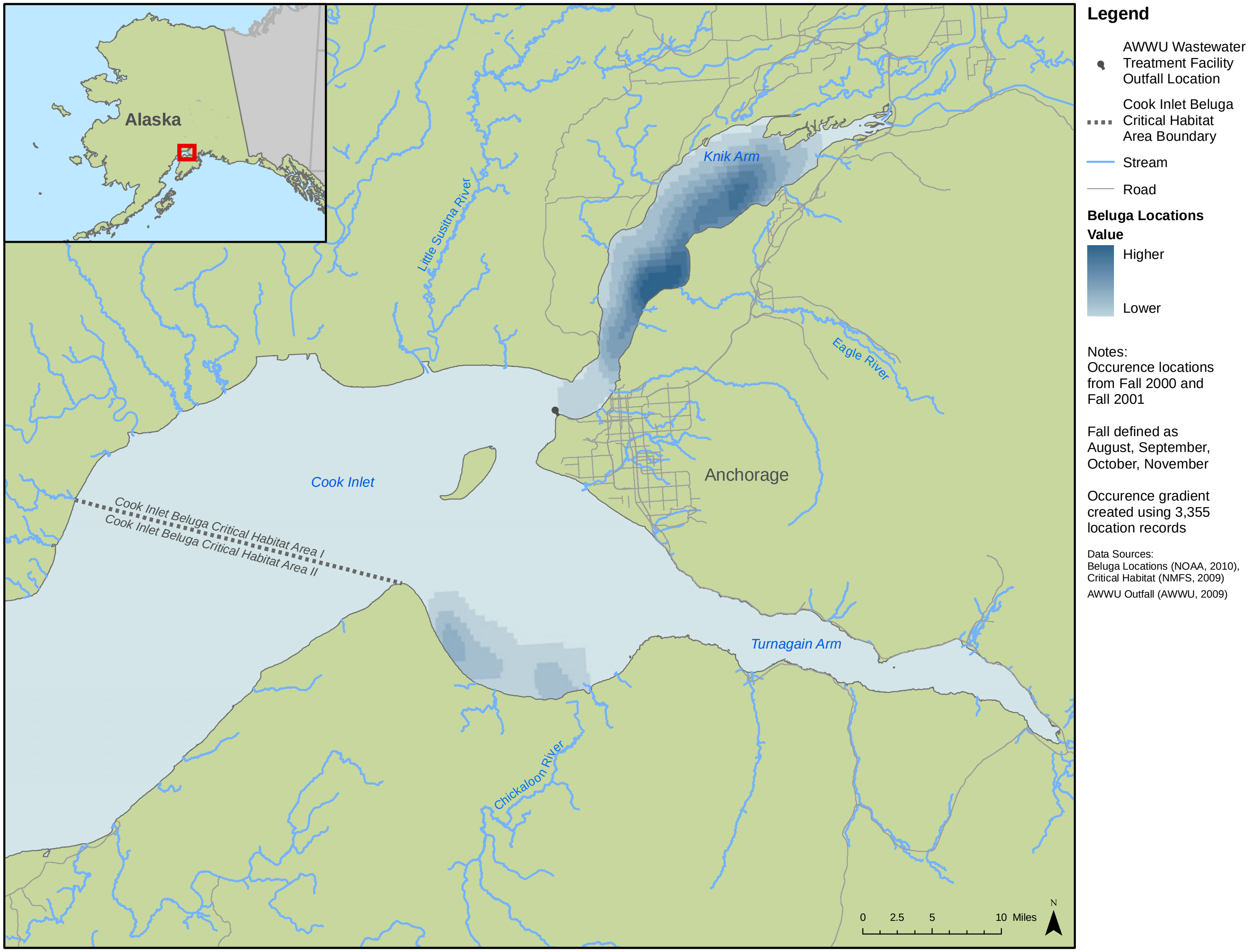
Species	Population	Contaminant of Concern	Excerpts from Publications	Source
Harbor porpoise	North & Baltic seas	PBDEs, PCBs, POPs	"Elevated POP concentrations in harbour porpoises (*Phocoena phocoena*) that died from infectious diseases compared with those that died from trauma suggests that contaminant-associated immunotoxicity is affecting immunocompetence" (Jepson et al., 1999).	Ross 2006 (p.228)
Bottlenose dolphin	Florida	biphenyls, DDT, DDEs	"…data indicate that in bottlenose dolphins a reduced in vitro immune response is associated with increasing levels of PCBs and DDT in peripheral blood. The small sample size in this study (n=5) and the lack of control (uncontaminated) dolphins from which we can determine the normal range of immune responses, precludes drawing extensive conclusions. However, these data are consistent with the results of other studies which show that PCBs and DDT can suppress immune response."	Lahvis 1995 (p.70)
CA sea lion	S California	Organochlorines	"Premature births in California sea lions (*Zalophus californianus*) have also been associated with high levels of organochlorines" (DeLong et al., 1973).	DeGuise et al., 1993)
Harbor seal (captive)		PCBs, PCDDS, PCDFs	"Harbor seals appear to be sensitive to a wide range of toxic effects following exposure to PCBs and other dioxin-like compounds (i.e., PCDDs, PCDFs) through the food chain. Results of feeding studies using captive harbor seals indicate that reproductive impairment (Reijnders, 1986), immunotoxicity (De Swart, 1995, Ross, 1995), and alterations of thyroid hormone and retinol (vitamin A) homeostasis (Brouwer et al., 1989) occur in adult harbor seals with low to moderate PCB burdens (mean PCB ~17 to 25 ppm/lipid basis)."	Shaw et al., 1999 (p.11)
Harbor (seal (captive)	Dutch Wadden Sea	PCBs, Organochlorines	"I conclude that the reproductive success of the seals receiving the diet with the highest level of pollutants was significantly decreased…the reproductive process is disrupted in the post-ovulation phase…the results from this study show that the reproductive failure in common seals from the Dutch Wadden Sea is related to feeding on fish from that polluted area. The available epidemiological experimental data on effects and levels of PCBs in seals and mink fed on fish from this area suggest that these organochlorines are the main cause of this failure."	Reijnders et al., 1986
Harbor seal (captive)	Dutch Wadden Sea	PCBs	"Female harbour seals were held in captivity. During a period of two years, one group received contaminated fish from the Dutch Wadden Sea, while a second group was given relatively clean fish from the Atlantic Ocean. Concentrations of individual polychlorinated biphenyl (PCB) congeners were measured in fish, seal blood and occasionally in faeces of seals...On a wet-weight basis, the concentrations of all congeners were lower in seal blood than in their food, but when expressed on a lipid basis, the non-metabolized congeners were biomagnified. At the end of the experiment, the PCB concentrations were significantly lower ($P< 0.001$) in the seals which had received fish from the Atlantic Ocean."	Boon et al., 1987

Table C-4. Selected Summary of Literature Review of the Effects of Contaminants on Marine Mammals

Species	Population	Contaminant of Concern	Excerpts from Publications	Source
Harbor seal (captive)	Dutch Wadden Sea	PCBs, POPs, Organochlorines	"In two captive studies, harbour seals fed fish caught from more POP contaminated waters caused reproductive impairment and immunotoxicity (Reijnders, 1986; De Swart et al., 1994; Ross et al., 1996). In addition, circulating vitamin A and thyroid hormone concentrations were reduced in the exposed seals" (Brouwer et al., 1989; De Swart et al., 1994).	Ross 2006 (p.228); also see killer whale above
Harbor seal (wild, then captive)	Baltic Sea and Atlantic Ocean	Organochlorines	"…we carried out an immunotoxicological study under semifield conditions. Two groups of 11 harbour seals (*Phoca vitulina*) originating from a relatively uncontaminated area were fed herring from either the highly polluted Baltic Sea or the relatively uncontaminated Atlantic Ocean. Changes in immune function were monitored over a 2.5-year period. The seals that were fed contaminated Baltic herring developed significantly higher body burdens of potentially immunotoxic organochlorines and displayed impaired immune responses as demonstrated by suppression of natural killer cell activity and specific T-cell responses....These results demonstrate that chronic exposure to environmental contaminants accumulated through the food chain affects immune function in harbour seals..."	De Swart et al., 1996
Harbor seal		PCPs	"Uterine stenoses and occlusions were reported in different populations of seals in association with high PCB loads" (Helle et al., 1976).	DeGuise et al., 1993
Harbor seal (neonatal, wild, stranded)	Central California	PCBs	"The threshold for immune and endocrine-disrupting effects of bioactive PCB congeners may be quite low (PCB ~3 ppm, lipid basis) for neonatal harbor seals."	Shaw et al., 1999 (p.12)
Ringed seal	Arctic (Beaufort Sea)	Mercury	"Hg liver concentration in ringed seals from Holman, Sachs Harbour and Tuktoyaktuk have reached as high as 200 mg/g" (Stern, unpublished results).	Stern 2009
Gray seal	United Kingdom	PBDEs, PCBs, POP	"Hall et al. (2003) recently reported an association between thyroid hormone alterations and PBDEs in the concentration range of 61 – 1,500 ng/g, lw, in blubber of live-captured gray seal pups and juveniles from UK waters."	Shaw 2006 (p.831)
River otter		PCBs	See killer whale above.	

[a] Becker is currently reanalyzing old and new Cook Inlet beluga (CIB) tissue data under contract to NMFS/Anchorage. This draft report is expected to be submitted to NMFS in early 2010 and available to the public on the NMFS CIB website in summer 2010 (pers. comm., B. Mahoney, NMFS/Anchorage, Nov 2009).

Appendix D
Distribution of Beluga Whales in Cook Inlet



Notes:
Occurence locations from Fall 2000 and Fall 2001

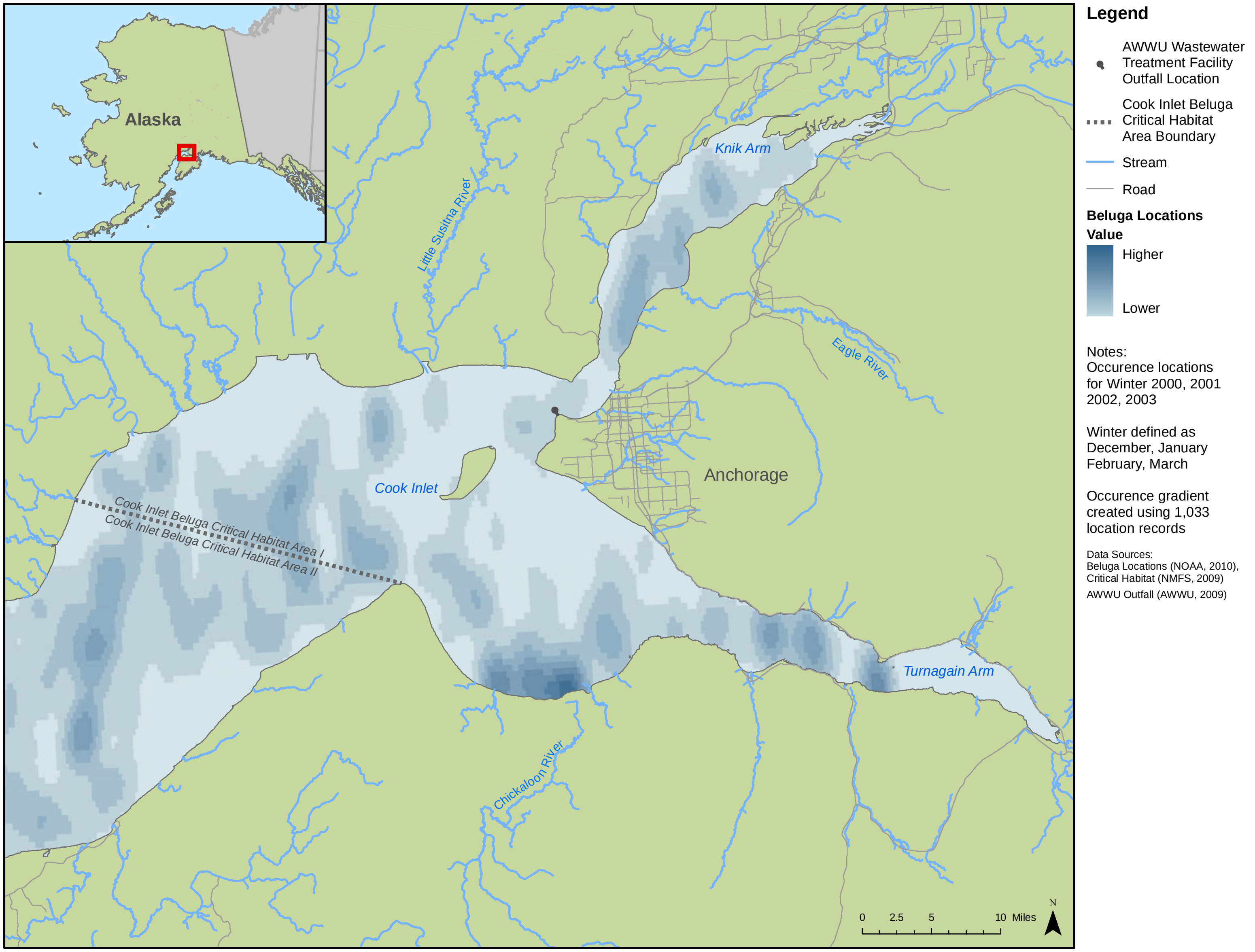
Fall defined as August, September, October, November

Occurence gradient created using 3,355 location records

Data Sources:
Beluga Locations (NOAA, 2010),
Critical Habitat (NMFS, 2009)
AWWU Outfall (AWWU, 2009)

FIGURE D-1
FALL BELUGA SATELLITE LOCATION OCCURENCE GRADIENT

AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)



Notes:
Occurence locations for Winter 2000, 2001 2002, 2003

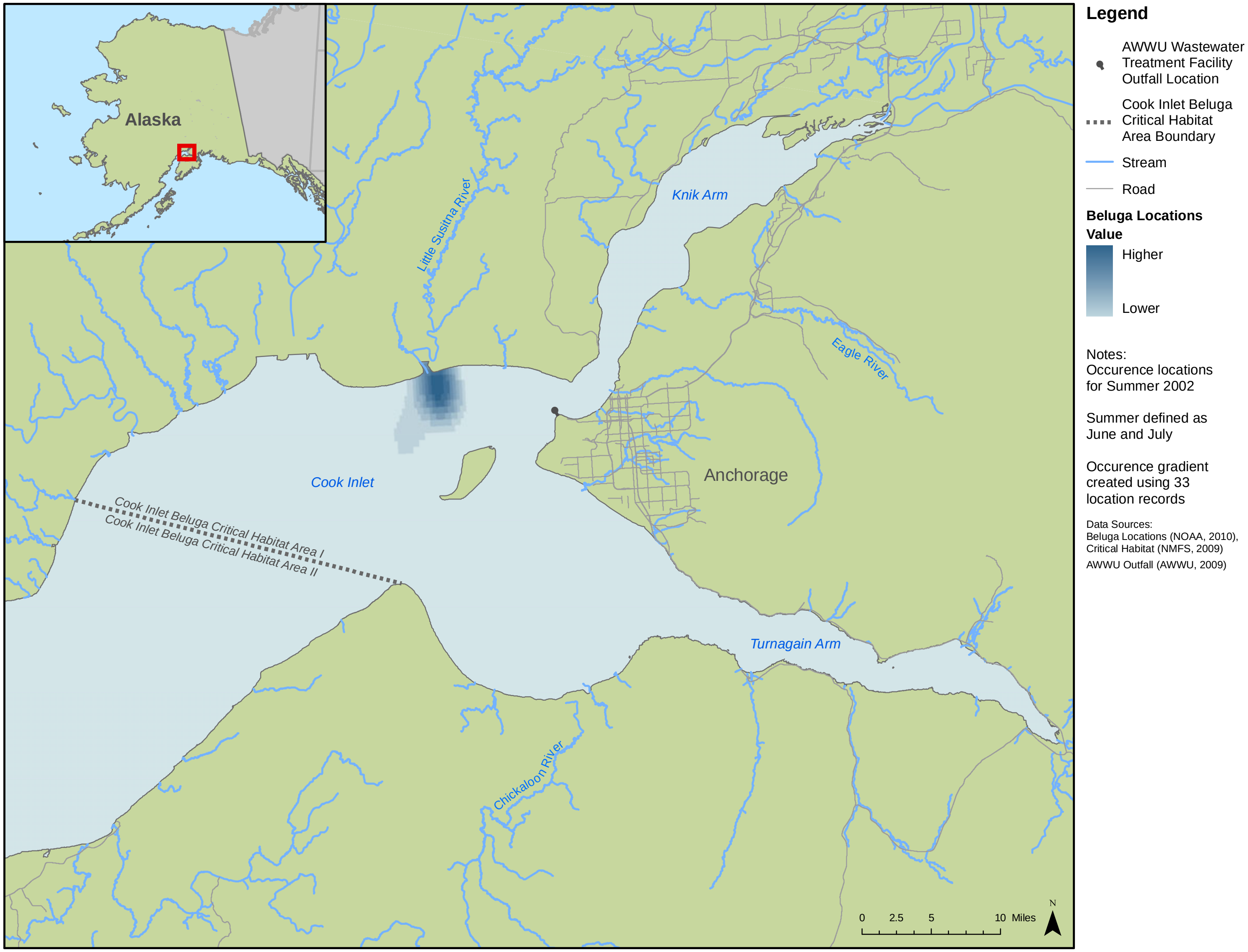
Winter defined as December, January February, March

Occurence gradient created using 1,033 location records

Data Sources:
Beluga Locations (NOAA, 2010),
Critical Habitat (NMFS, 2009)
AWWU Outfall (AWWU, 2009)

FIGURE D-2
WINTER BELUGA SATELLITE LOCATION OCCURENCE GRADIENT

AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)



Notes:
Occurence locations for Summer 2002

Summer defined as June and July

Occurence gradient created using 33 location records

Data Sources:
Beluga Locations (NOAA, 2010),
Critical Habitat (NMFS, 2009)
AWWU Outfall (AWWU, 2009)

FIGURE D-3
SUMMER BELUGA SATELLITE LOCATION OCCURENCE GRADIENT

AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

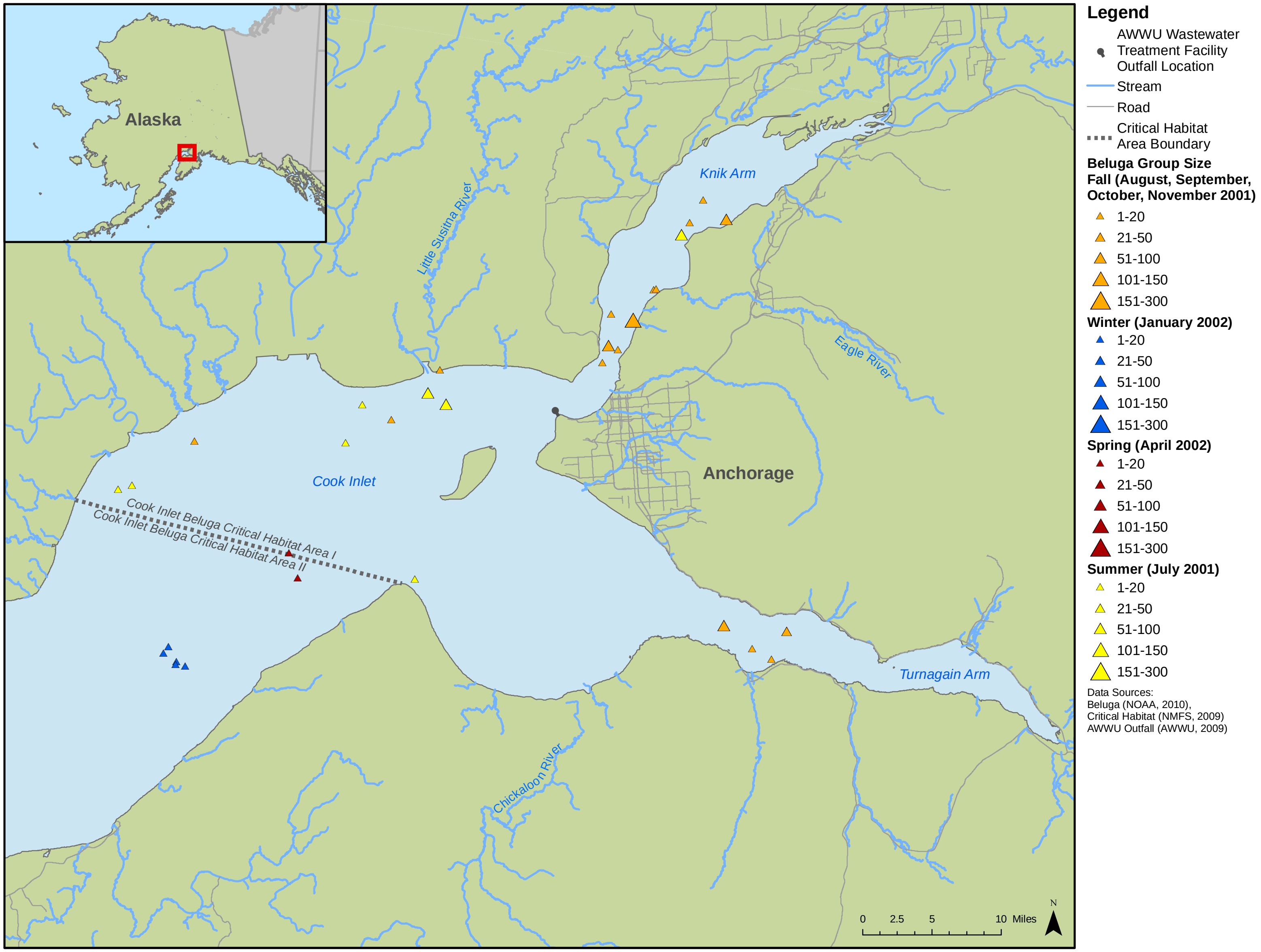
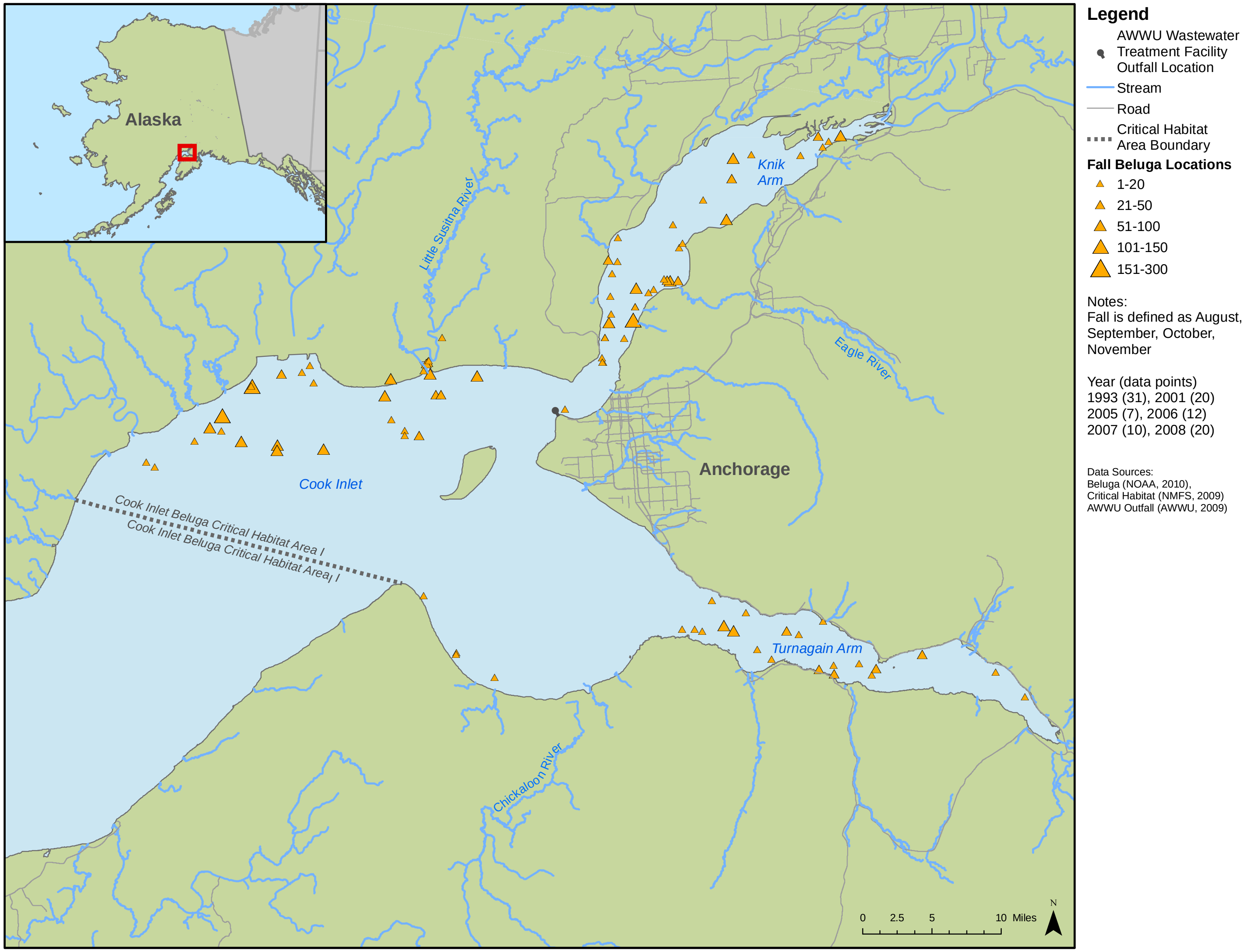


FIGURE D-4
"ALL MONTH" BELUGA LOCATION DATA FOR SUMMER 2001 TO SPRING 2002
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)



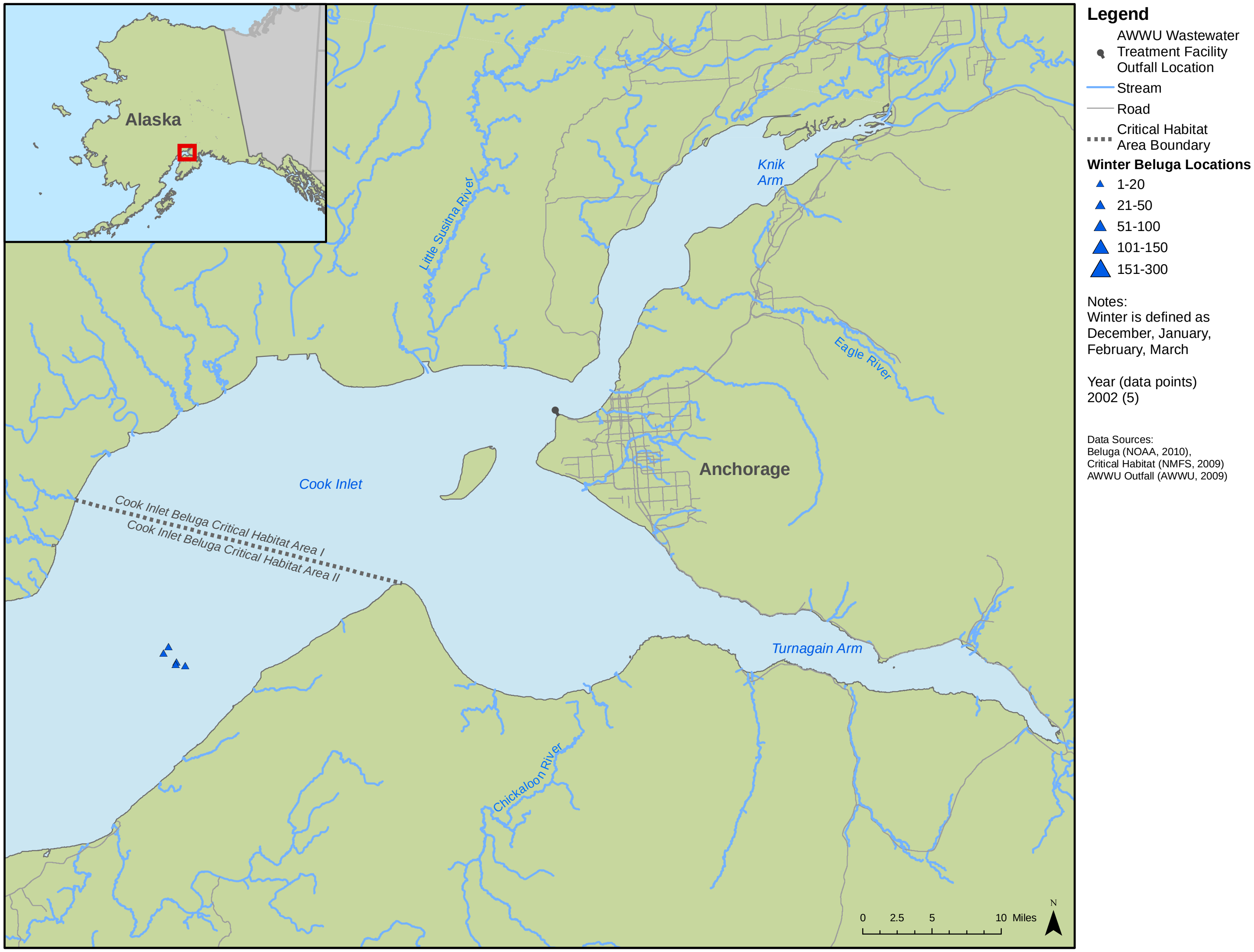
Notes:
Fall is defined as August, September, October, November

Year (data points)
1993 (31), 2001 (20)
2005 (7), 2006 (12)
2007 (10), 2008 (20)

Data Sources:
Beluga (NOAA, 2010),
Critical Habitat (NMFS, 2009)
AWWU Outfall (AWWU, 2009)

FIGURE D-5
FALL "CIBSIGHT" BELUGA LOCATION DATA

AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)



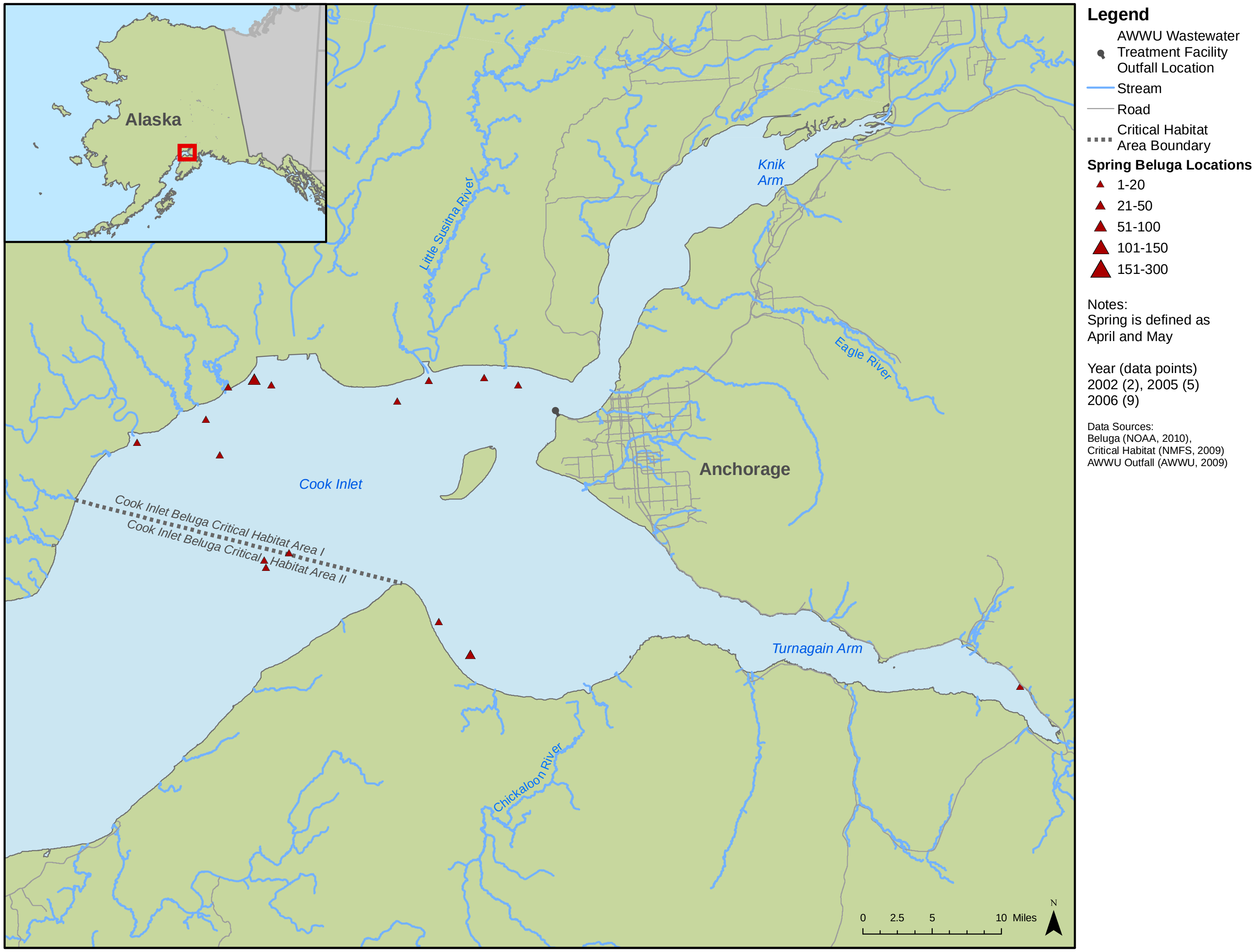
Notes:
Winter is defined as December, January, February, March

Year (data points)
2002 (5)

Data Sources:
Beluga (NOAA, 2010),
Critical Habitat (NMFS, 2009)
AWWU Outfall (AWWU, 2009)

FIGURE D-6
WINTER "CIBSIGHT" BELUGA LOCATION DATA

AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

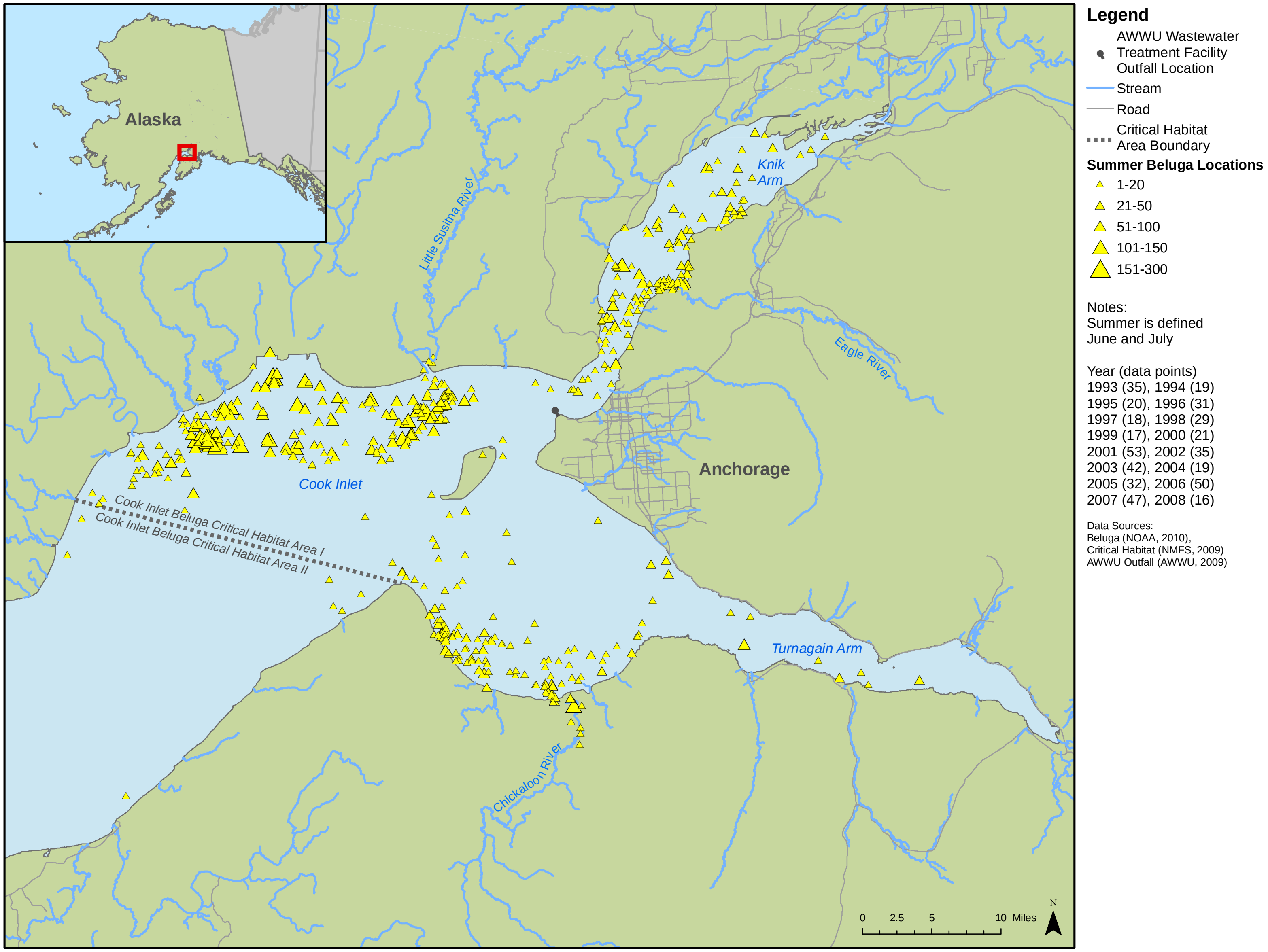


Notes:
Spring is defined as
April and May

Year (data points)
2002 (2), 2005 (5)
2006 (9)

Data Sources:
Beluga (NOAA, 2010),
Critical Habitat (NMFS, 2009)
AWWU Outfall (AWWU, 2009)

FIGURE D-7
SPRING "CIBSIGHT" BELUGA LOCATION DATA
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)



Notes:
Summer is defined
June and July

Year (data points)
1993 (35), 1994 (19)
1995 (20), 1996 (31)
1997 (18), 1998 (29)
1999 (17), 2000 (21)
2001 (53), 2002 (35)
2003 (42), 2004 (19)
2005 (32), 2006 (50)
2007 (47), 2008 (16)

Data Sources:
Beluga (NOAA, 2010),
Critical Habitat (NMFS, 2009)
AWWU Outfall (AWWU, 2009)

FIGURE D-8
SUMMER "CIBSIGHT" BELUGA LOCATION DATA
AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

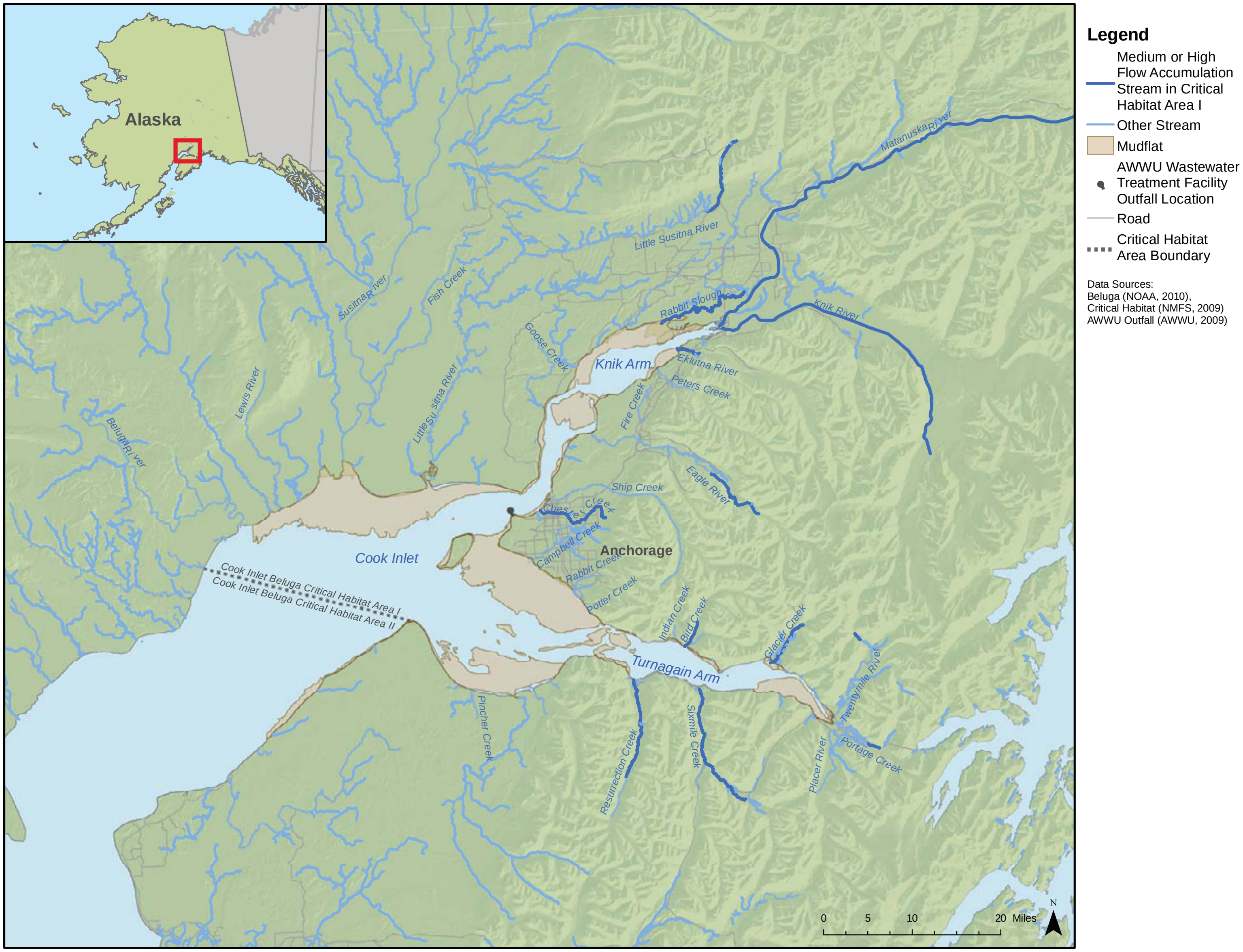
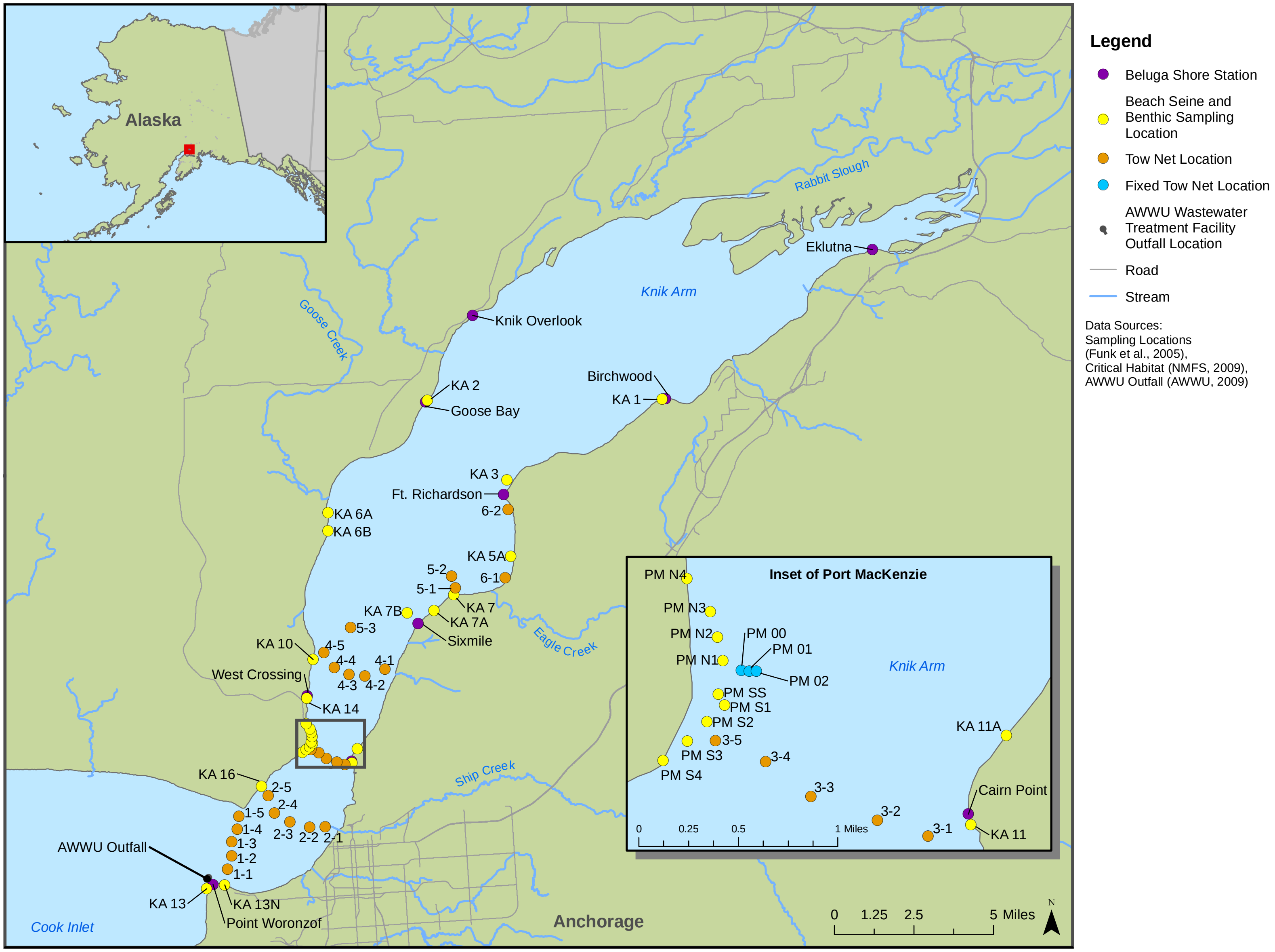


FIGURE D-9
BELUGA HABITAT

AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)



Data Sources:
Sampling Locations
(Funk et al., 2005),
Critical Habitat (NMFS, 2009),
AWWU Outfall (AWWU, 2009)

FIGURE D-10
SAMPLING LOCATIONS

AWWU BIOLOGICAL EVALUATION
ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)

Appendix E
Modeling Plan for the Biological Evaluation of the Effects of Discharge Permit Reauthorization on Cook Inlet Beluga Whales

Modeling Plan for the Biological Evaluation of the Effects of Discharge Permit Reauthorization on Cook Inlet Beluga Whales

Submitted to
U.S. Environmental Protection Agency, Region 10
Seattle, Washington

Submitted by
Anchorage Water and Wastewater Utility

Prepared by
CH2M HILL

Table of Contents

Attachments

Table

Figures

Acronyms and Abbreviations

AWWU	Anchorage Water and Wastewater Utility
DTM	digital terrain model
EFDC	Environmental Fluid Dynamics Code
EPA	U.S. Environmental Protection Agency Region 10
ESA	Endangered Species Act
MLLW	Mean Lower-Low Water
NGDC	National Geophysical Data Center
NPDES	National Pollutant Discharge Elimination System
POC	parameters of concern
TSS	total suspended sediment
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
UTM	Universal Transverse Mercator
WPCF	Water Pollution Control Facility

APPENDIX E

Modeling Plan for the Biological Evaluation of the Effects of Discharge Permit Reauthorization on Cook Inlet Beluga Whales

E.1 Introduction

The U.S. Environmental Protection Agency (EPA) is reviewing the Anchorage Water and Wastewater Utility (AWWU) application for renewal of the Asplund National Pollutant Discharge Elimination System (NPDES) permit and associated 301(h) waiver. As a part of its decision process, EPA must obtain federal agency certifications that its proposed action (permit reauthorization) will not adversely affect threatened or endangered species or their critical habitats in the area—as listed by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). This must be done to conform to Section 7 of the Endangered Species Act (ESA).

A biological evaluation (BE) is a critical component of consultation between EPA and the agencies with respect to the Asplund 301(h) waiver. EPA has tasked AWWU with drafting a BE for listed species to support EPA Section 7 consultations with NMFS and USFWS.[1] The BE will be submitted to EPA and will be used by the agency, in whole or in part, to determine whether permit reauthorization is likely to affect the continued existence of species protected by the ESA, or adversely modify their habitat. Numerical modeling of the transport and distribution of effluent, and effluent constituents, from the Asplund water pollution control facility (WPCF) is needed to support the ecological risk assessment requirements of the BE. This modeling plan describes the proposed approach.

E.1.1 Purpose

The purpose of this modeling plan is to present the proposed modeling approach. The modeling plan is intended to provide EPA, AWWU, and CH2M HILL the opportunity to discuss and reach consensus on the proposed approach. This draft modeling plan will be finalized following discussions with EPA staff.

E.1.2 Background

Understanding the exposure of endangered species to regulated and unregulated constituents based on migration, residence, habitat requirements, and circulation (including nearfield plume dilution and farfield circulation) will be critical to producing an effective and acceptable BE. Numerical modeling will be used to quantify effluent constituent concentrations in receiving waters and sediments affected by the discharge.

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[1] Consultation letters from NMFS (25 June 2009) and USFWS (20 May 2009) to Lisa Olson/EPA indicate that the Cook Inlet population of beluga whales represents the only federally-listed species to be included in this BE.

Based on experience with hydrodynamic models, plume modeling, Cook Inlet (CI), and the objectives of the BE, the Environmental Fluid Dynamics Code (EFDC) model is recommended as the most appropriate farfield model to address the mixing, fate, and transport of the parameters of concern (POC). This model is in the public domain, has been widely applied in similar applications, is supported and endorsed by EPA for complex modeling to support environmental permitting, and has a graphical pre- and post-processor.

Nearfield modeling has previously been done (CH2M HILL, 1998) for this discharge using the EPA UDKHDEN initial dilution model and subsequent dilution routines based on a passive diffusion analysis (the Brooks method), which is accepted by EPA. It is unlikely that additional detailed modeling will be required because discharge flows have remained about the same since the previous modeling. Therefore, results of the previous modeling can be applied directly without further analysis. If additional modeling of detailed initial dilution is required, the same model will be used. Modeling was also conducted by Tetra Tech (1997) prior to the installation of the existing diffuser and will be reviewed for applicability to support the BE.

E.1.3 Approach

The EFDC model is a general-purpose modeling package for simulating three-dimensional (3D) flow, transport, and biogeochemical processes in surface water systems including: rivers, lakes, estuaries, reservoirs, wetlands, and near shore to continental shelf scale coastal regions. The model was originally developed at the Virginia Institute of Marine Science to use for estuarine and coastal applications. In addition to hydrodynamic, salinity, and temperature transport simulation capabilities, EFDC includes sub-models to simulate sediment transport, eutrophication, and the transport and fate of toxic contaminants in the water and sediment bed. EFDC is unique among advanced surface water models in using a single source code to dynamically couple hydrodynamics (Hamrick, 1992, 1996) with sediment/toxic chemical transport (Tetra Tech, 2003), and eutrophication (Park et al., 1995). The code is widely used by federal agencies, including the U.S. Army Corps of Engineers (USACE), EPA, and the United States Geological Survey (USGS). Details of the physical and numerical basis of EFDC and additional description of the model are provided in Attachment I; references cited are listed in Attachment E1.

To investigate the physical processes, sediment/toxics dynamics, and water quality in Upper CI, a 3D EFDC model will be developed. The model will provide a tool to quantify the exposure of CI beluga whales, other protected species, and important prey species to contaminants contained in the Asplund WPCF discharge. The model will simulate the hydrodynamic and transport processes based on:

- Tidal forcing
- Density effects
- Open water and iced-over conditions
- An integrated nearfield plume sub-model dynamically coupled to the farfield circulation model

- Wind-generated currents
- Inflow from major rivers
- Effluent loading from AWWU

E.1.4 Scope and Limitations

The scope of the modeling limited to predicting the concentration, fate, and transport of effluent and effluent-derived sediments discharged from the Asplund WPCF in the water column and sediments of Upper CI. Simulation of individual effluent constituents will not be considered individually, but inferred from the concentrations in, and dilutions of, whole effluent and effluent-derived sediment.

The farfield model will be configured to trace the concentration of whole effluent and effluent-derived sediments from the Asplund WPCF. The concentrations of specific constituents will be inferred from the known or assumed effluent concentrations. The effluent constituents will be considered as conservative substances in the water column, with the exception of removal by adsorption to sediments and subsequent sedimentation. Partitioning between dissolved and sediment associated constituent phases will be based on available data and best scientific judgment. Sediment grain size distribution and loadings will be based on available data and known characteristics of typical wastewater effluent. Effluent-derived sediment accumulation will be based on modeled sedimentation rates

The time available to develop the BE is limited. Therefore, the farfield model will be calibrated and verified using available data. No additional field data will be collected. The primary calibration will be based on water level responses and salinity variations. The intent of the model is to provide overall transport and average concentrations of whole effluent. Experience indicates that the model will adequately provide the required data without extensive detailed calibration and verification. Detailed predictions of fine scale temporal and spatial current patterns and variations in effluent concentrations are not required for the purposes of the BE.

Because of the time constraints, the model domain (study area) will be configured to include the critical habitat of the target species; i.e., the beluga whale.[2] The areal extent of the model domain will be extended far enough down CI to avoid tidal reflux on a tidal excursion, but will not be extended outside the inlet. This approach will provide confidence that boundary effects do not substantially or significantly affect the predictions of whole effluent concentrations and sedimentation processes within the study area.

Time constraints for BE development also dictate that a limited number of model scenarios (environmental and seasonal conditions) will be considered. It is generally thought that winter conditions, with limited freshwater flows into the study area and ice cover, result in the most limited flushing action in Upper CI. Therefore, this will be the primary model scenario. For comparison (but only if time permits), a summer scenario using maximum freshwater flows and open water surface will also be modeled.

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[2] Currently, there is no other designated critical habitat in the project area.

E.2 Model Domain

The exact model domain will be determined from evaluating the literature, available data, preliminary modeling results, and beluga whale migration patterns, focusing on where the whales reside in relation to winter hydraulic circulation patterns. A preliminary EFDC model grid constructed as an example is shown on Figure E-1. This example configuration has approximately 7,700 computational cells. The typical grid size is about 250 by 500 meters in the Knik Arm around the Point Woronzof diffuser, with a maximum size of 1,000 by 1,000 meters near the open boundary. The final grid sizes in the vicinity of the Point Woronzof diffuser may be refined based on analysis of the diffuser, nearfield modeling results, the velocity field in the Knik Arm around the diffuser, and initial effluent plume excursion.

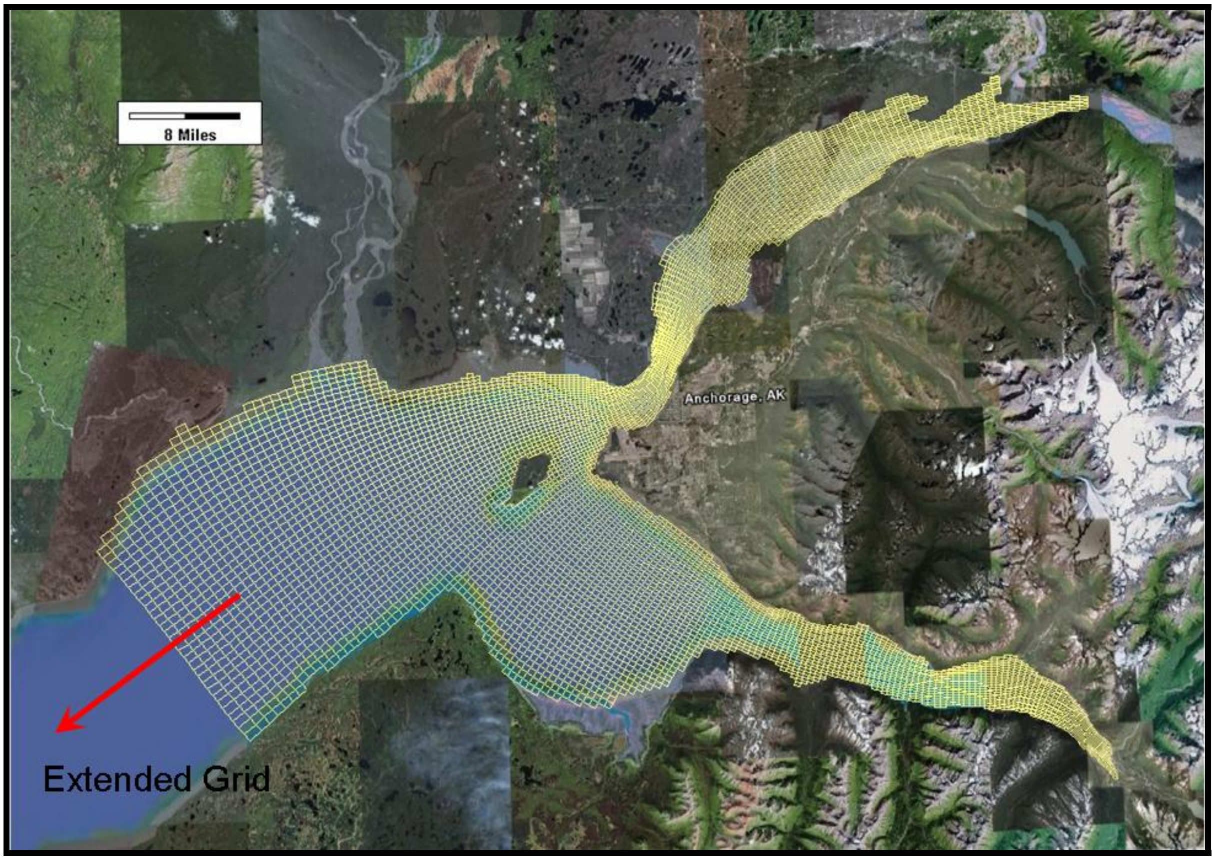

FIGURE E-1. COOK INLET EFDC MODEL GRID

An initial examination of beluga whale habitat indicates that the example grid shown in Figure E-1 will need to be extended down the inlet to provide sufficient information for the BE. Figure E-2 shows the March habitat of the beluga whale based on available information. It is proposed that model grid be extended to the limit shown in Figure E-2. This would provide ample coverage for the habitat in the vicinity of the Asplund WPCF discharge, with sufficient down-inlet coverage to provide an appropriate boundary to account for tidal reflux effects in the vicinity of the discharge. The approximate limit of model application for the BE is shown on Figure E-2. If no effects of the discharge are determined for this area, then it is reasonable to assume that areas further down-inlet are not affected.

It is anticipated, time permitting, that the model will be run for a time period of one year, with conditions selected to represent critical conditions within an annual cycle. It is estimated that the simulation (computer) run time for such a simulation for the extended grid will be approximately 2 days per run. At a minimum, the model will be run for selected monthly periods representing the seasonal conditions when beluga whales are present. Critical conditions are those that will result in the highest concentrations of effluent in Upper CI.

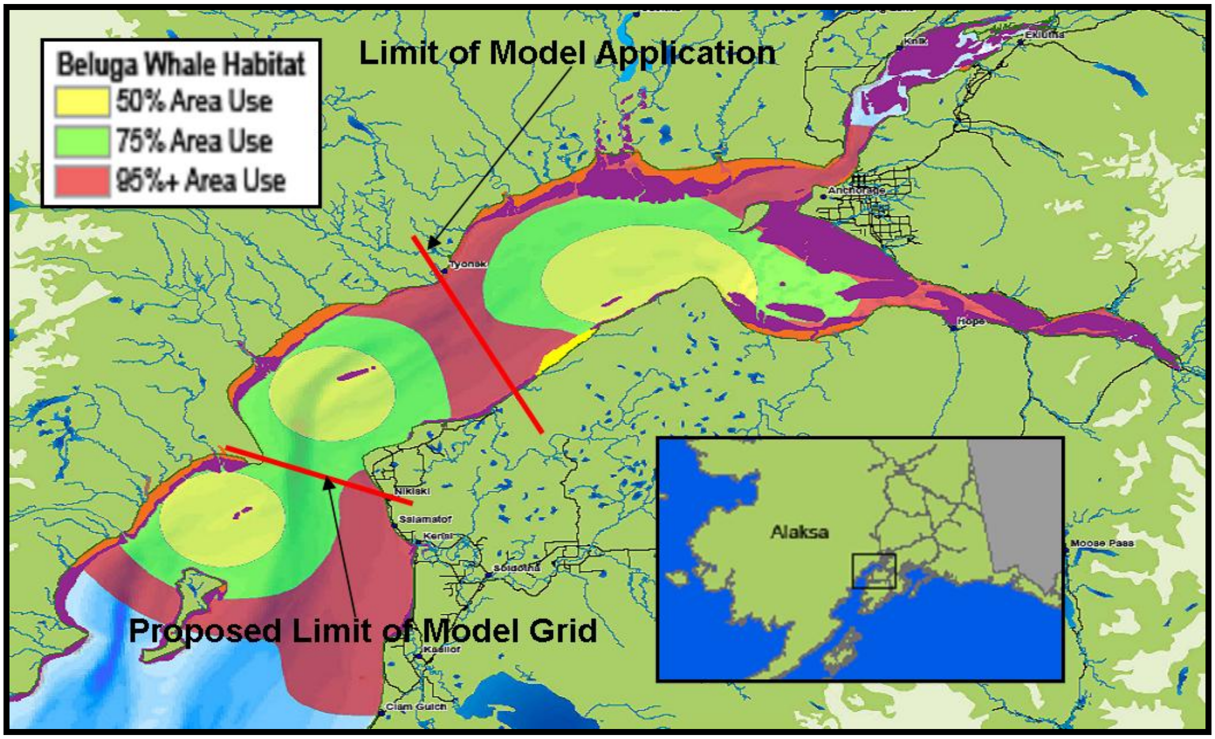

FIGURE E-2. EXAMPLE OF BELUGA WHALE HABITAT FOR MARCH (DEVELOPED FROM NMFS SATELLITE TAGGING DATA)

E.3 Model Boundaries and Input

The bathymetry and boundary inputs will be based on available data. These parameters are described in this section. The descriptions provided are preliminary and will be modified or adjusted as additional available data are identified and acquired.

E.3.1 Bathymetry and Datums

National Geophysical Data Center (NGDC)[3] bathymetry data will be used, where available. For the CI near Anchorage and the Knik Arm, the NGDC bathymetry surveys were generally conducted during the 1982-1995 period. The most recent data for each

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[3] (http://www.ngdc.noaa.gov/mgg/bathymetry/ relief.html)

overlapping area will be used to obtain the most recent representation of bathymetry available. With respect to Turnagain Arm and the upper part of Knik River, NGDC bathymetry are either not available or are out of date. Figure E-3 provides a representation of the digital terrain model (DTM) generated using the currently assembled bathymetric data for the preliminary model grid shown on Figure E-1.

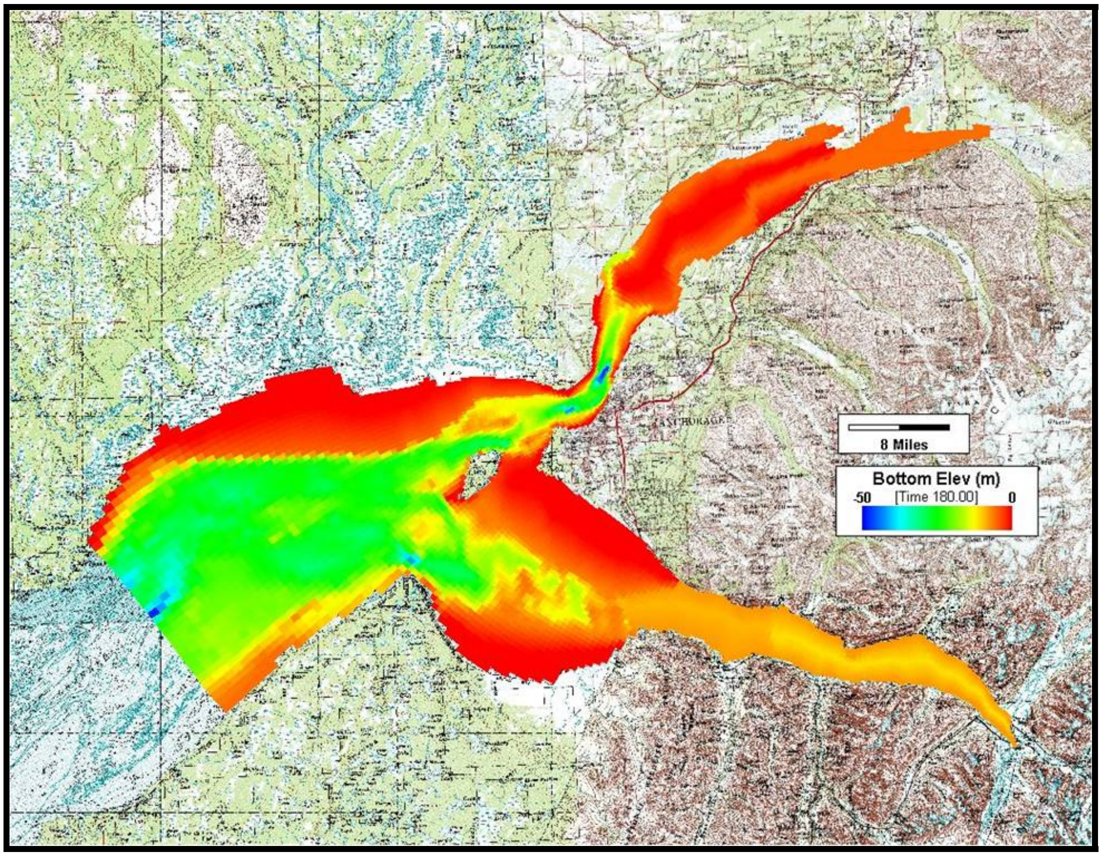

FIGURE E-3. MODEL BATHYMETRY USED FOR PRELIMINARY GRID

Figure E-4 shows boundaries of various NGDC surveys conducted in the study area. Each of the boundaries is colored with respect to the date of the survey. For example, the red polygons represent survey boundaries for the most recent date range of 1980 to 2004. These data will be used to extend the model grid as required

The vertical datum to be used for all water surface elevations and bathymetry will be based on the Mean Lower-Low Water (MLLW) as defined at the NOAA Station “Anchorage, Knik Arm, CI, AK“ (ID 9455920) or at the tidal station selected for the extended model grid application (see Section 3.2.1).

The horizontal datum is WGS84[4]/NAD83[5] and the grid system will be the Universal Transverse Mercator (UTM) Zone 5. The area of interest spans two UTM zones, but the grid system coordinates will all be relative to Zone 5.

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[4] World Geodetic System 1984 (dating from 1984; last revised in 2004)

[5] North American Datum 1983

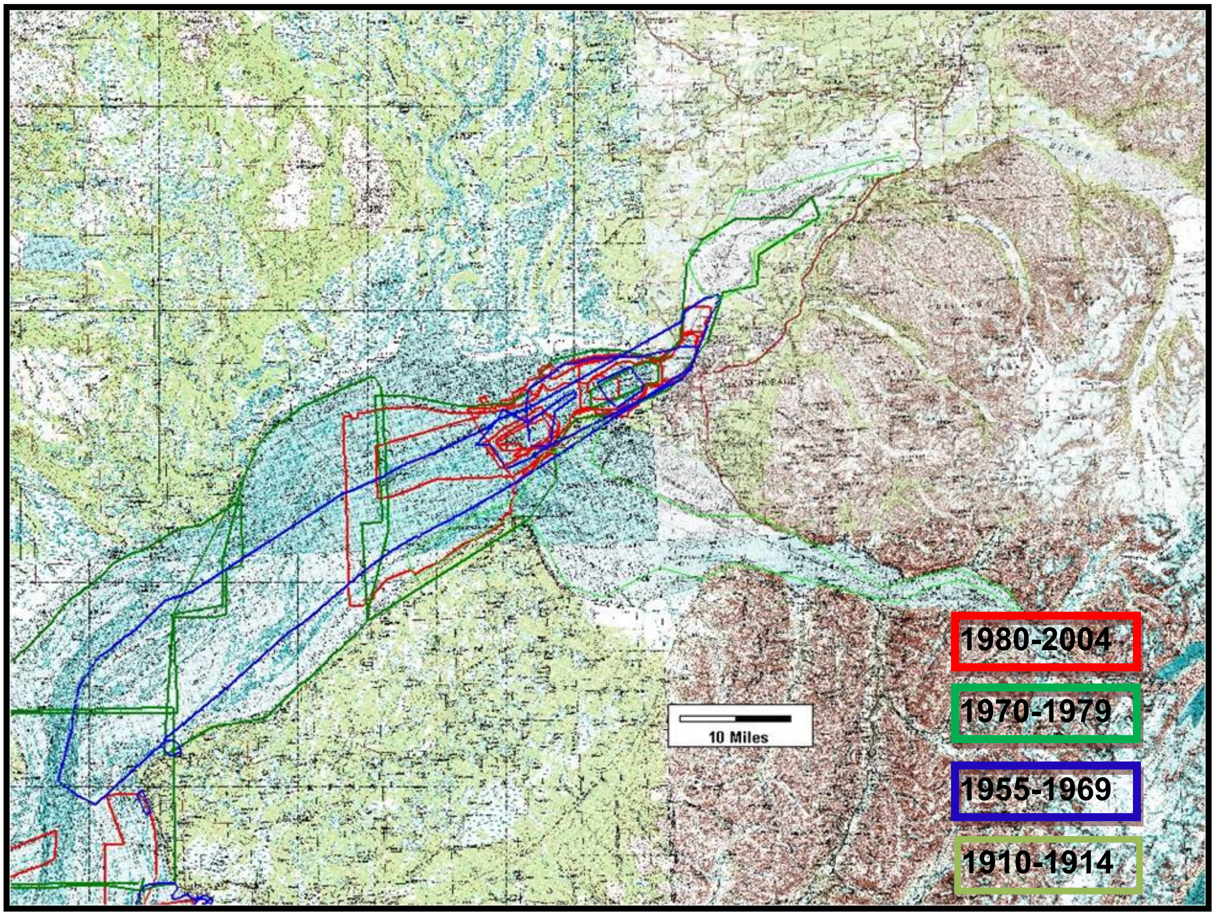

FIGURE E-4. NGDC BATHYMETRY DATA AVAILABLE FOR EXTENSION OF MODEL GRID

E.3.2 Boundary Conditions

Once the grid and bathymetry are determined, the boundary conditions will be assigned to the appropriate grid cells based on location and boundary condition type. The boundary types are:

- Ocean tidal forcing on south side (open boundary)
- Inflows of water from rivers along coastline
- Jet/plume for the AWWU discharge

Figure E-5 shows the EFDC model grid with the boundary condition locations identified and labeled by boundary group for the preliminary grid shown on Figure E-1. Additional boundary conditions will be included for the extended model grid, when developed, based on available data.

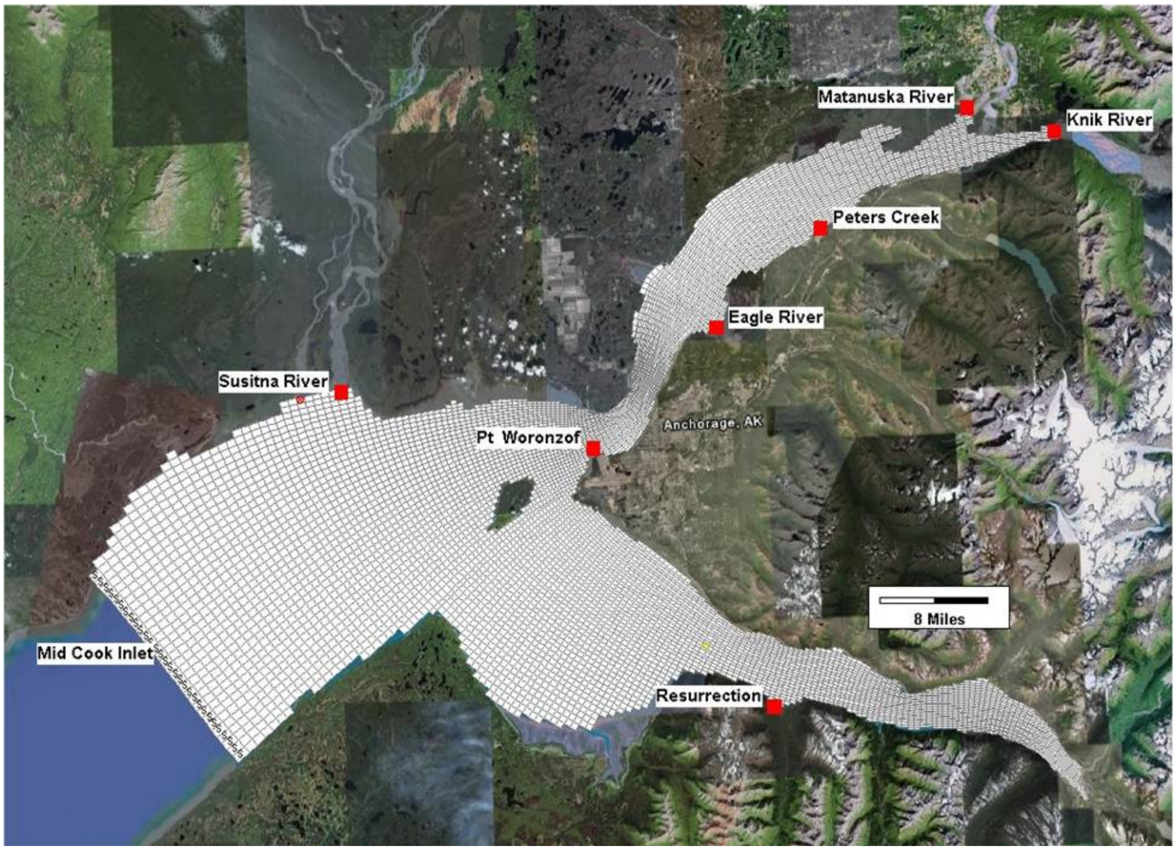

FIGURE E-5. BOUNDARY CONDITIONS FOR THE PRELIMINARY MODEL GRID

E.3.2.1 Open Boundary

For the preliminary model grid shown in Figure E-1 the open boundary would be set using data derived from the NOAA Anchorage tidal station (ID 9455920)[6]. For the proposed extended model grid, the open boundary will be set using the NOAA tidal station at Nikiski (Station ID 9455760)[7]

E.3.2.2 Flow Boundaries

There are a number of major rivers that flow into the CI. For some of these rivers the USGS has stations with flow data[8]. The data inventory of the available stations shown for the preliminary grid is listed in Table E-1. Any additional available data obtained will be used for the final model grid. Flows from other sources will be estimated based on watershed size relative to known sources, if necessary and appropriate.

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[6] (http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=9455920%20Anchorage,%20AK&type=Tide%20Data)

[7] (http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=9455760%20Nikiski,%20AK&type=Tide+Predictions)

[8] (http://waterdata.usgs.gov/ak/nwis/si)

Table E-1. Inventory Flow Available at Various USGS Stations for Major Rivers

USGS Station	Name	Beginning	Ending
15294350	Susitna R at Susitna Station AK	October 1, 1974	March 31, 1993
15267900	Resurrection C NR Hope	October 1, 1967	March 31, 1986
15277410	Peters C NR Birchwood	August 1, 1973	September 30, 1983
15284000	Matanuska R at Palmer AK	April 21, 1949	September 20, 2009
15281000	Knik R NR Palmer	October 1, 1959	September 30, 2008
15277100	Eagle R at Eagle River	October 1, 1965	June 30, 1981

E.3.2.3 AWWU Loading Input

The Asplund WPCF effluent discharge will be included using a modeled conservative tracer to enable visualization and analysis of the pollutant migration in the ambient flow field. EFDC has an internally-coupled Lagrangian plume sub-model as a boundary condition type. Its primary objective is to use momentum and density gradients to vertically distribute the effluent's mass vertically into the cell's layers. Preliminary testing using the AWWU discharge indicates that this approach should work as a viable coupling of the discharge plume into the farfield EFDC model. This method provides the most flexible and robust method of coupling the two, given the significant ambient flows and gradients.

The effluent flow rates will be based on the flow projected at the end of the anticipated renewal permit period. Based on the most recent Anchorage Wastewater Master Plan and the current renewal application, this corresponds to an annual average flow of 35 mgd in year 2016. Seasonal variations in flow will be accounted for by examining the last five years of monthly discharge monitoring reports and developing a monthly variation in average daily flows consistent with the annual average flow. The effluent flows to be used are described in detail in Attachment E2.

Effluent-derived sediment loading will be based on the total suspended sediment (TSS) load in the discharge. The currently permitted monthly average TSS concentration is considered overly conservative because the recent data indicates loadings well below the current permit limits. Therefore, TSS load will be based on a reasonable potential analysis of the monthly TSS concentrations over the last five years. The grain size (settling velocity) distribution will be the distribution recommend in the EPA Amended 301(h) Technical Support Document. The TSS concentrations and grain size distributions that will be used are described in detail in Attachment III.

E.3.2.4 Other Inputs

Wind and atmospheric data will be developed from the Anchorage airport meteorological station data. Water temperature and salinity data will be generated from available data sets and literature values for CI.

E.3.3 Nearfield Considerations

EFDC has a plume module that distributes the discharge loading throughout the water column based on plume rise characteristics. This is based on loading the effluent plume into the cell in which the discharge is located. It is recognized that the space and time scales, as well as the overall mixing processes, involved in initial dilution are typically different than those used in the farfield modeling. Therefore, details of nearfield plume distribution may not be adequately represented. There may be a small area around the boundary represented by the discharge that is not well-represented by the farfield model results. If this is found to be the case, the area affected will be determined and an initial dilution model will be used to provide more detailed nearfield effluent concentrations. If required, the nearfield model will be the same as used for previous Asplund WPCF permit renewal applications. The model inputs will be modified for the appropriate effluent flows as necessary.

E.4 Model Calibration and Execution

At a minimum, the model conditions will be adjusted to represent the full range of neap and spring tides for the critical seasonal condition. It is postulated that winter conditions represent the most critical to address. At this time, EFDC does not include a specific ice sub-model. Therefore, the proposed approach is to address the winter “ice” condition by turning off wind inputs for the area of the model expected to be frozen over. This will remove any wind-driven currents and/or mixing. This approach is considered adequate for the purposes of the BE. CI hydrodynamics for other seasons will be simulated if time permits.

E.4.1 Calibration

The model will be calibrated against measured data at representative locations within the domain. The primary data for calibration will be water level, temperature, and salinity at the Anchorage NOAA gage. The model calibration and validation will be done based on time periods with the best available data. Pollutant concentrations available from the AWWU effluent sampling will also be used if time permits. With respect to velocity and flow patterns, it is anticipated that the model will be calibrated to available current data only if time permits and appropriate existing data are identified. Calibration against previous drogue releases will be done, again if time permits, using the new EFDC particle tracking capability.

E.4.2 Sensitivity Analysis

To the extent practicable, the sensitivity of the discharge and transport simulation to a range of input parameters will be verified against existing data sets from Upper CI in comparison to measured data.

E.4.3 Scenario Simulations

Separate EFDC models will be configured for the identified critical condition to simulate the contaminant fate and transport. Additional model scenarios will be run if time permits. However, the critical condition alone is considered sufficient for the purposes of the BE. Factors to be evaluated during the BE include the tidal ranges, seasonal impacts, wind and wave actions, and critical combinations of these conditions. Pollutant mass fate and transport, as well as Lagrangian particle tracking, will be used to identify exposure concentrations and exposure times.

E.4.4 Sediment Transport

Transport of discharged sediments will be included in the model simulations (see Section 3.2.3). The deposition and accumulation of effluent-derived sediments will be predicted. At least four size fractions (settling velocity classes) will be included. It will not be possible to calibrate the sediment transport portion of the model because of insufficient available data. Sediment transport model calibration is difficult and generally does not provide substantial additional confidence in model predictions. The sediment transport routines in EFDC are based on sound physical and mathematical representations and are considered adequate for the screening level estimates required for the BE. If required, the sensitivity of the sediment accumulation predictions will be investigated. This would be necessary only in the case where the sediment-associated concentrations of POCs approach levels of concern (generally within an order of magnitude).

E.5 Presentation of the Results

Plan views, vertical profiles, and time series plots will be used to present the modeling results. Animations of appropriate illustrative and/or critical conditions will also be provided.

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Attachment E1
EFDC Description

ATTACHMENT E1

EFDC Description

Governing Physics of EFDC

The EFDC hydrodynamic model is a variable-density, unsteady-flow model that uses the Boussinesq approximation, hydrostatic pressure field, and internal solutions of vertical eddy viscosity and diffusivity. The EFDC model solves the vertically hydrostatic, free-surface, turbulent-averaged equations of motions for a variable density fluid.

Dynamically-coupled transport equations for turbulent kinetic energy, turbulent length scale, salinity, and temperature are solved. The two turbulence parameter transport equations implement the Mellor-Yamada level ‘2.5’ turbulence closure scheme (Mellor and Yamada, 1982; Galperin et al., 1988). The bottom stress formulation for friction, accounting for the rate of momentum loss at the sediment bed/water interface, is represented using a turbulent boundary layer formulation based on a quadratic function of near-bottom velocity. Water temperature is solved as an integral part of the hydrodynamic model, with heat transport simulated using the atmospheric heat exchange model developed by Rosati and Miyakoda (1988), in which solar radiation at the water surface is reduced as a function of depth in the water column.

The state equations and numerical solution methods used in the EFDC hydrodynamic model are given in Hamrick (1992; 1996), Blumberg and Mellor (1987), and Martin and McCutcheon (1999). The interested reader is referred to these sources since the equations of the model are not presented in this report.

E.7 Numerical Solution Schemes of EFDC

The spatial domain of a water body can be represented in EFDC using (a) Cartesian, or curvilinear orthogonal coordinates in the horizontal (x,y) domain; and (b) a stretched, or sigma, coordinate scheme in the vertical (z) domain. The numerical scheme used in EFDC to solve the equations of motion uses a second-order accurate, spatial finite difference scheme on a staggered or C grid. The model's time integration uses a second-order accurate, two time-level, finite difference scheme, with an internal/external mode splitting procedure to separate the internal shear from the external free surface gravity wave. The external mode solution is semi-implicit and simultaneously computes the two-dimensional surface elevation field by a preconditioned conjugate gradient procedure. The external solution is completed by the calculation of the depth-averaged velocities using the new surface elevation field. The model's semi-implicit external solution allows large time steps that are constrained only by the stability criteria of the explicit central difference or high-order upwind advection scheme (Smolarkiewicz and Margolin, 1993) used for the nonlinear accelerations.

Horizontal boundary conditions for the external mode solution include options for simultaneously specifying the surface elevation only, the characteristic of an incoming wave (Bennett and McIntosh, 1982), free radiation of an outgoing wave (Bennett, 1976; Blumberg and Kantha, 1985), or the normal volumetric flux on arbitrary portions of the boundary. The EFDC model's internal momentum equation solution, at the same time step as the external solution, is implicit with respect to vertical diffusion. The internal solution for the momentum equations is defined in terms of the vertical profile of shear stress and velocity shear. Time-splitting inherent in the two time-level scheme is controlled by periodic insertion of a second-order accurate two-time level trapezoidal step. In addition to the general 3D (x,y,z) spatial domain, the EFDC model can also be readily configured as a two-dimensional model in either the horizontal (2D: x,y) or vertical (2D: x,z) planes.

The EFDC model implements a second-order accurate in space and time, mass conservation fractional-step solution scheme for the Eulerian transport equations for salinity, temperature, suspended sediment, water quality constituents, and toxic contaminants. The transport equations are temporally integrated at the same time step or twice the time step of the momentum equation solution (Smolarkiewicz and Margolin, 1993). The advective step of the transport solution uses either the central difference scheme used in the Blumberg-Mellor (1987) model or a hierarchy of positive definite upwind difference schemes. The highest accuracy upwind scheme, second-order accurate in space and time, is based on a flux-corrected transport version of Smolarkiewicz's multidimensional positive definite advection transport algorithm (Smolarkiewicz and Clark, 1986; Smolarkiewicz and Grabowski, 1990), which is monotonic and minimizes numerical diffusion. The horizontal diffusion step, if required, is explicit in time, while the vertical diffusion step is implicit. Horizontal boundary conditions include time-variable material inflow concentrations, upwind outflow, and a damping relaxation specification of climatological boundary concentrations.

Enhancements to EFDC

The version of EFDC used for this project incorporates a number of enhancements to the base EPA EFDC code[9]. These enhancements have been made to assist model development and application. Key enhancements to the EFDC code include the following:

- Dynamic memory allocation allows the user to use the same executable code for applications to different water bodies. This eliminates the need to re-compile the EFDC code for different applications because of different maximum array sizes required to specify the computational grid domain and time series input data sets. Dynamic allocation also helps prevent inadvertent errors and provides better traceability for source code development.
- Lagrangian particle tracking, with particle inputs assuming neutrally buoyant/zero mass particles or fixed depth drogues.
- Wind-generated wave bed shear stress.

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[9] (www.epa.gov/ceampubl/swater/efdc/index.htm)

- Enhanced heat exchange options that use equilibrium temperatures for the water and atmospheric interface and spatially variable sediment bed temperatures.
- New output snapshot controls for targeting specific periods for high frequency output within the standard regular output frequency.
- Streamlining the code for quicker execution times.
- Customizing linkage of model results for the Windows-based EFDC_Explorer graphical pre- and post-processor.

State Variables and Computed Output Variables of EFDC

Hydrodynamic models simulate velocity and transport fields, elevation of the free water surface, and bottom stress. The EFDC state variables include stage height or free water surface elevation, salinity, water temperature, and velocity. A three-dimensional application of EFDC simulates velocity in three-dimensions (x,y,z) as the 'u' and 'v' horizontal (x,y) components and the 'w' vertical (z) component. Turbulent kinetic energy and turbulent macroscale length scale parameters are also included as state variables. Water density is computed as a function of water temperature and salinity. EFDC computes horizontal diffusivity as an output variable of the model from horizontal turbulent closure methods. EFDC also computes vertical eddy viscosity and vertical eddy diffusivity from vertical turbulence closure schemes as output variables of the model.

EFDC_Explorer Description

The availability and capabilities of pre- and post-processing tools are critical to cost-effective and successful setup, calibration, and application of an EFDC model. The EFDC_Explorer pre- and post processor is Windows-based graphical user interface (GUI) public-domain software designed to support model setup, Cartesian and curvilinear grid generation, testing, calibration, and data visualization, including plots and animation of model results (Craig, 2008). EFDC_Explorer currently supports the following EFDC applications:

- Hydrodynamics
- Density dependent flow state variables: i.e., salinity and temperature
- Sediment transport (including the latest SEDFlume implementation)
- Particle/drogue tracks
- Toxics
- Water quality with sediment diagenesis
- Tracers

EFDC_Explorer is currently being used by EPA, USGS, USACE, Oklahoma Department of Environmental Quality, Texas Commission on Environmental Quality, Southwest Florida Water Management District, St. Johns River Water Management District, Suwannee River Water Management District, and private consulting firms in the U.S. and other countries.

Attachment E2
Effluent Flow and TSS Loading for Model Application

Effluent Flow and TSS Loading for Model Application

PREPARED FOR:	AWWU
PREPARED BY:	CH2M HILL
DATE:	20 November 2009

The biological evaluation (BE) for the beluga whale in Upper CI requires hydrodynamic transport and dilution modeling of the Asplund water pollution control facility (WPCF) effluent discharge. Required inputs for the model(s) include effluent flow rate and suspended solids loading rate. This Technical Memorandum describes the proposed flow and total suspended sediment loadings to be used for the EFDC farfield transport model and nearfield initial dilution model (if required).

Modeling Horizon

The model simulations and predictions will be based on a time horizon consistent with the renewal of the Asplund WPCF National Pollutant Discharge Elimination System (NPDES) permit. It is anticipated that the renewal NPDES permit will be for a period of five years and will become effective sometime within the next two years. Effluent flow is expected to slowly increase over the permit period. Therefore, the projected flow for year 2016 was chosen as an appropriate time horizon for the critical flow condition likely to occur during the permit period.

Projected Effluent Flow

The 2006 Anchorage Wastewater Master Plan (WWMP) includes a projected annual average daily influent flow (AADF) for year 2016 of 33.8 mgd. It is reported that approximately 1.14 mgd is added to the influent flow during plant operations (Mark Spano, personnel communication, 12 November 2009). Based on these data, an AADF of 35 mgd is the proposed basis for the model input.

Seasonal Effluent Flow Variations

The WWMP indicates that seasonal variations of influent flow in the Anchorage area are expected, and may not be insignificant. The monthly discharge monitoring reports (DMRs) for 2004 through 2008 were examined to estimate the seasonal variations. The average monthly effluent flows (AMF) are shown in Table E2-1. The *relative* AMF compared to the AADF was determined for *each of these years* as shown in Table E2-2.

Based on the average of the relative AMF over the five year period of record, the 2016 projected AADF of 35 mgd was used to develop projected AMFs to account for seasonal effects. The results of the calculation are shown in Table E2-3. These AMF values are the flows that will be used in the transport and dilution modeling. Using average flows and loadings is considered to be the appropriate approach to simulate long-term effects on the beluga whale for this model application.

Table E2-1. Average Monthly Effluent Flow (AMF in mgd) at the Asplund WPCF

Month	2004	2005	2006	2007	2008
Jan	27.966	29.976	27.153	25.682	27.315
Feb	27.657	38.366	27.005	25.120	28.334
Mar	28.052	30.789	26.134	25.121	29.546
Apr	34.343	29.266	28.777	32.299	30.513
May	30.127	27.584	26.672	27.997	31.101
Jun	27.624	26.638	26.835	26.599	29.255
Jul	26.219	25.938	26.917	26.096	29.770
Aug	26.846	29.725	31.719	27.530	29.507
Sep	30.295	31.601	30.318	29.362	30.467
Oct	31.306	24.401	29.724	28.610	29.039
Nov	29.938	26.979	28.591	28.046	27.926
Dec	29.733	26.787	28.482	28.397	27.601
Average	29.176	29.0046	28.194	27.572	29.198

Table E2-2. Relative AMF Compared to Annual Average for each Year at the Asplund WPCF (Example: Jan 2004 AMF/2004 AADF = 27.966/29.176 = 0.96)

Month	2004	2005	2006	2007	2008	Average
Jan	0.96	1.03	0.96	0.93	0.94	0.96
Feb	0.95	1.32	0.96	0.91	0.97	1.02
Mar	0.96	1.06	0.93	0.91	1.01	0.97
Apr	1.18	1.01	1.02	1.17	1.05	1.08
May	1.03	0.95	0.95	1.02	1.07	1.00
Jun	0.95	0.92	0.95	0.96	1.00	0.96
Jul	0.90	0.89	0.95	0.95	1.02	0.94
Aug	0.92	1.02	1.13	1.00	1.01	1.02
Sep	1.04	1.09	1.08	1.06	1.04	1.06
Oct	1.07	0.84	1.05	1.04	0.99	1.00

Table E2-2. Relative AMF Compared to Annual Average for each Year at the Asplund WPCF (Example: Jan 2004 AMF/2004 AADF = 27.966/29.176 = 0.96)

Month	2004	2005	2006	2007	2008	Average
Nov	1.03	0.93	1.01	1.02	0.96	0.99
Dec	1.02	0.92	1.01	1.03	0.95	0.99

Table E2-3. Projected Monthly Average Effluent Flow (AMF in mgd) at the Asplund WPCF for Year 2016

Month	Relative Flow (from Table 2)	Projected Monthly Average Flow
Jan	0.96	33.755
Feb	1.02	35.770
Mar	0.97	34.111
Apr	1.08	37.963
May	1.00	35.072
Jun	0.96	33.486
Jul	0.94	32.996
Aug	1.02	35.554
Sep	1.06	37.182
Oct	1.00	35.006
Nov	0.99	34.608
Dec	0.99	34.497
AADF	1.00	35.000

Total Suspended Solids Loading

The current permit limitation for monthly average total suspended solids (TSS) is a maximum of 170 mg/l. However, the facility performance generally results in values far below that level, as recorded in the DMRs and shown in Table E2-4. Use of the current permit level for model input would be unrealistic. The maximum for each month over the period of record would be a more realistic approach (see Table E2-4), but may not adequately account for potentially higher future loadings.

Table E2-4. Monthly Average TSS Concentrations (mg/l) at the Asplund WPCF

Month	2004	2005	2006	2007	2008	2009	Maximum
Jan	45	55	52	50	52	50	55
Feb	48	45	50	54	50	53	54
Mar	49	58	54	53	49	58	58
Apr	50	58	55	56	51	60	60
May	49	56	55	62	54	63	63
Jun	49	55	59	66	55	60	66
Jul	50	58	54	65	53	55	65
Aug	50	51	56	62	56	59	62
Sep	51	57	54	59	50	48	59
Oct	51	54	53	57	47		57
Nov	49	51	54	53	47		54
Dec	50	53	54	48	46		54
Average	49	54	54	57	51	56	57

Two approaches were considered to develop a conservative yet realistic TSS loading:

1. Project loadings into the future.
2. Use a reasonable potential analysis to evaluate a maximum TSS concentration.

Plotting annual average TSS concentrations does *not* show good correlation over time (probability level of only about 35 percent). Projecting the TSS concentrations to year 2016 indicates a maximum annual average TSS of 61 mg/l (see Figure E-1). This is almost the same as that based on using the maximum average monthly concentrations shown in TableE2-4 (57 mg/l). A reasonable potential analysis was done for the data set in Table E2-4, on a *month-by-month* basis, using the following procedures and assumptions:

- The method used is that described in EPA's *Technical Support Document for Water Quality-based Toxics Control* (EPA/505/2-90-001, reprinted and corrected June 5, 1992).
- A 99% confidence level and 99% probability level were applied.
- EPA recommends a coefficient of variation (CV) of 0.6 for small data sets; however, the small variability in the observed data for TSS does not support this approach. Using this default CV predicts unrealistically high potential maximum TSS concentrations. Therefore, the actual CVs (0.06 to 0.10) were used. These CVs are consistent with, and justified by, the CV calculated for all monthly data for all years combined (0.09), representing 72 data points.

- October through December values for 2009 were taken as the average values for these months for 2004-2008.

The results are shown in Table E2-5, with the maximum monthly values from Table E2-4 included for comparison. The calculated monthly average TSS concentrations are higher than the current values, higher than the projected value mentioned above, reasonably conservative (realistic, but likely higher than actual), and will be used in transport and dilution modeling.

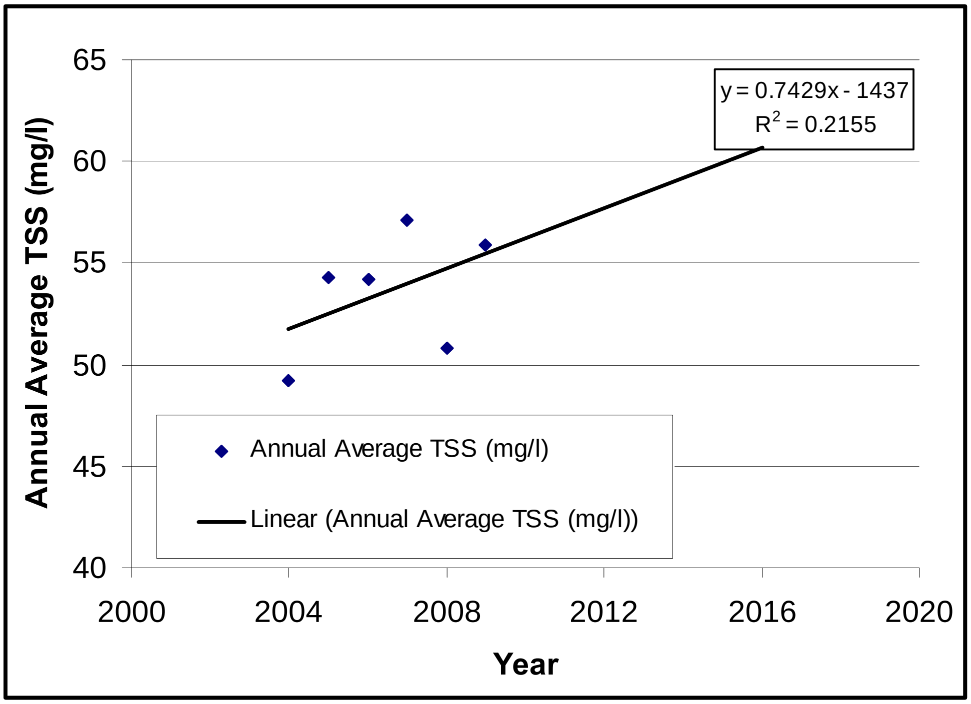


FIGURE E2-1. ANNUAL AVERAGE TSS AVERAGES FOR YEAR 2009 OCT-DEC VALUES ARE AVERAGES FROM 2004 THROUGH 2008.

Table E2-5. Projected Monthly Average TSS (mg/l) for the Asplund WPCF for Year 2016 based on a Reasonable Potential analysis

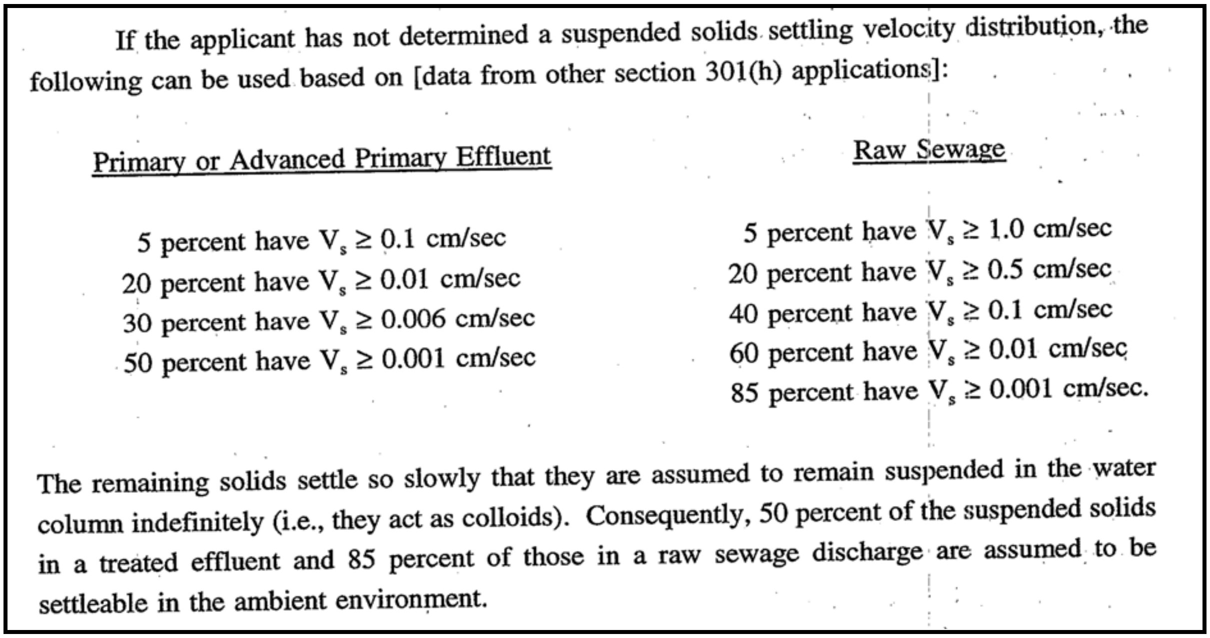
Month	Projected Monthly TSS for 2016	Maximum Observed Monthly TSS 2004-2009 (from Table E2-4)
Jan	64	55
Feb	63	54
Mar	70	58
Apr	71	60
May	79	63
Jun	84	66

Table E2-5. Projected Monthly Average TSS (mg/l) for the Asplund WPCF for Year 2016 based on a Reasonable Potential analysis

Month	Projected Monthly TSS for 2016	Maximum Observed Monthly TSS 2004-2009 (from Table E2-4)
Jul	81	65
Aug	76	62
Sep	72	59
Oct	68	57
Nov	62	54
Dec	63	54

Suspended Solids Settling Velocity

Model input requires specification of sediment settling velocity. There is no available information on the grain size or settling velocity distribution of the Asplund WPCF effluent TSS. Therefore, it is proposed to use the the nominal distribution for primary effluent provided in the EPA *Amended Section 301(h) Technical Support Document* (EPA 842-B-94-007, September 1994). This distribution is given in Appendix B-1 of the Technical Support Document (Page B-7) and is provided in Figure E2-2.



If the applicant has not determined a suspended solids settling velocity distribution, the following can be used based on [data from other section 301(h) applications]:

Primary or Advanced Primary Effluent	Raw Sewage
5 percent have $V_s \geq 0.1$ cm/sec	5 percent have $V_s \geq 1.0$ cm/sec
20 percent have $V_s \geq 0.01$ cm/sec	20 percent have $V_s \geq 0.5$ cm/sec
30 percent have $V_s \geq 0.006$ cm/sec	40 percent have $V_s \geq 0.1$ cm/sec
50 percent have $V_s \geq 0.001$ cm/sec	60 percent have $V_s \geq 0.01$ cm/sec
	85 percent have $V_s \geq 0.001$ cm/sec.

The remaining solids settle so slowly that they are assumed to remain suspended in the water column indefinitely (i.e., they act as colloids). Consequently, 50 percent of the suspended solids in a treated effluent and 85 percent of those in a raw sewage discharge are assumed to be settleable in the ambient environment.

FIGURE E2-2. DEFAULT EFFLUENT SUSPENDED SEDIMENT SETTLING VELOCITIES FROM EPA'S 301(H) TECHNICAL SUPPORT DOCUMENT

Five settling velocity classes can be derived from this distribution from simple linear interpolation:

- 50 percent never settles
- 20 percent settles at 0.0035 cm/sec
- 10 percent settles at 0.008 cm/sec
- 15 percent settles at 0.055 cm/sec
- 5 percent settles at 0.1 cm/sec

EPA Regions 2 and 9 have accepted this approach, and it is the approach proposed for the model application considered here.

Appendix F

Hydrodynamic Development and Calibration and Model Results

Hydrodynamic Model Development and Calibration and Model Results

Submitted to
U.S. Environmental Protection Agency, Region 10
Seattle, Washington

Submitted by
Anchorage Water and Wastewater Utility

Prepared by
CH2M HILL

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Attachment

Tables

Figures

Acronyms and Abbreviations

3D	three-dimensional
ADCP	acoustic Doppler current profiling
AWWU	Anchorage Water and Wastewater Utility
BC	boundary condition
BE	biological evaluation
CI	Cook Inlet
EFDC	Environmental Fluid Dynamics Code
EPA	U.S. Environmental Protection Agency Region 10
EPOC	emerging parameters of concern
mg/L	milligrams per liter
MLLW	Mean Lower-Low Water
NGDC	National Geophysical Data Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
POA	Port of Anchorage
POC	parameters of concern
ppt	parts per trillion
RelRMS	relative root mean squared
TSS	total suspended solid
TSS_{AWWU}	concentrations for the Asplund WPCF sediment classes
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WPCF	Water Pollution Control Facility

APPENDIX F

Hydrodynamic Model Results

F.1 Introduction

The U.S. Environmental Protection Agency Region 10 (EPA) is reviewing the Anchorage Water and Wastewater Utility (AWWU) application for renewal of the Asplund Water Pollution Control Facility (WPCF) National Pollutant Discharge Elimination System permit and associated 301(h) waiver from secondary treatment standards for 5-day biochemical oxygen demand and total suspended solids (TSS). As a part of its decision process, EPA must obtain federal agency certifications that its proposed action (permit reauthorization) will not adversely affect threatened or endangered species or their critical habitats in the area, as listed by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). This is required to conform to Section 7 of the Endangered Species Act.

A biological evaluation (BE) is a critical component of consultation among EPA, NMFS, and USFWS with respect to the Asplund WPCF 301(h) waiver. Developing the BE requires evaluating the fate and transport of effluent-derived constituents throughout the critical habitat of the Cook Inlet (CI) population of beluga whales. A numerical model was developed and used to assist with this element of the BE.

F.1.1 Purpose

Numerical modeling of the transport and distribution of effluent and effluent constituents from the Asplund WPCF is required to support an ecological risk assessment appropriate for the BE. A three-dimensional (3D) hydrodynamic and transport model was developed for the Upper CI. The model was used to predict mixing and transport of effluent-derived water column and sediment constituents. This Appendix presents the model development, calibration, and applications for the Upper CI AWWU BE model.

F.1.2 Background

EPA has tasked AWWU with drafting a BE for listed species to support EPA Section 7 consultations with NMFS and USFWS.[1] The BE will be submitted to EPA and used by the agency to help determine whether permit reauthorization is likely to affect the continued existence of species protected by the Endangered Species Act or to adversely modify their habitat.

Understanding the exposure of endangered species to regulated and unregulated constituents based on migration, residence, habitat requirements, and circulation (including nearfield plume dilution and farfield circulation) is critical to support an

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[1] Consultation letters from NMFS (25 June 2009) and USFWS (20 May 2009) to Lisa Olson/EPA indicate that the Cook Inlet population of beluga whales represents the only federally listed species to be included in this BE.

effective BE. Numerical modeling was used to quantify effluent-derived constituent concentrations in receiving waters and sediments.

Nearfield modeling has previously been conducted (CH2M HILL, 1998) for this discharge using the EPA UDKHDEN initial dilution model and subsequent dilution routines based on a passive diffusion analysis (the Brooks method), which was accepted by EPA. No additional nearfield modeling was conducted as part of this BE.

The Environmental Fluid Dynamics Code (EFDC) (Hamrick, 1996) model was selected as the most appropriate farfield model to address the mixing, fate, and transport of the parameters of concern (POC), based on experience with hydrodynamic models, plume modeling, CI, and the objectives of the BE. This model is in the public domain, has been widely applied in similar applications, is supported and endorsed by EPA for complex modeling to support environmental permitting, and has a graphical preprocessor and postprocessor (Craig, 2009) to assist in visualizing the model results.

The EFDC model is a general-purpose modeling package for simulating 3D flow, transport, and biogeochemical processes in surface water systems, including rivers, lakes, estuaries, reservoirs, wetlands, and near shore to continental shelf-scale coastal regions. The model was originally developed at the Virginia Institute of Marine Science for estuarine and coastal applications. In addition to hydrodynamic, salinity, and temperature transport simulation capabilities, EFDC includes sub-models to simulate sediment transport, eutrophication, and the transport and fate of toxic contaminants in the water and sediment bed.

EFDC is unique among advanced surface water models in using a single source code to interface hydrodynamics (Hamrick, 1992) with sediment transport (Tetra Tech, 2000), toxic chemicals (Tetra Tech, 1999), and eutrophication (Park et al., 1995) within a single source code (Hamrick, 1996). The code is widely used by federal agencies, including the U.S. Army Corps of Engineers, EPA, and the United States Geological Survey (USGS). Details of the physical and numerical basis of EFDC and an additional description of the model are provided in Attachment F1.

F.1.3 Approach

To investigate the physical processes, sediment dynamics, and POC concentrations in Upper CI, a 3D EFDC model was developed. The model quantifies the exposure of CI beluga whales and important prey species to effluent-derived constituents from the Asplund WPCF discharge. The model simulates the hydrodynamic and transport processes based on the following factors:

- Tidal forcing
- Density effects
- Open water and iced-over conditions
- An integrated near-field plume sub-model dynamically coupled to the farfield circulation model
- Wind-generated currents

- Inflow from major rivers
- Effluent loading from the Asplund WPCF

Because of the large number of potential POCs, the transport and distribution of whole effluent was simulated by using a dye-tracer as a surrogate. The concentrations of individual effluent constituents were determined based on the concentration of effluent at any point in space and time represented by the dye-tracer concentration and the known or assumed concentrations of individual constituents in the whole effluent.

The model simulations were conducted for the following three representative categories:

- Conservative substances (no degradation of the dye tracer)
- Slowly degrading substances (half life of the dye tracer = 150 days)
- Rapidly degrading substances (half life of the dye tracer = 7 days)

To address the effluent-derived constituents that are bound to effluent-derived suspended solids (those with high octanol-water coefficients), the transport, distribution, and settling of effluent-derived suspended solids were simulated. It was assumed that those constituents with high octanol-water coefficients ($>10^5$) would be directly associated with the suspended solids. Sediment grain size distribution and loadings were based on available data and known characteristics of typical wastewater effluent. Effluent-derived sediment accumulation was estimated based on modeled sedimentation rates.

F.1.4 Scope and Limitations

The farfield model was configured to trace the concentration of whole effluent, using the dye tracer, from the Asplund WPCF. The concentrations of specific constituents can be directly determined from the known or estimated effluent concentrations.

The farfield model was developed and calibrated using available data. No additional field data were collected. Existing data from the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service, the U.S. Army Corps of Engineers, and other available sources were assembled, analyzed, and, as appropriate, incorporated into the modeling process. The primary calibration was based on water level responses and NOAA velocity data. The intent of the model was to provide overall transport and average concentrations of whole effluent within the Upper CI. Detailed predictions of fine-scale temporal and spatial current patterns and associated fine-scale variations in effluent concentrations are not required for the purposes of the BE.

The model domain was configured to include the Class I critical habitat of the beluga whale.[2] The areal extent of the model domain was extended to the Forelands, which is considered to be far enough down CI to avoid significant tidal reflux of effluent back into the primary study area during a tidal excursion.

Representative model scenarios were considered. It is generally considered that winter ice cover conditions, with limited freshwater flows into the study area, represent the

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[2] Currently, there is no other designated critical habitat in the project area.

most critical period. To test this assumption, whole-year runs from end of winter to the next year’s end of winter were conducted.

F.1.5 Conceptual Model

The CI above the Forelands (see Section F.2 for a detailed description of the model domain) is designated as the Upper CI. This region includes those areas of CI between the Forelands and Anchorage, Alaska, and the two major CI branches, Knik Arm and Turnagain Arm. This region is characterized by large tidal ranges of more than 8 meters at Nikiski and 10 meters at the Port of Anchorage (POA). These large ranges result in a very energetic system with a significant amount of horizontal and vertical mixing. Dissolved-phase constituents are vertically well mixed. This is particularly true in the shallower areas of Knik and Turnagain Arms.

The high-energy environment has a significant impact on the sediment dynamics in the Upper CI. Large-scale scour/deposition, bedload transport, and suspended load transport result in significant bathymetric changes year-to-year and, at times, even month-to-month. The origin of the sediments is largely glacial flour, which is delivered to the system by several rivers and streams. These sediments are transported within the Upper CI by current patterns driven by fresh water inflows, tides, and winds. The strong currents keep the main channel relatively clear from deposition. However, the tidal flats, large scale eddy zones, and edges of the channels experience periodic and often transient deposition and scour. Sediment transport processes can result in up to 10 meters of bed elevation change in relatively short time periods. The upper fringes of the tidal flats experience the least amount of energy and are, therefore, the main depositional areas within the Upper CI.

Within a tidal cycle, strong currents can resuspend sediments, subsequently depositing the same material as the tides approach slack tide. This process, along with the variation in bathymetry, results in significant lateral and temporal variation in sediment concentrations in the water column. There are significant vertical gradients of suspended sediments depending on the strength of the flows.

F.2 Model Domain

The primary objective of the modeling was to assess the distribution of Asplund WPCF discharge within the Class 1 critical habitat area (Figure F-1). Therefore, the model domain was developed primarily from beluga whale migration patterns. Available data and previous modeling studies were also considered. As mentioned above, the southernmost limit of the model grid near the Forelands, as shown on Figure F-1, was located to provide ample coverage for the habitat in the vicinity of the Asplund WPCF discharge with sufficient down-inlet coverage to avoid significant tidal reflux effects in the vicinity of the discharge and the Class I critical habitat area.

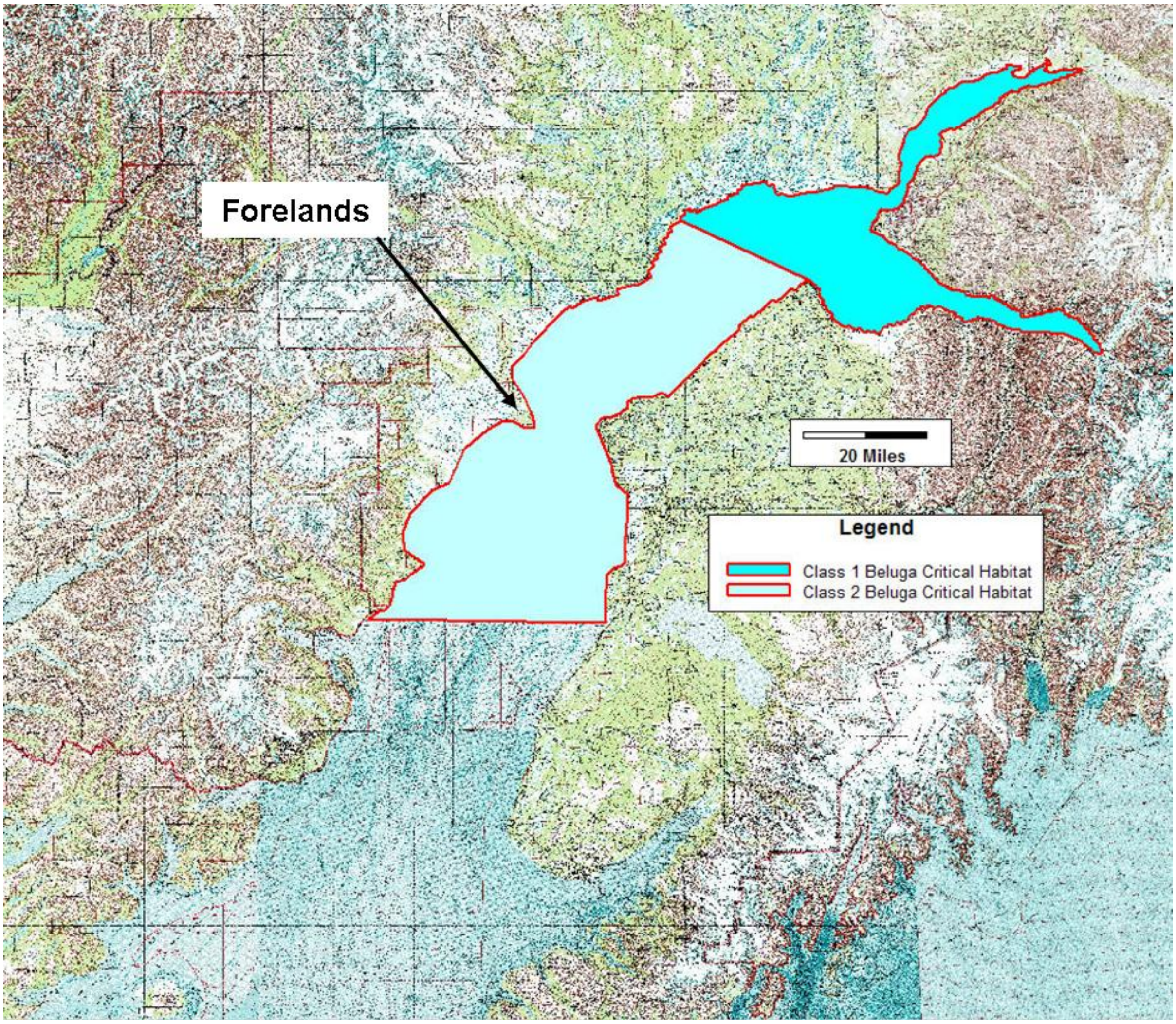

FIGURE F-1. CLASS 1 AND CLASS II CRITICAL HABITAT FOR COOK INLET BELUGA WHALES

A curvilinear orthogonal EFDC grid was constructed covering the model domain area, as shown on Figure F-2. This configuration has 9,321 horizontal computational cells with four sigma stretch depth layers[3] for a total of 37,284 computational cells. The average orthogonal deviation was approximately 0.4 degree, well below the acceptable upper limit of 3 degrees. The typical grid size is about 160 meters by 160 meters in the Knik Arm around the Asplund WPCF outfall diffuser and a maximum of 1,200 meters by 3,000 meters near the open boundary. Figure F-3 shows a detailed view of the grid, bathymetry in the area around the diffuser, and the currently established regulatory zone of initial dilution.

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[3] The model has four depth layers that maintain the same **relative** vertical dimensions as the total water depth changes; the layers stretch and compress to conform to the bottom elevation changes.

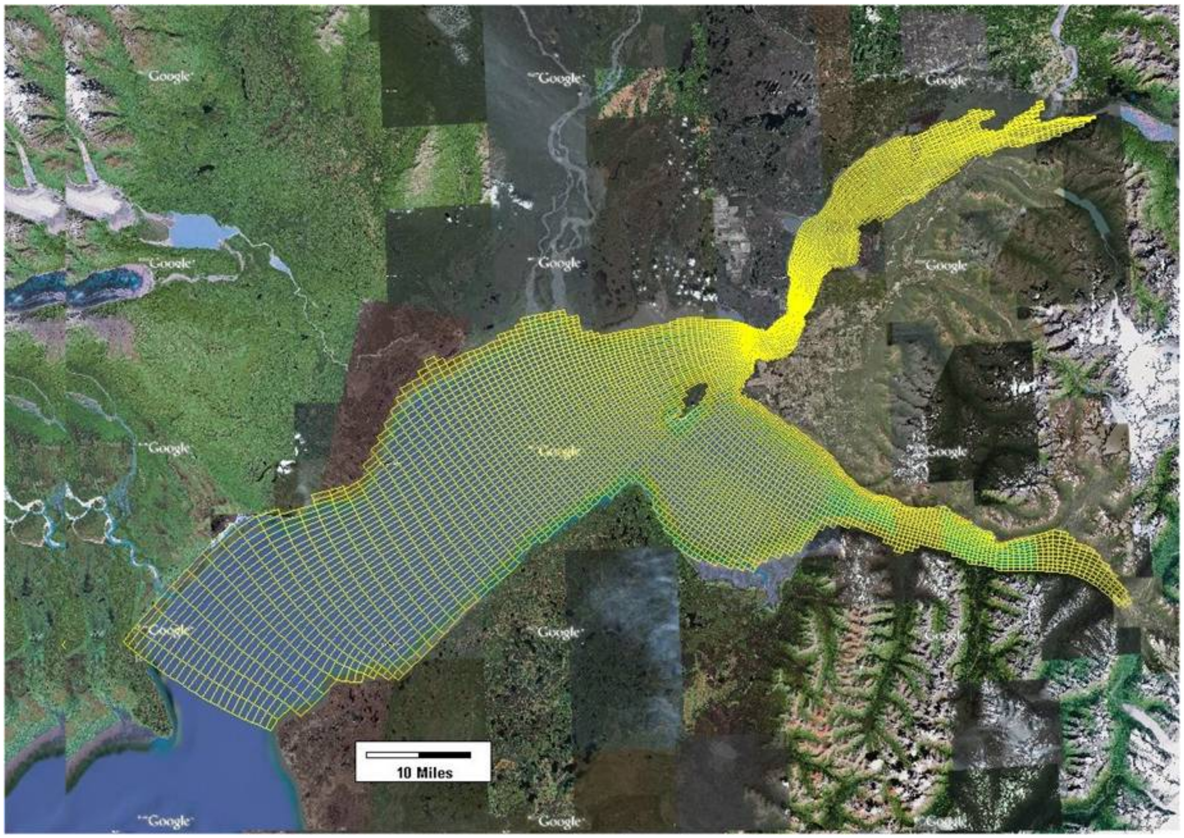

FIGURE F-2. UPPER COOK INLET EFDC MODEL GRID

F.3 Model Boundaries and Input

The bathymetry and boundary inputs were based on available data. These parameters are described in this section.

F.3.1 Datums

The vertical datum used for all water surface elevations and bathymetry was the Mean Lower-Low Water (MLLW), as defined at the NOAA Station “Anchorage, Knik Arm, CI, Alaska” (ID 9455920) at the POA.

The horizontal datum was WGS84[4]/NAD83[5], and the grid system is the Universal Transverse Mercator Zone 5. The area of interest spans two Universal Transverse Mercator zones, but the grid system coordinates were computed relative to Zone 5.

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[4] World Geodetic System 1984 (dating from 1984; last revised in 2004).

[5] North American Datum 1983.

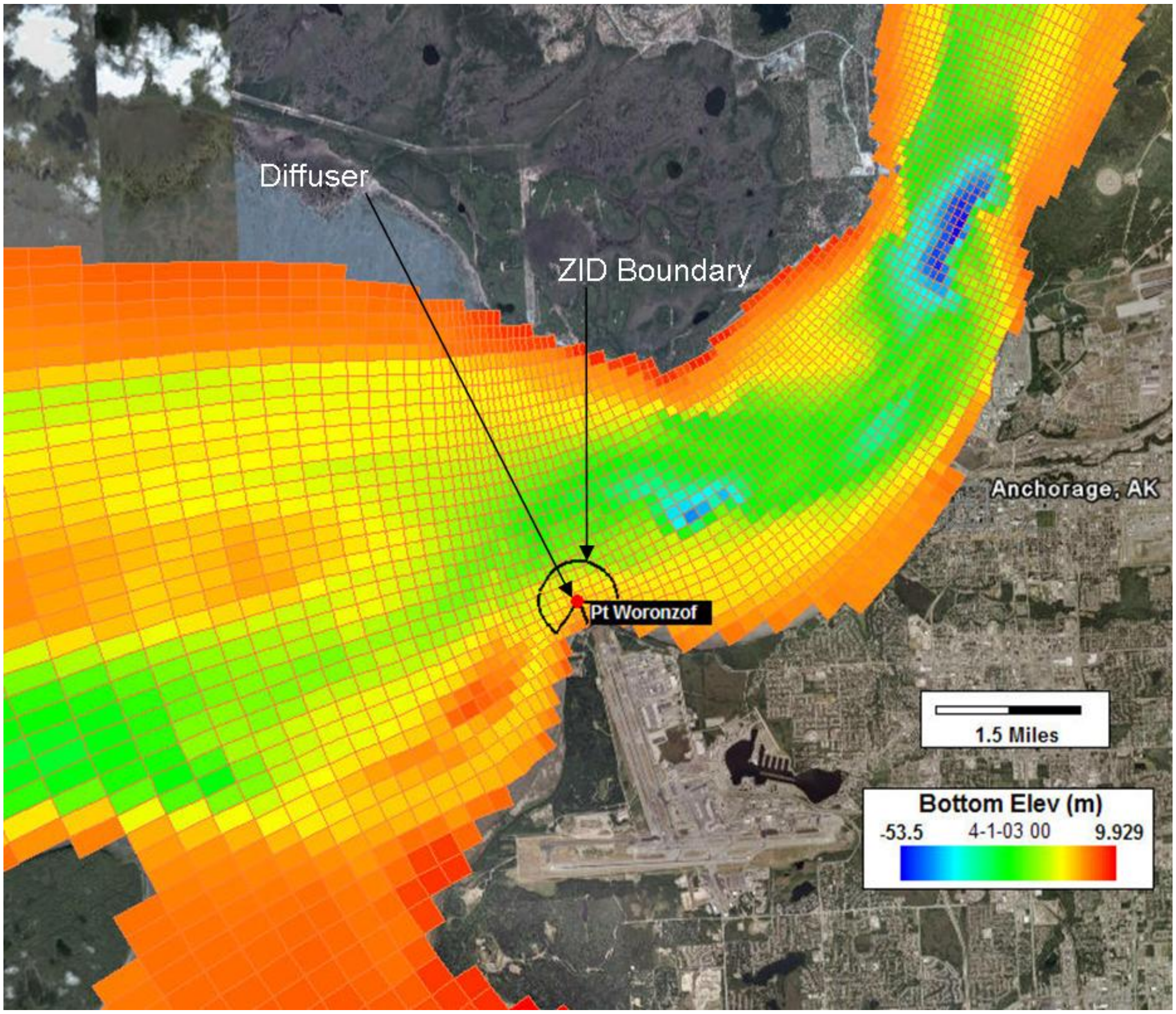

FIGURE F-3. EFDC GRID AND BATHYMETRY IN THE AREA AROUND THE ASPLUND WPCF DIFFUSER

F.3.2 Bathymetry

National Geophysical Data Center (NGDC)[6] bathymetric data were used as the primary data source. For the CI near Anchorage and the Knik Arm, the NGDC bathymetry surveys were generally conducted during the 1982 through 2004 period. The most recent data for each overlapping area were used to obtain the most recent representation of bathymetry available. NGDC bathymetric data are either not available or are out of date for Turnagain Arm and the upper part of Knik River. Bathymetry for these areas was interpolated from NOAA maps. The bathymetry from these sources was updated with data from the recently surveyed Knik Arm Bridge area and Turnagain Arm mud flat area.

Figure F-4 shows the bathymetric data for the vicinity of the Asplund WPCF discharge, which was surveyed by NOAA and the KABATA Knik Arm Bridge Project during 2003

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[6] (http://www.ngdc.noaa.gov/mgg/bathymetry/ relief.html).

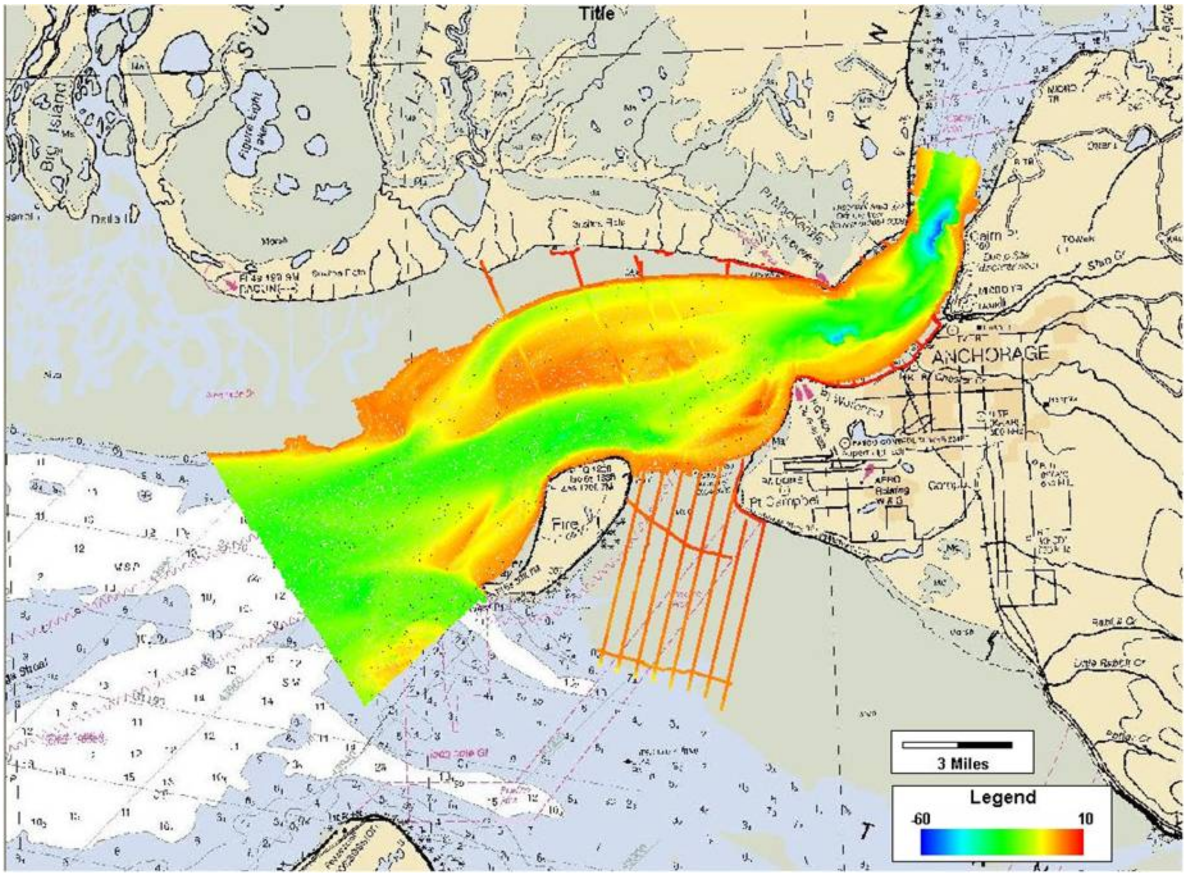

FIGURE F-4. 2003-2004 SURVEYED BATHYMETRY NEAR AWWU

through 2005. It is noted that prior to these data being incorporated into the final version of the Upper CI EFDC model, older bathymetry had been used for preliminary modeling. Preliminary dye tracer modeling results using the older bathymetric data were different than the final model dye tracer results. Using the older bathymetric data, the effluent was transported into Turnagain Arm much more than when using the final model bathymetry incorporating the more recent data bathymetric data. Figure F-5 represents the digital terrain model generated using the currently assembled bathymetric data for the model grid shown on Figure F-1.

A review of the historical bathymetric data in Knik Arm from the KABATA Report (HDR, 2007) indicates that bathymetry in the Knik Arm channel region is variable and can experience changes of as much as 7.5 meters within a decade. The latest available data were used for the model development; however, the highly changeable bathymetric conditions may limit the model in its representation of local flows at small scales in some locations. For the purposes of the BE, targeted at providing typical overall conditions in the study area, the small scale variability in flows is not considered a significant effect.

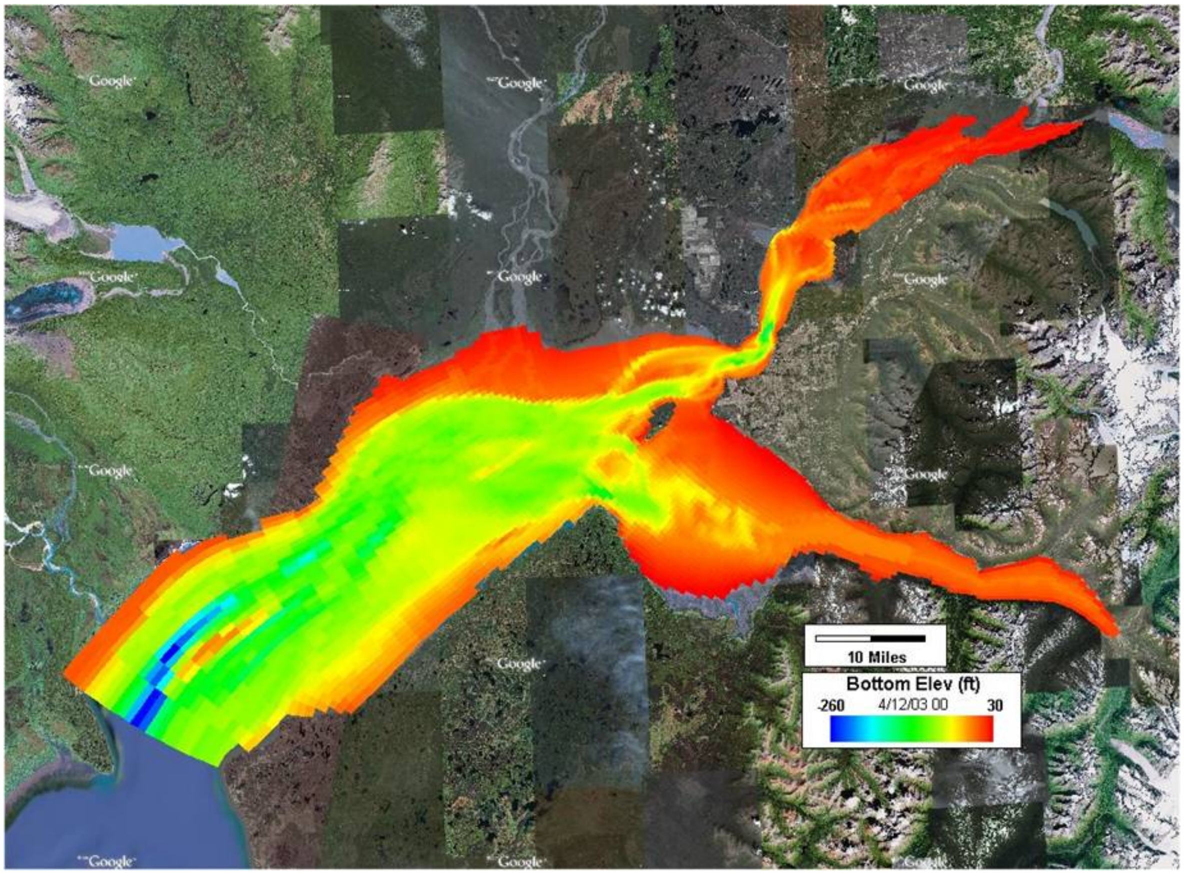

FIGURE F-5. FINAL EFDC MODEL BATHYMETRY

F.3.3 Suspended Solids

For the purposes of this BE, the loading of suspended solids into the Upper CI can be grouped into two major categories: natural sediments from rivers flowing into the Upper CI and suspended solids discharged from the Asplund WPCF diffuser. There are no data available for grain size or settling velocities for the Asplund WPCF effluent. Therefore, the Asplund WPCF effluent TSS grain size distribution was approximated based on the EPA 301(h) guidance document.[7]

Information on sedimentation in Upper CI and Turnagain Arm is very limited. After a review of the KABATA report (KABATA, 2006), it was decided to use the Knik Arm TSS data for the model. Eight sediment classes were used in the model, two non-settling classes, and six settleable solids classes. These classes were treated as non-cohesive sediment classes within EFDC. Typical values for settling and scour parameters based on Van Rijn's (1984) approach were applied. No available data exist to perform additional calibration for sediment transport. Model simulations based on the available data and generalized for the sedimentation parameters are considered to be sufficient and appropriate for the purposes of this BE.

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[7] Amended Section 301(h) Technical Support Document. EPA 842-B-94-007. United States Environmental Protection Agency, Office of Water. September 1994.

Unique sediment classes were used to distinguish between effluent-derived sediments and natural sediments. This enabled evaluating percent contributions from effluent-derived sediments compared to natural sediments during post-processing of model results.

The following sediment classes were used:

- Non-Settleable Sediment Classes
  - Class 1 – AWWU: 50 percent of Asplund TSS loadings
  - Class 2 – NATURAL: 10 percent of freshwater TSS loadings
- Settleable Sediment Classes
  - Class 1 – AWWU: 30 percent of Asplund TSS loadings, particle size 9 microns
  - Class 2 – Natural: 30 percent of freshwater TSS loadings, particle size 25 microns
  - Class 3 – AWWU: 20 percent of Asplund TSS loadings, particle size 30 microns
  - Class 4 – Natural: 20 percent of freshwater TSS loadings, particle size 60 microns
  - Class 5 – Natural: 20 percent of freshwater TSS loadings, particle size 125 microns
  - Class 6 – Natural: 20 percent of freshwater TSS loadings, particle size 250 microns

Separating the sediments into these classes allowed the separate analysis of each size class and provided a method of estimating the Asplund WPCF contribution to both the water column TSS and the bottom sediment deposition. Because of complexity and the lack of data, bedload transport and initial bed conditions were not considered. The approach used provides an estimate of the fraction of effluent-derived sediments in total sediment deposition and is sufficient for the purposes of this BE.

F.3.4 Boundary Conditions

Boundary conditions (BC) were assigned to the appropriate grid cells based on location and BC type. The boundary types are:

- Ocean tidal forcing on south side (open boundary)
- Freshwater inflows of water from rivers along coastline
- Jet/plume for the AWWU discharge

Figure F-6 shows the EFDC model grid with the BC locations identified and labeled by boundary group.

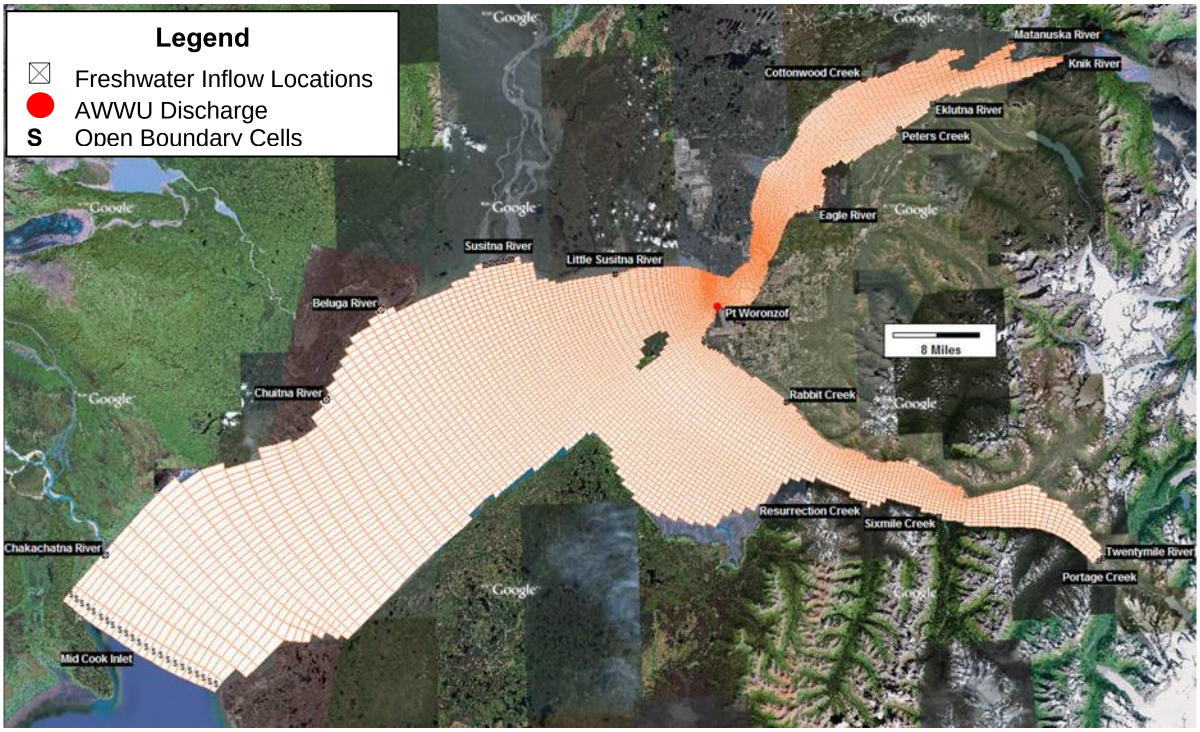

FIGURE F-6. EFDC BOUNDARY CONDITION LOCATION MAP

F.3.4.1 Open Boundary

For the model grid shown on Figure F-1, the open boundary was set using data derived from the NOAA Nikiski tidal station (ID 9455760). The time series of water surface elevations applied at the open boundary is shown in Attachment F2.

F.3.4.2 Flow Boundaries

A number of major rivers flow into the Upper CI. USGS flow data are available for some of these rivers.[8] The data from the available stations for the corresponding flow boundaries are listed in Table F-1. Non-gauged inflows into Upper CI were estimated based on watershed size and time-variable areal unit flow rates from comparable gauged streams (data are provided in Attachment F2).

Water Temperature

There are only two stations in Upper CI (the POA and Nikiski) for which recorded water temperature is available. The water temperature at Nikiski was used for the open tidal forcing boundary, while the temperature at POA station was used for calibration. The data were filtered, and obviously bad data were removed.

There is very little available information on water temperature of the rivers flowing into the model domain. Therefore, the water temperature of Kenai River (USGS 15258000) was used for all flow boundaries in the model.

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[8] (http://waterdata.usgs.gov/ak/nwis/si).

Table F-1. List of United States Geological Survey Flow Stations

Flow BC Name	USGS Station	Station Name	Data Date	Drainage Area (sq km)
Resurrection C	15267900	Resurrection C near Hope	1983	149
Sixmile C	15271000	Sixmile C near Hope	2003	234
Portage C	15272280	Portage C at Portage Lake Outlet near Whittier	2003	41
Twentymile R	15272380	Twentymile R near Portage	2003	141
Rabbit C	15273045	Rabbit C at Old Seward Hwy near Anchorage	2007	13
Eagle R	15277100	Eagle R at Eagle	1978	192
Peters C	15277410	Peters C near Birchwood	1980	88
Eklutna R	15280200	Eklutna R at Old Glenn Hwy at Eklutna	2003	172
Knik R	15281000	Knik R near Palmer	2003	1,180
Matanuska R	15284000	Matanuska R at Palmer	2003	2,070
Susitna R	15294350	Susitna R at Susitna Station	1990	19,400
Cottonwood	15286000	Cottonwood C near Wasilla	1996	74
Chuitna R	15294450	Chuitna R near Tyonek	1983	131

Salinity

The salinity was measured in an oceanographic transect across the Forelands in spring and fall 2002 (Okkonen, 2003). The salinity varied between 22 to 25 parts per trillion (ppt). Therefore, a value of 24 ppt was specified at the open boundary during the model simulation period. The water flowing from all rivers was considered as fresh (zero salinity) for model simulations.

Solids

TSS data at some USGS stations on several rivers are available, as listed in Table F-2; the number of samples and the period they were taken are also indicated. The model requires time-series input data. A regression relation between TSS and flow as a power function was constructed to generate the TSS required time-series. However, application of regression equations is limited to the normal flow condition in the range of reported samples. For the extremely high flow condition in the Susitna River, the resulting TSS series was reduced to a reasonable range during model runs. For the rivers without TSS data, equations from similar scouring or non scouring rivers were used. The TSS time series were then divided into one non-settling class and four non-cohesive sediment classes as described above.

Table F-2. Summary of Flow versus Total Suspended Solid Concentration Regressions

Station Name	USGS ID	Data Period		N	Equation	R^2
		From	To			
Resurrection C near Hope	15267900	25/Jun/68	13/May/71	16	$1.7018Q^{0.6768}$	0.4217
Eagle R at Eagle River	15277100	13/Sep/66	21/Jun/71	33	$5.154Q^{0.8603}$	0.7632
Peters C near Birchwood	15277410	19/Nov/80	6/Oct/81	9	$1.6642Q^{1.0785}$	0.6065
Knik R near Palmer	15281000	19/Jul/53	26/Jul/65	78	$3.8933Q^{0.8425}$	0.6628
Matanuska R at Palmer AK	15284000	11/Jun/52	21/Aug/07	305	$2.8782Q^{1.1343}$	0.6174
Susitna R at Susitna Station	15294350	15/Oct/52	28/Aug/85	105	$0.0069Q^{1.705}$	0.7410
Rabbit C at Old Seward Hwy	15273045	31/Jul/84	28/Mar/85	19	$6.8581Q^{0.4384}$	0.3727
Eklutna R	15277600	21/Jun/85	27/Aug/87	35	$4.4172Q^{1.2318}$	0.8187

N = number of samples

Asplund WPCF Discharge

The coupling of the nearfield diffuser release to the farfield model was accomplished using the EFDC jet/plume boundary type. This method incorporates nearfield plume dynamics to vertically spread the effluent into the water column within the cell in which the discharge is located. Once distributed using this computational approach, EFDC then applies the standard advection/diffusion approach to simulate subsequent farfield transport.

The discharge from the Asplund WPCF was set to a constant 35 million gallons per day for all of the computational periods. This reflects the expected monthly average discharge described in the 301(h) permit application. Monthly TSS concentration data for the Asplund WPCF (Attachment F2) were divided into three classes, as described above. The ratio of the TSS mass loading rate from the Asplund WPCF to total natural sources was about 1:50,000 (Table F-3) during the 1-year simulation. The effluent-derived sediment is about 0.002 percent of the natural suspended sediment load

As described above, for the dissolved phase constituents, a dye tracer with concentration of 1.0 milligram per liter (mg/L) in the effluent was used. Typically, the monthly temperature of released water was much warmer than the ambient water, resulting in an effluent concentration distributed throughout the entire water column in the discharge cell.

Table F-3. TSS Mass Loading from April 1, 2003, to March 31, 2004

TSS Loading Sources	Mass Loading (Million Tons)
Natural TSS	
Matanuska R	492,000
Knik R	575,000
Eklutna R	31.2
Peters C	259
Eagle R	4,170
Rabbit C	6.2
Resurrection C	162
Sixmile C	532
Portage C	571
Twentymile R	1,010
Little Susitna R	103
Beluga R	863,000
Chuitna R	1,070
Chakachatna R	2,350
Susitna R	7,930,000
Total	9,870,000
AWWU	
Asplund WPCF	197
AWWU/Natural Loading Ratio	*1:50,102*

F.3.4.3 Meteorological/Atmospheric Data

Wind and atmospheric data from the Anchorage airport meteorological station data (WBAN 26451) were used for model input. Figure F-7 provides a wind rose for the model simulation period of April 1, 2003, through March 31, 2004. Annual wind stick plots are provided in Attachment F3.

The surface wind shear, and thus wind-induced currents and mixing, was turned off during the winter period (29 December to 22 March) to account for ice effects on the system. Air temperature, atmospheric pressure, and humidity were from the same source used in the model. Solar radiation was estimated from theoretical levels using latitude/longitude and typical cloud cover observations.

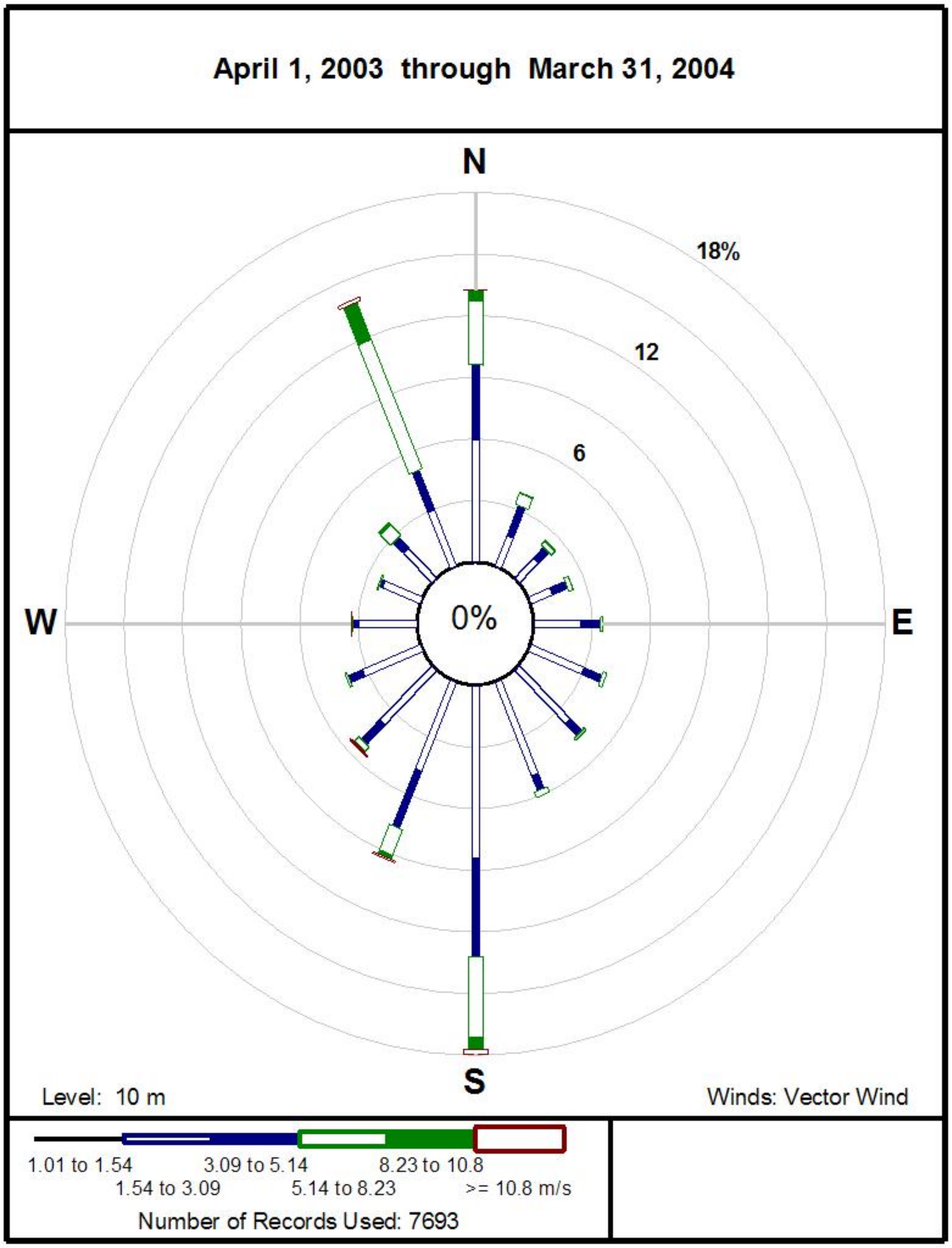

FIGURE F-7. WIND ROSE OF THE ANCHORAGE AIRPORT METEOROLOGICAL DATA: APRIL 2003 TO MARCH 2004

F.4 Model Calibration

The EFDC model was calibrated for the 2003 to 2004 period. This period was chosen for the overlap of calibration data sets, primarily the NOAA velocity data. The model was calibrated against measured data at representative locations within the domain. The primary data for calibration consisted of water levels recorded at the POA NOAA gauge, current velocities from five acoustic Doppler current profiling (ADCP) current meter stations, and temperatures from the POA.

F.4.1 Tidal Levels

Water level was calibrated using the Anchorage NOAA data station (ID 9455920) data. During calibration, the tidal series of Nikiski at the open boundary was adjusted by 1.239 meters in level and 45 minutes in time to obtain the best comparison of both water level and velocity. The need for such an adjustment is not uncommon to this type of modeling and, in this case, was primarily required to adjust the tidal amplitudes at Nikiski to the MLLW datum at Anchorage and to obtain the best fit of calibration results in the study area. It is noted that water level and velocity were calibrated simultaneously to avoid conflicting effects.

Figure F-8 shows the comparison of water level between the model calculations and the data at the Anchorage NOAA station. The calibration results are very good, with water levels at the POA accurately simulated by the model both in phase and amplitude.

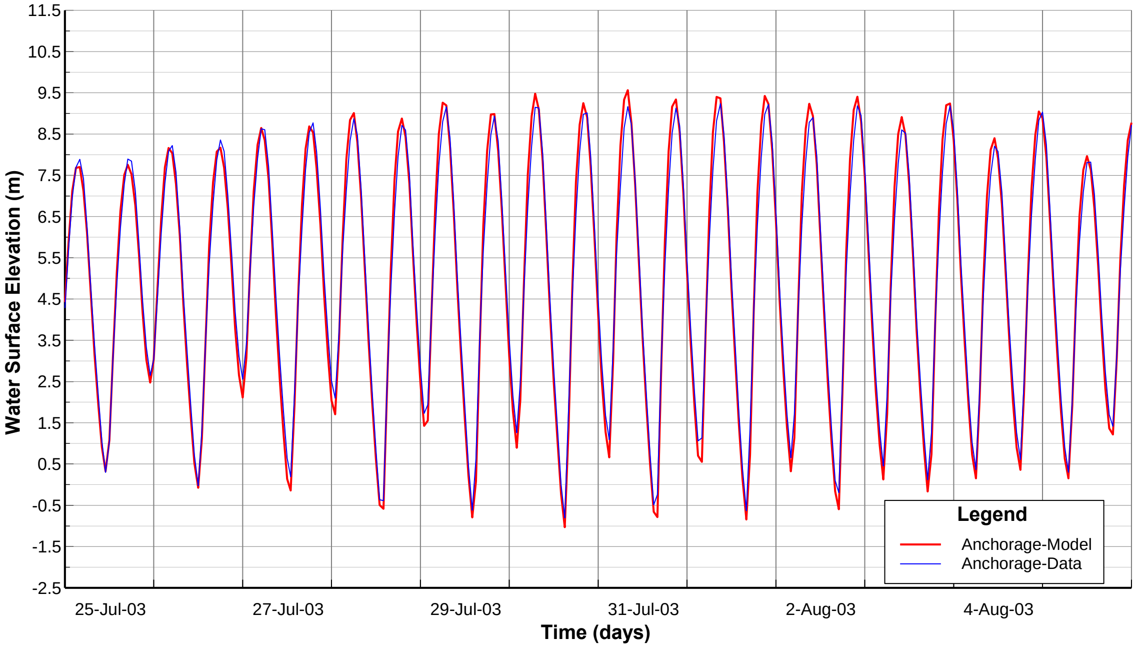

FIGURE F-8. MODEL PREDICTION VERSUS OBSERVED TIDAL DATA AT PORT OF ANCHORAGE

F.4.2 Velocity

ADCP velocity data from five NOAA stations (Table F-4) were used for calibration. The data were downloaded from http://tidesandcurrents.noaa.gov. The ADCP East and North velocity components were depth-averaged for comparison to the EFDC-computed depth-averaged velocities.

Table F-4. List of NOAA ADCP Stations Used for Velocity Calibration

Station Name	Station ID	Latitude	Longitude
Beluga Shoal	COI0307	61° 6.082' N	150° 33.693' W
Fire Island	COI0306	61° 9.651' N	150° 33.895' W
Knik Arm, NW of POA	COI0301	61° 16.693' N	149° 53.671' W
Knik Arm, East Side	COI0302	61° 16.478' N	149° 52.933' W
Port Mackenzie	COI0303	61° 15.135' N	149° 55.240' W

Figures F-9 and F-10 provide plan views of the velocity pattern during a typical tidal cycle for ebb and flood conditions. The black vectors display the model results (only every sixteenth vector was plotted to prevent overcrowding), and the red vectors are the corresponding NOAA ADCP-measured velocities for that same time in the tidal cycle indicated in the inset in the lower left corner of the figure.

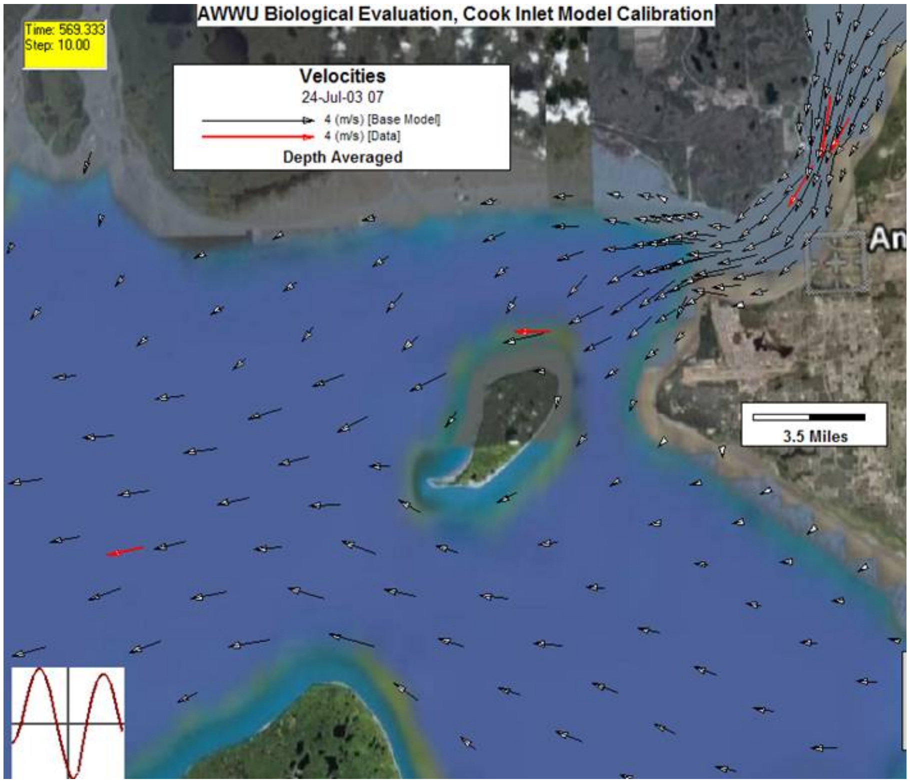

FIGURE F-9. 2D PLAN VIEW OF VELOCITY COMPARISONS WITH NOAA ADCP: EBB TIDE

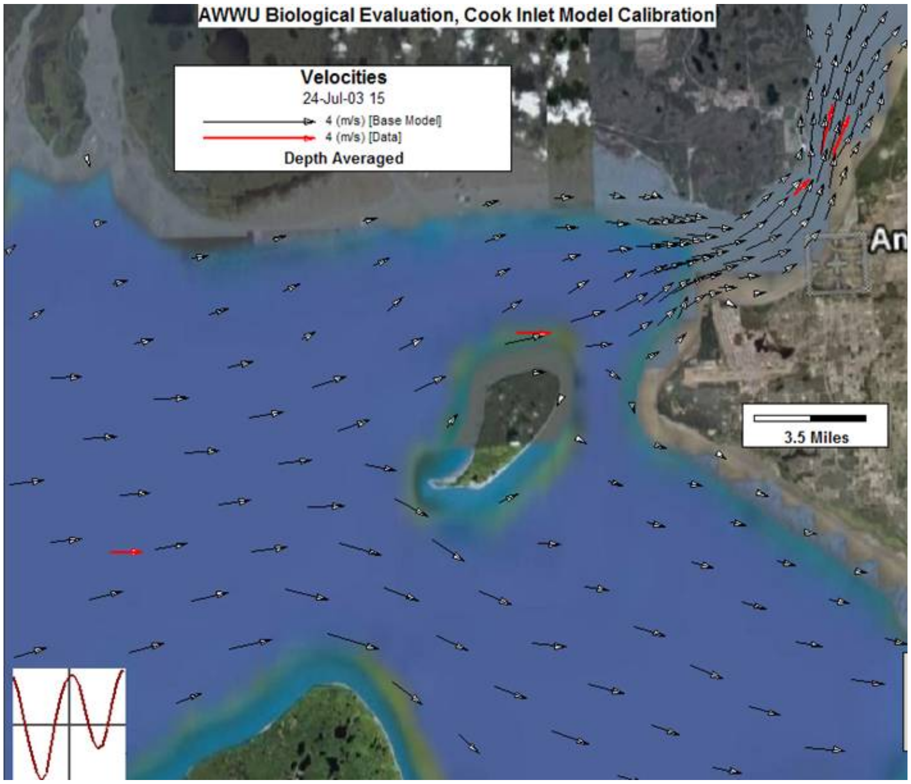

FIGURE F-10. 2D PLAN VIEW OF VELOCITY COMPARISONS WITH NOAA ADCP: FLOOD TIDE

Figures F-11 and F-12 compare east and north velocity components at Beluga Shoal in the center of the model and at Knik Arm NW of the POA. Good agreement was obtained for the velocity components for the Beluga Shoal, Knik Arm NW, and Fire Island measurement stations. The velocity calibration at Port Mackenzie (Figure F-13) was not as good. This is believed to result from the complexity of the fine-scale hydrodynamic conditions around Cairn Point relative to the coarse grid used in the model. Eddies off Cairn Point have been observed just after ebb flow starts. These eddies were not reproduced in the model. It is believed that the Port McKenzie station velocities recorded by the NOAA ADCP were influenced by this eddy, thus contributing to the differences in the observed and modeled velocities. The model, with a grid size of 160 meters by 160 meters, is limited in its ability to simulate such eddies. It is estimated that it would take a grid refinement of approximately four times smaller cells (resulting in 16 times more cells in the Cairn Point region) to reproduce the eddy. The objectives of the Upper CI model to address fate and transport of the Asplund WPCF effluent and simulate overall effluent concentrations within the Class 1 beluga habitat area are not compromised by the lack of such fine-scale and transient circulation features. The velocity calibration is generally very good and is sufficient for the purposes of this BE.

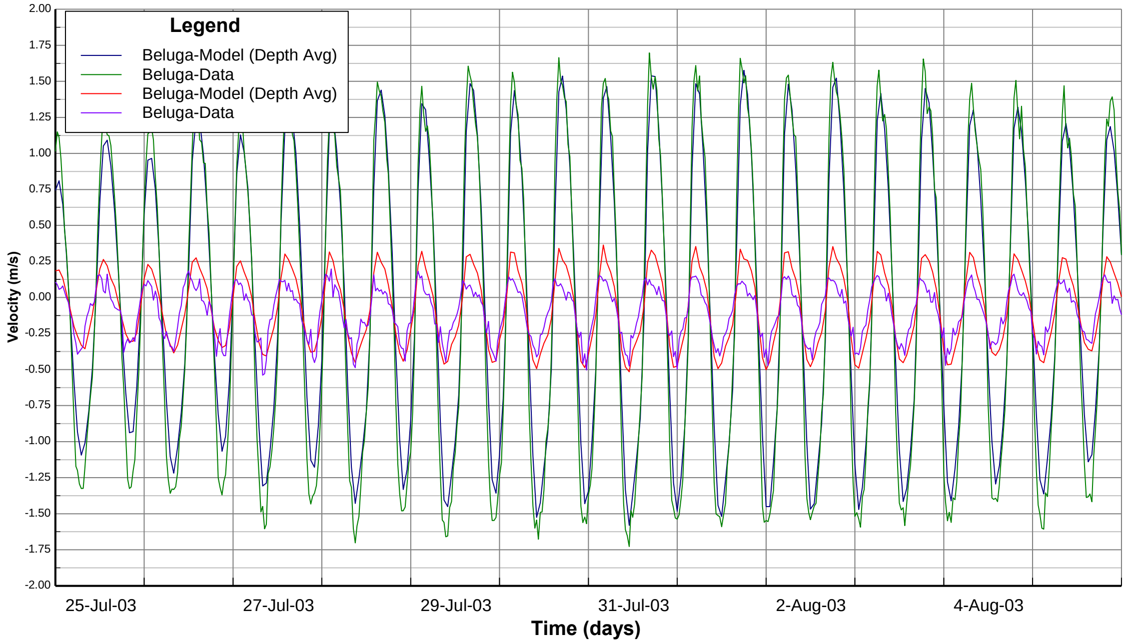

FIGURE F-11. VELOCITY COMPONENT COMPARISONS AT BELUGA SHOAL

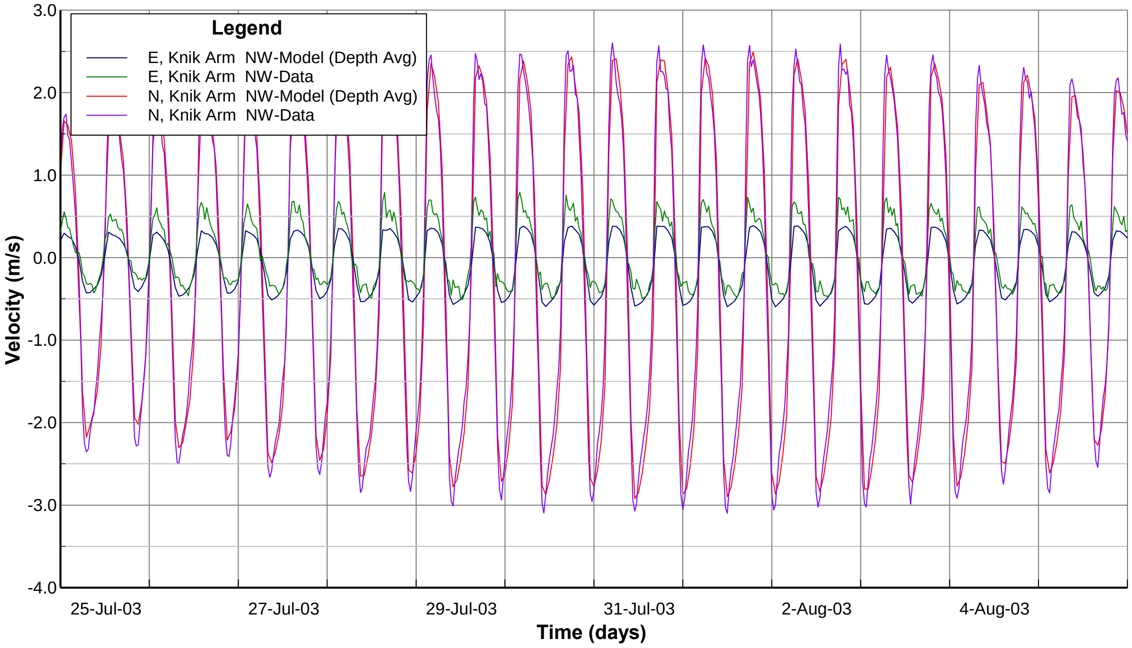

FIGURE F-12. VELOCITY COMPONENT COMPARISONS AT KNIK ARM NW

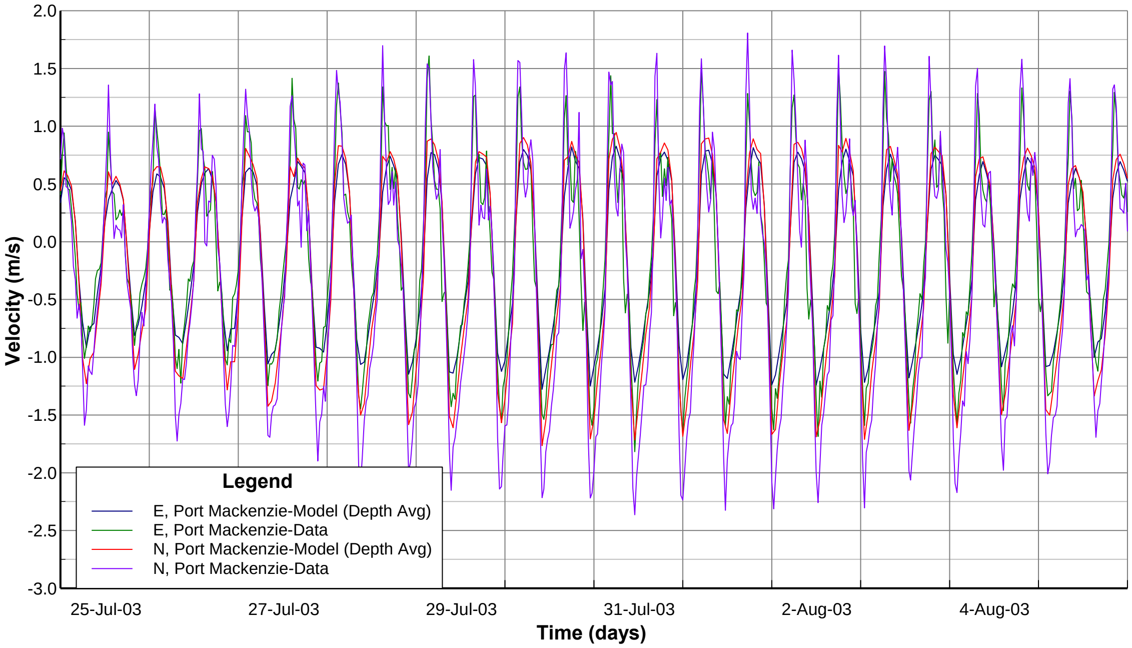

FIGURE F-13. VELOCITY COMPONENT COMPARISONS AT PORT MACKENZIE

F.4.3 Temperature/Salinity/Ice Cover

General transport process calibration was done using water temperature. Temperature calibration was based on data from the Anchorage NOAA station. The EFDC model does not include a specific ice cover sub-model. The approach used to address the winter “ice” condition was to turn off surface wind forcing for the area of the model expected to be frozen over. This approach removed any wind-driven currents and/or mixing during the winter period and is considered adequate for the purposes of this BE. For the water temperature simulations, the EFDC model was modified to address the winter period by limiting the water temperature to just above the freezing point for salt water. A simple linear relationship was used if the computed water temperature was less than 0°C. The temperature was computed as follows:

$$Temperature = -1.3\left(\frac{Salinity}{35}\right) \tag{1}$$

Where: temperature is in °C and salinity is salinity in gallons per liter (g/L).

This approach does not account for ice processes and the heat gain/loss during the winter time. However, it does produce a reasonable temperature to be used for the fate and transport computations in EFDC.

Figure F-14 shows the time-series comparison for the calibration period. The calibration results were good and indicate that the general transport processes were well simulated by the model.

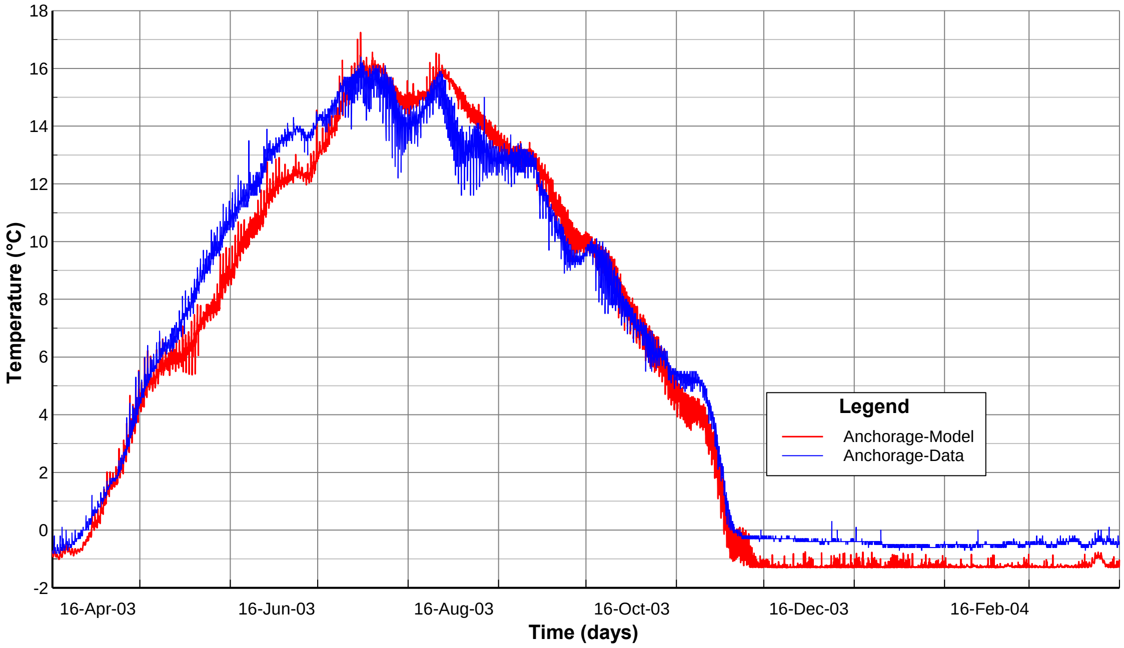

FIGURE F-14. WATER TEMPERATURE CALIBRATION, TIME-SERIES COMPARISON

Very few salinity measurements were available. For the Knik Arm Bridge Environmental Assessment, discrete salinity measurements were taken from July 27 to August 2, 2004, in the Knik Arm bridge area. The data were in the range of 4.0 to 6.0 ppt, with an average of 5.0 ppt on the surface and 5.4 at the bottom. The simulated salinities for 2003 (Figure F-15) were higher than those observed for 2004; however, the freshwater inflows were likely different, which would affect the overall transport in this area and result in somewhat different salinities. The predicted salinities support the overall calibration and the modeling objectives.

F.4.4 Summary of EFDC Hydrodynamic Calibration

The calibrated hydrodynamic model adequately reproduces the Upper CI advection and diffusion of dissolved/suspended material in the water column. Table F-5 summarizes the relative root mean squared (RelRMS) error statistic for each of the calibration parameters and stations.

$$RelRMS = \frac{\frac{\sqrt{\sum_{i=1}^{N}(o_i - x_i)}}{N}}{(O_{max} - O_{min})} * 100 \qquad (2)$$

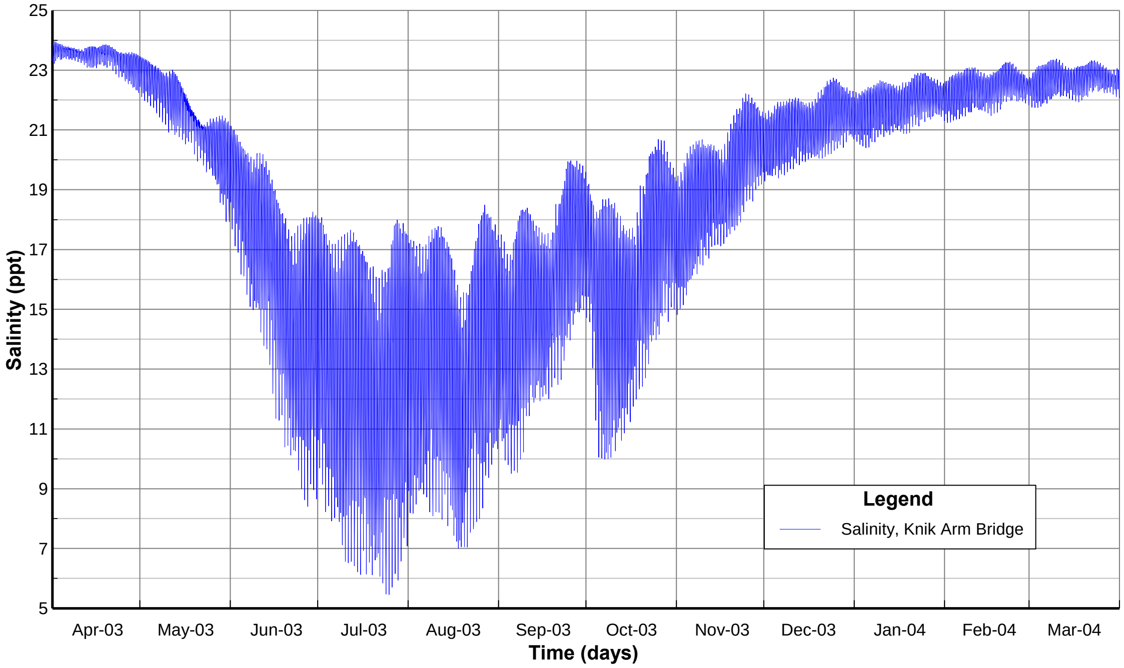

FIGURE F-15. COMPUTED SALINITIES IN THE KNIK ARM UPSTREAM OF CAIRN POINT

Table F-5. Calibration Period Summary Statistics: Relative RMS

Station ID	Parameter	Layer/ Type	Starting Date/Time	Ending Date/Time	# Pairs	Rel RMS	Data Average	Model Average
Water Surface (meters above MLLW)								
Anchorage	Elevation	Surface	2003-04-01	2004-04-29	9,461	2.7	5.024	4.996
Velocity Components (m/s)								
Beluga	X	Depth Avg	2003-07-15	2003-08-17	1,587	5.8	-0.101	-0.06
	Y	Depth Avg	2003-07-15	2003-08-17	1,587	15.9	-0.102	-0.075
Fire Island	X	Depth Avg	2003-07-15	2003-08-19	1,688	8.3	-0.109	-0.121
	Y	Depth Avg	2003-07-15	2003-08-19	1,688	62.2	0.003	-0.005
Knik Arm NW	X	Depth Avg	2003-07-15	2003-08-19	1,674	11.4	0.028	-0.086
	Y	Depth Avg	2003-07-15	2003-08-19	1,674	4.7	-0.257	-0.253
Knik Arm E	X	Depth Avg	2003-07-15	2003-08-19	1,508	8.2	0.025	0
	Y	Depth Avg	2003-07-15	2003-08-19	1,508	11.4	0.256	0.117
Port Mackenzie	X	Depth Avg	2003-07-15	2003-08-19	1,685	9.3	-0.153	-0.138
	Y	Depth Avg	2003-07-15	2003-08-19	1,685	8.9	-0.348	-0.235
Temperature (°C)								
Anchorage	Temperature	Layer 4	2003-04-01	2004-04-29	9,370	5.2	5.459	5.001

This evaluation indicates that the hydrodynamic calibration of the Upper CI model was acceptable and supports the use of the EFDC model for the purposes of this BE.

F.4.5 Total Suspended Solids

As mentioned above, sediment transport was not calibrated. The sediment modeling for the Upper CI model was used to address sediment influx from the rivers and the Asplund WPCF effluent, sediment deposition/resuspension, and suspended sediment advection/diffusion. The initial condition sediment beds were set to zero and bedload transport was not simulated. The objective of the sediment transport modeling for this BE was to obtain reasonable TSS concentrations and behavior.

Figure F-16 shows a time series of the computed TSS concentrations near the Asplund WPCF diffuser for the simulation period. The range of TSS values is consistent with historical discrete water column samples of TSS in Knik Arm, which range from a few hundred mg/L to more than 4,000 mg/L. The simulated values are in overall agreement with the historical observations.

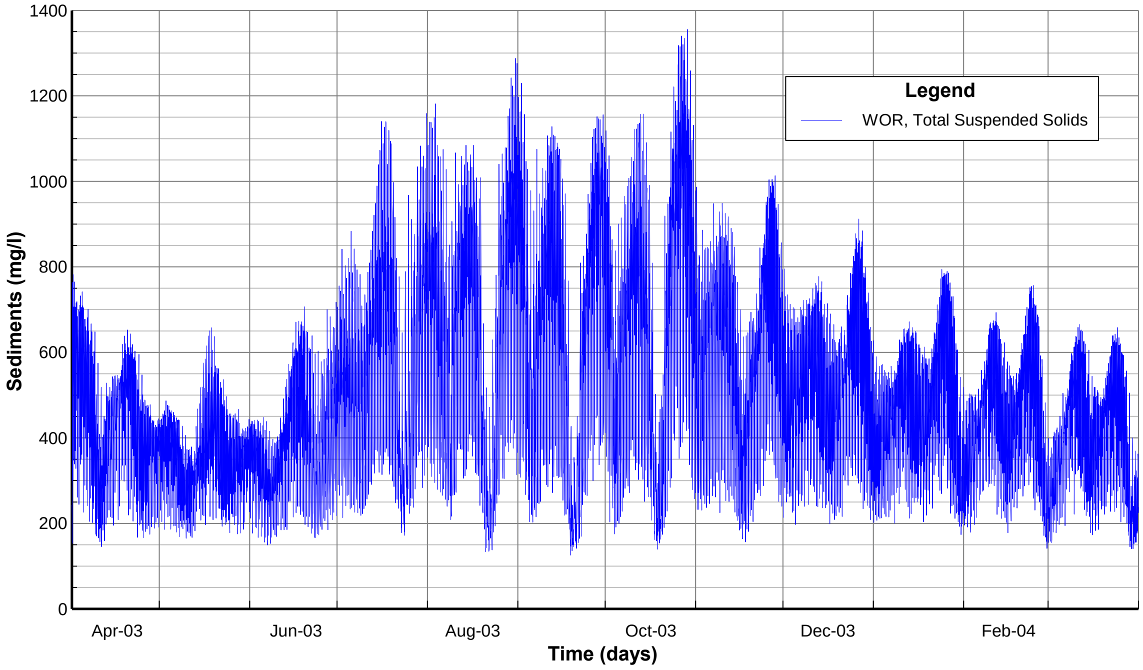

FIGURE F-16. COMPUTED TSS IN THE VICINITY OF THE ASPLUND WPCF DIFFUSER

F.5 Model Results

Using the calibrated model, three simulation scenarios were set up and run for a 1-year period using input data from 1-April- 2003 to 31-March-2004. The scenarios were:

- Conservative substances (no degradation)
- Slowly degrading substances (half life = 150 days)
- Rapidly degrading substances (half life = 7 days)

The only difference for each of these runs was the degradation rate of the dye tracer representing the effluent (and associated dissolved phase constituents). The effluent flow and associated effluent solids loading from the Asplund WPCF discharge and the freshwater inflows were the same for all runs.

To summarize the water column model results for each scenario, the Upper CI model was divided into three regions based on beluga migration patterns. The regions, outlined in red, are shown on Figure F-17. Within each of these regions, the water column constituent mass weighted averages were computed for hourly time snapshots. This provides a single representative concentration value for each region for each hour. The following subsections summarize these findings.

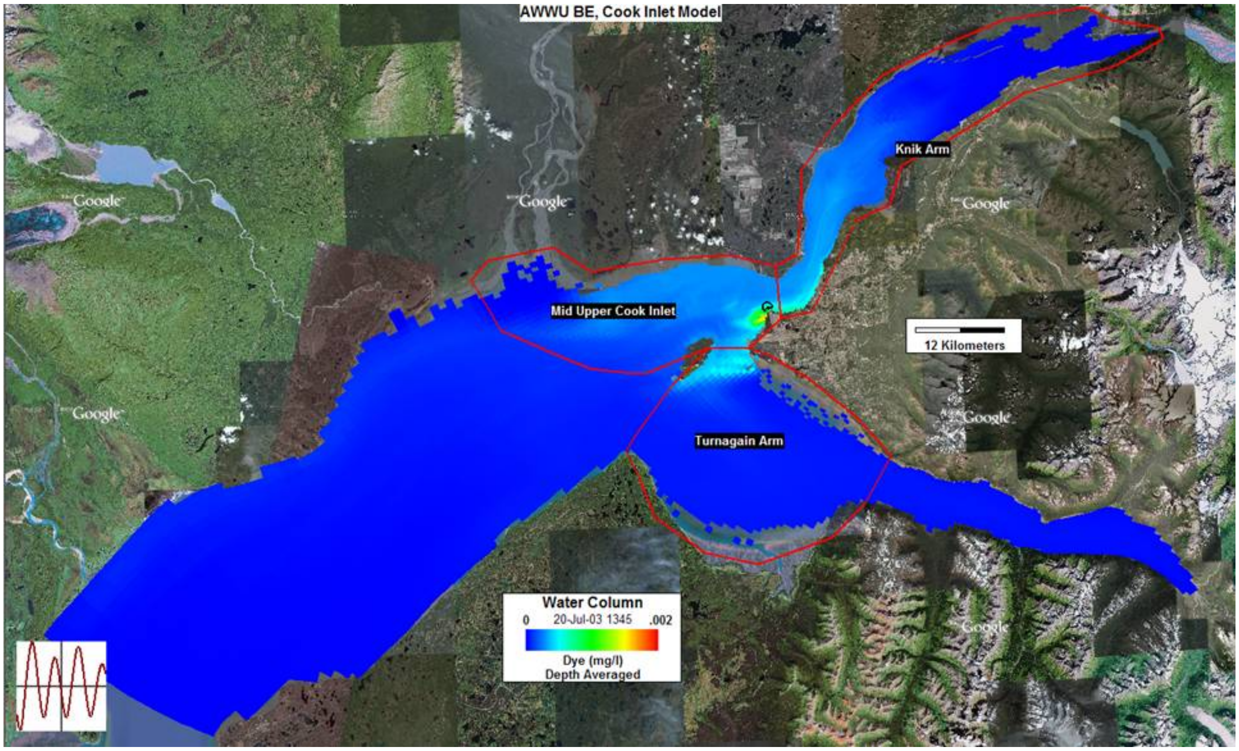

FIGURE F-17. LOCATION OF THE THREE WATER COLUMN SUMMARY REGIONS

F.5.1 Dissolved Constituents

F.5.1.1 No Degradation

Representative snapshots of dye concentration for summer and winter at high tide are displayed on Figures F-18 and F-19, respectively. The tide at the time of the snapshots is shown on the inset for each figure. Dye concentration was lower in summer, when there was a large volume of water flowing from streams. The seasonal trend of dye concentration is displayed on Figure F-20 for the three defined regions. Both Knik Arm and Upper CI have a strong seasonal variation, but this trend was not observed in Turnagain Arm. The reason for this may be the low water depth at the mudflat area between Fire Island and Point Woronzof, restricting flow into Turnagain Arm from the vicinity of the effluent discharge, as well as the absence of a large river source in Turnagain Arm.

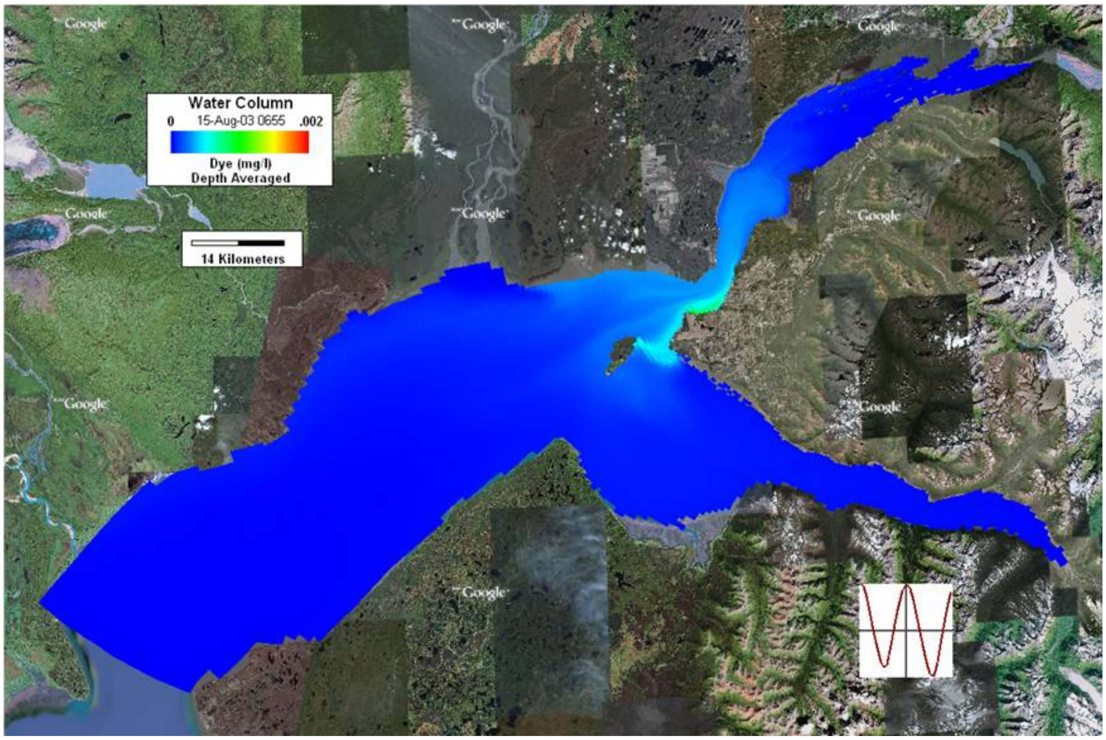

FIGURE F-18. PLAN VIEW OF DYE CONCENTRATION: SUMMER, NO DEGRADATION

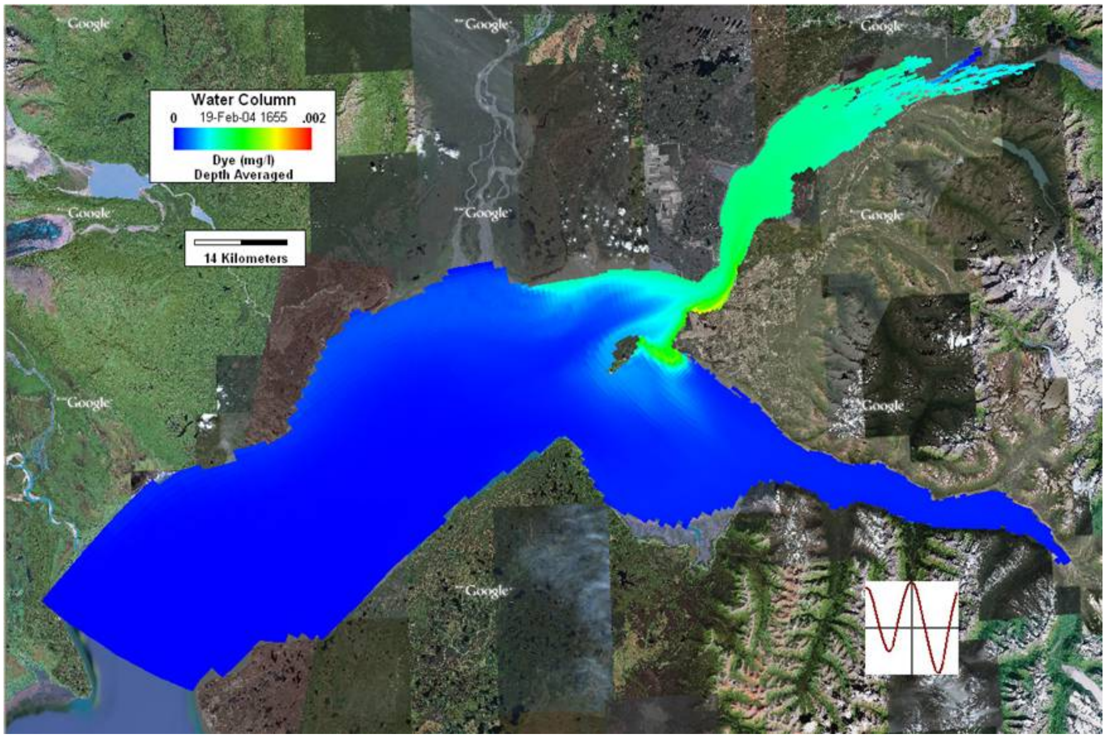

FIGURE F-19. PLAN VIEW OF DYE CONCENTRATION: WINTER, NO DEGRADATION

Figure F-20 is presented in terms of the dye tracer concentration. The dye concentrations are easily interpreted in terms of dilution and concentrations of effluent constituents. The dye-tracer concentration in the effluent was 1 mg/L; therefore, the effluent dilution is the reciprocal of the receiving water dye-tracer concentration[9]. For example, a dye-tracer concentration of 0.0001 represents an effluent dilution of 10,000:1, and a dye-tracer concentration of 0.0008 represents an effluent dilution of 1,250:1. These values represent a dynamic steady-state dilution of the effluent in the water column that includes the buildup of effluent that is not immediately flushed from the water body. The concentration of any effluent constituent in the receiving water is the initial whole effluent concentration divided by the dilution (or times the dye-tracer concentration).

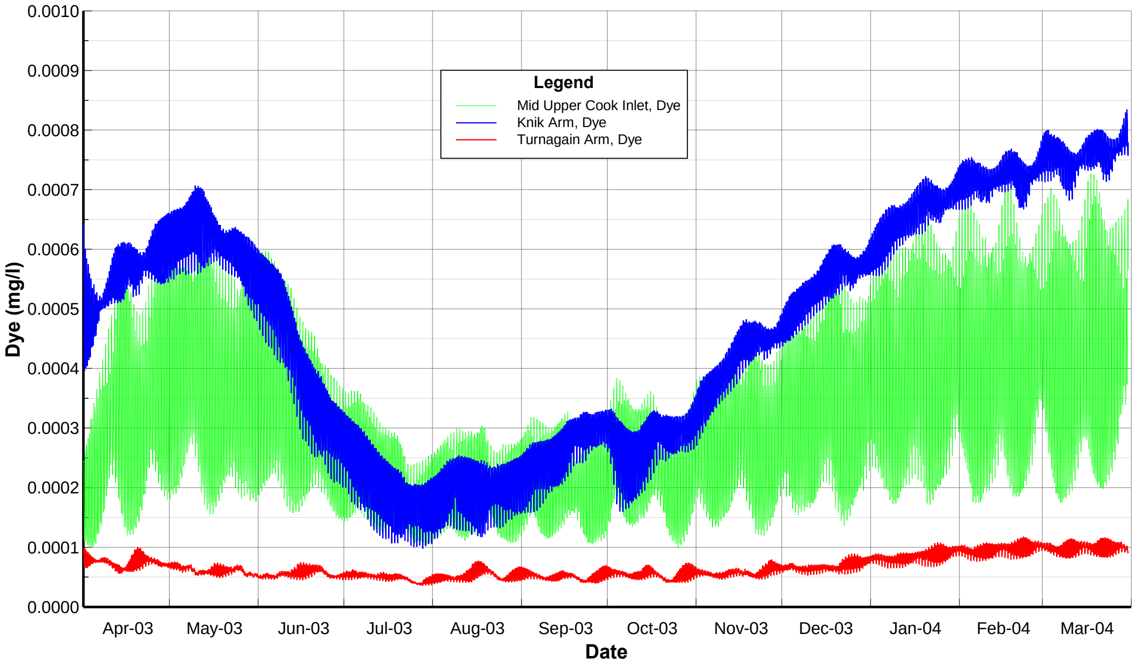

FIGURE F-20. DYE CONCENTRATION TIME-SERIES BASED ON HOURLY SNAPSHOTS FOR EACH REGION: NO DEGRADATION

F.5.1.2 Half Life: 150 Days

The result of the 150 days half life scenario was similar to that shown for the No Degradation results. The seasonal characteristic of dye concentration can be seen on Figures F-21 through F-23.

F.5.1.3 Half Life: 7 Days

Figures F-24 through F-26 show that, with a short half life, the dye concentration in all three regions was more weakly dependent on flow seasons.

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[9] The definition of dilution used here is the ratio of effluent volume to the total water volume (effluent plus receiving water)

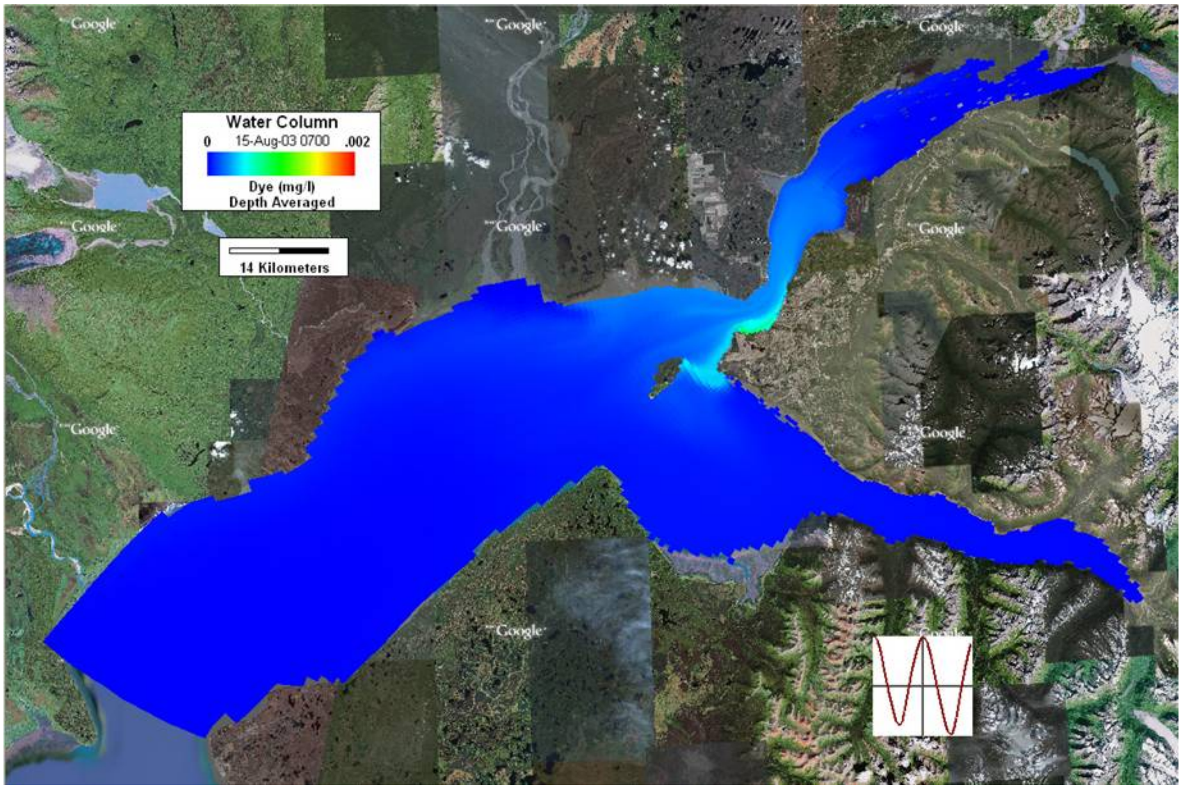

FIGURE F-21. PLAN VIEW OF DYE CONCENTRATION: SUMMER, 150 DAYS HALF LIFE

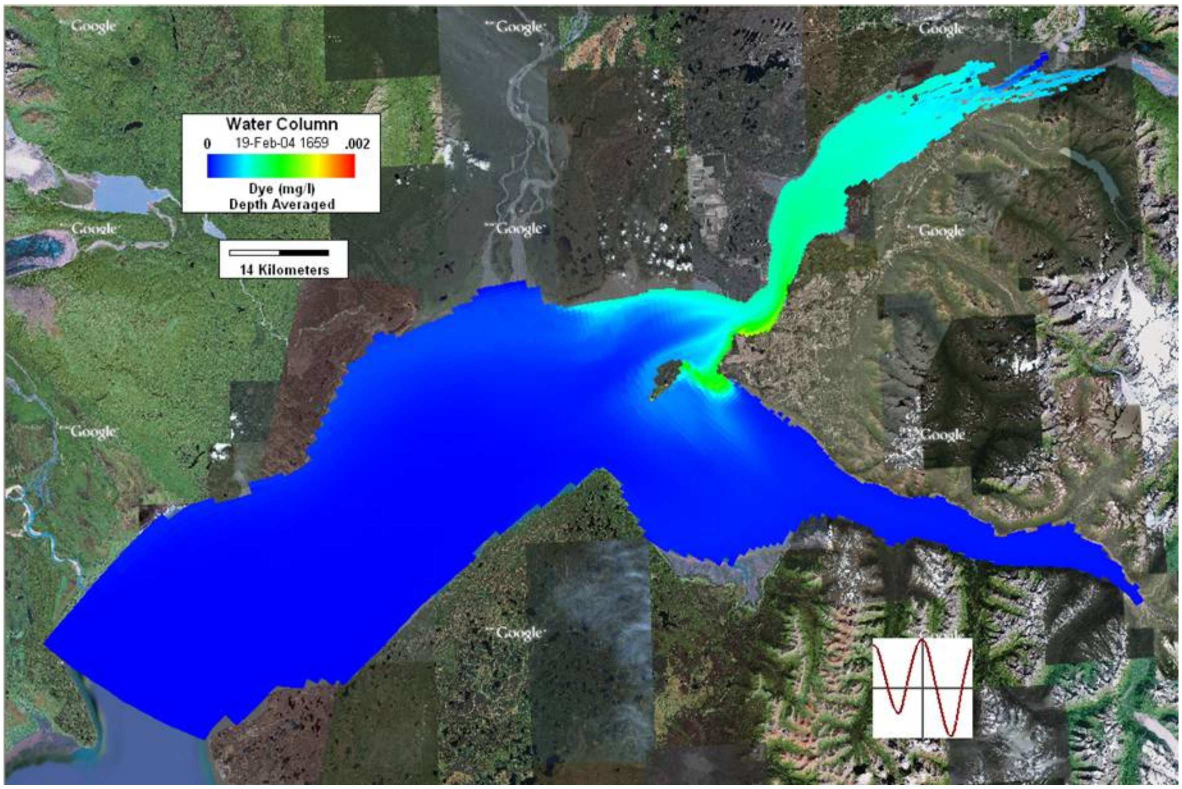

FIGURE F-22. PLAN VIEW OF DYE CONCENTRATION: WINTER, 150 DAYS HALF LIFE

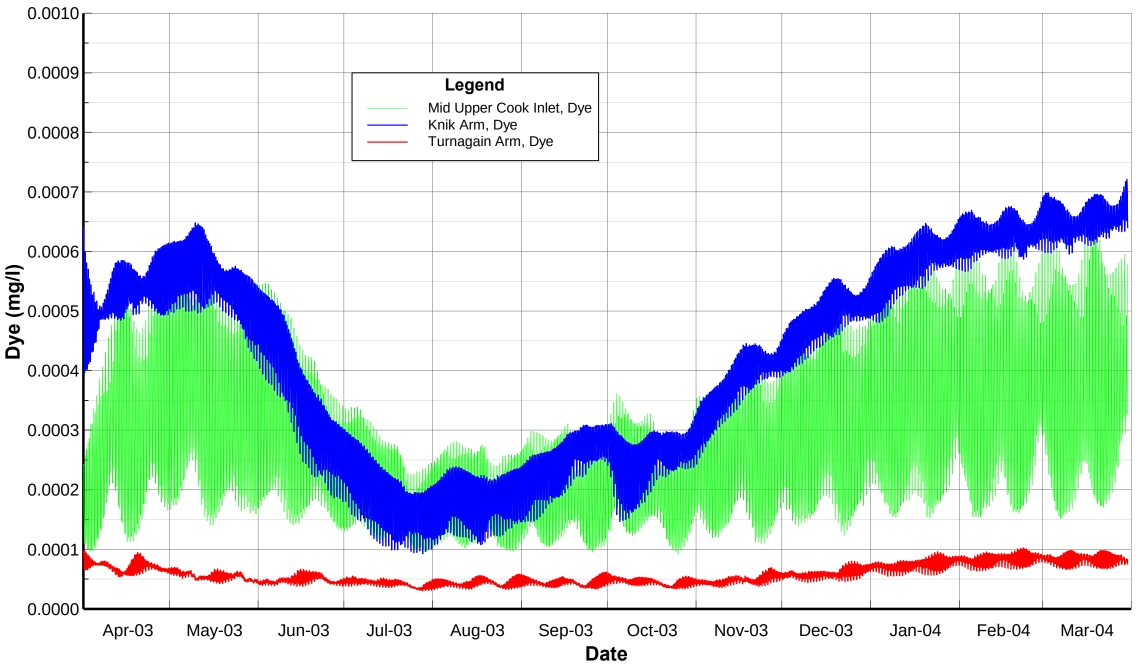

FIGURE F-23. DYE CONCENTRATION TIME SERIES FOR EACH REGION: 150 DAYS HALF LIFE

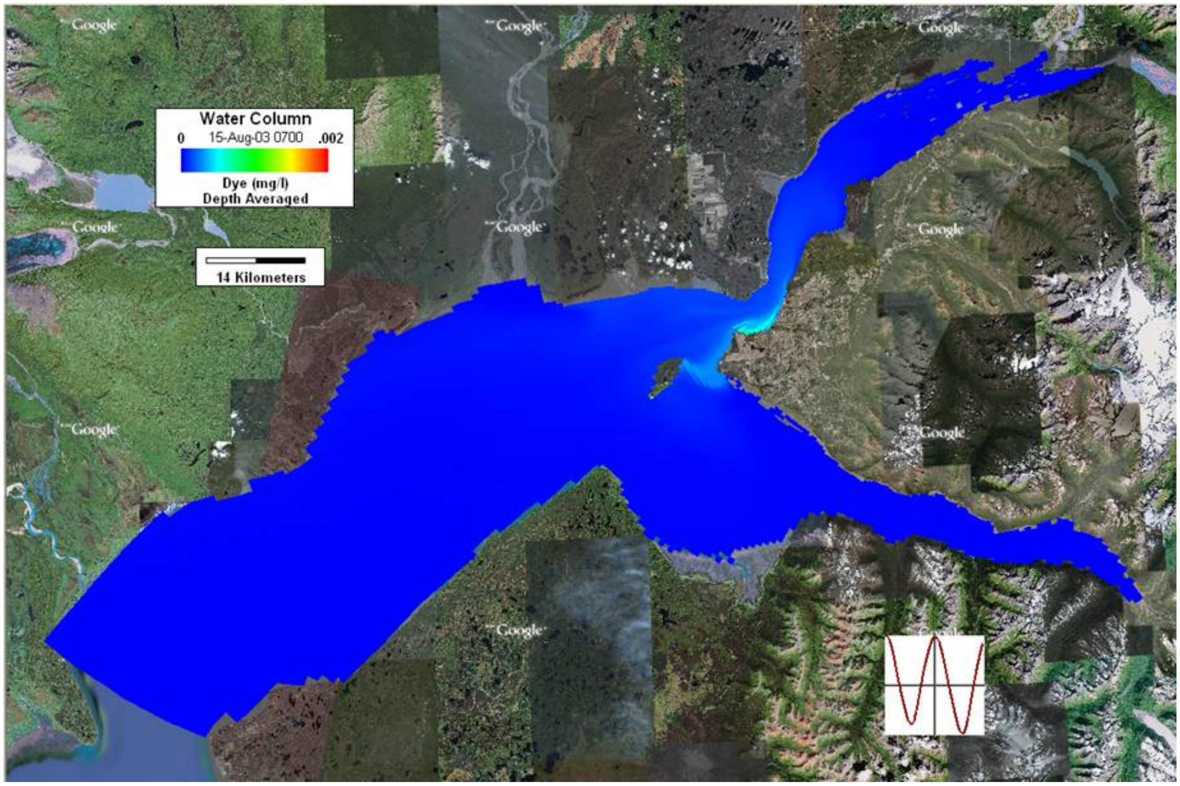

FIGURE F-24. PLAN VIEW OF DYE CONCENTRATION: SUMMER, 7-DAY HALF LIFE

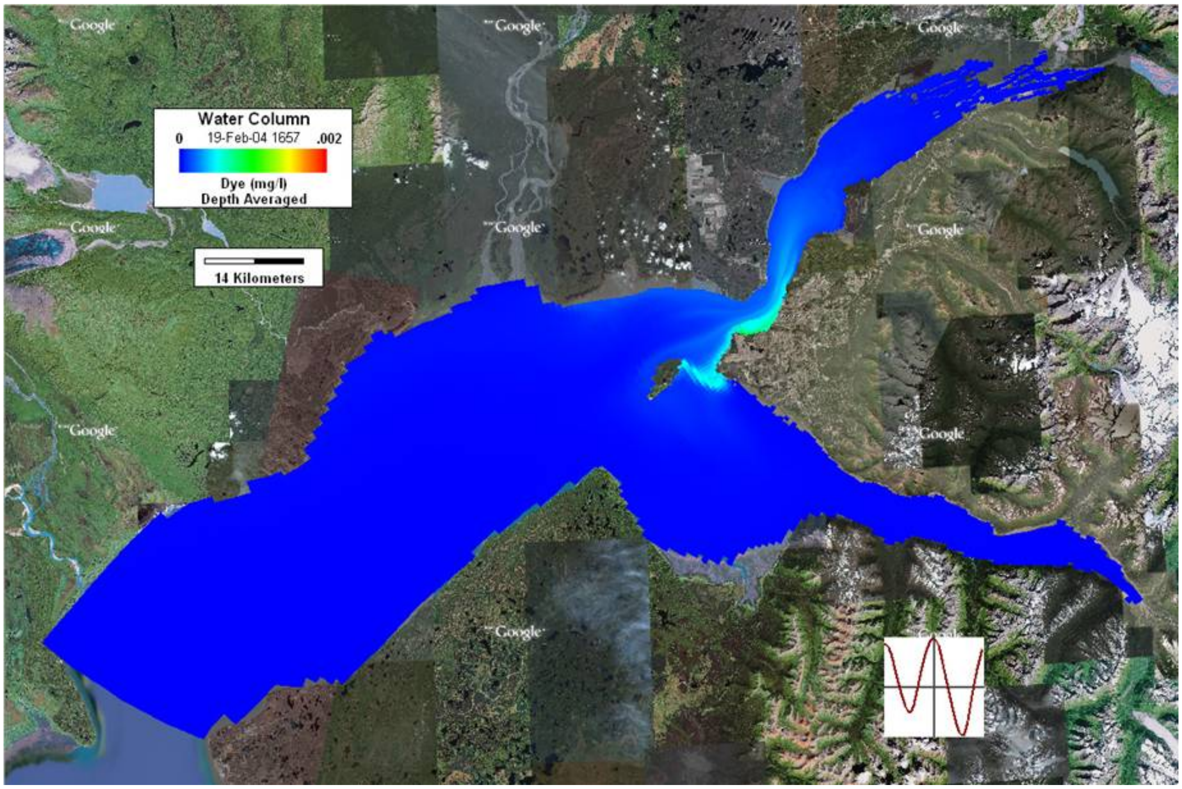

FIGURE F-25. PLAN VIEW OF DYE CONCENTRATION: WINTER, 7-DAY HALF LIFE

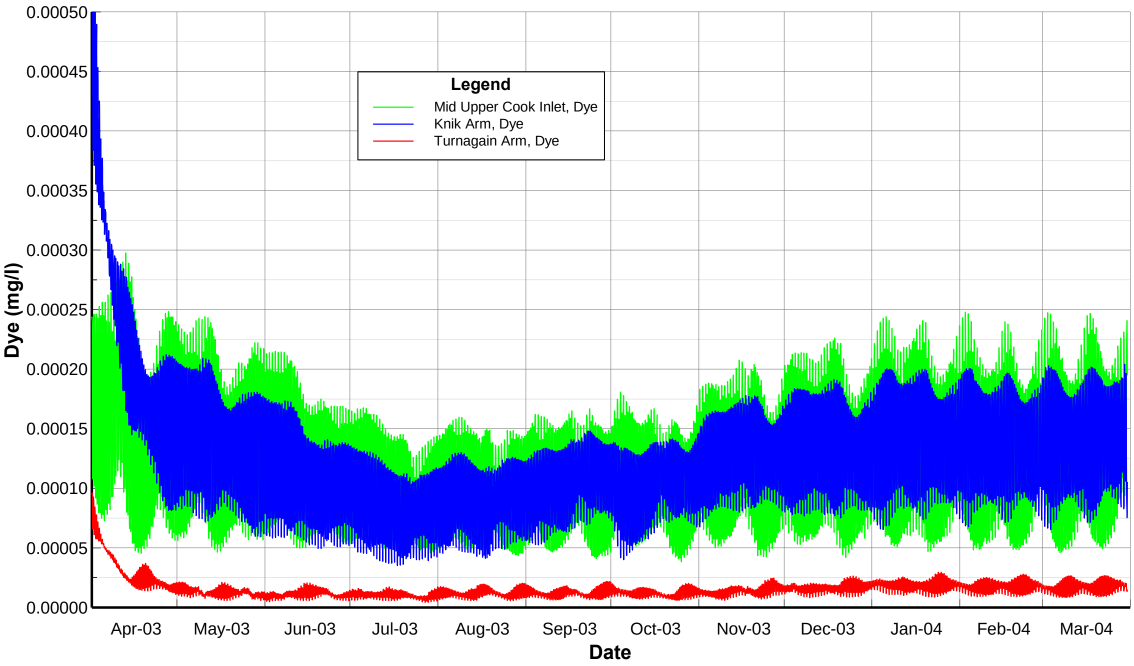

FIGURE F-26. DYE CONCENTRATION TIME SERIES FOR EACH REGION: 7-DAY HALF LIFE

F.5.1.4 Dissolved-phase Comparisons

Comparison of dye-tracer concentration in all three regions indicates that the dye concentration was significantly lower for the 7-day half life scenario. This can be seen on Figures F-27 through F-29. The concentrations predicted in the water column, using the dye tracer injection of 1 mg/L, were all below 1 part per billion. The winter/summer dilution effects are clearly discernable in all the plots, with the "No Degradation" case being the most pronounced. Turnagain Arm, on average, had the lowest concentrations of the modeled regions, with average concentrations generally below 0.1 part per billion. Figure F-6 provides a numerical summary of the average dye concentrations for each month by scenario and region. Attachment F4 provides a more detailed analysis of these results, showing monthly minimums, maximums, and confidence limits.

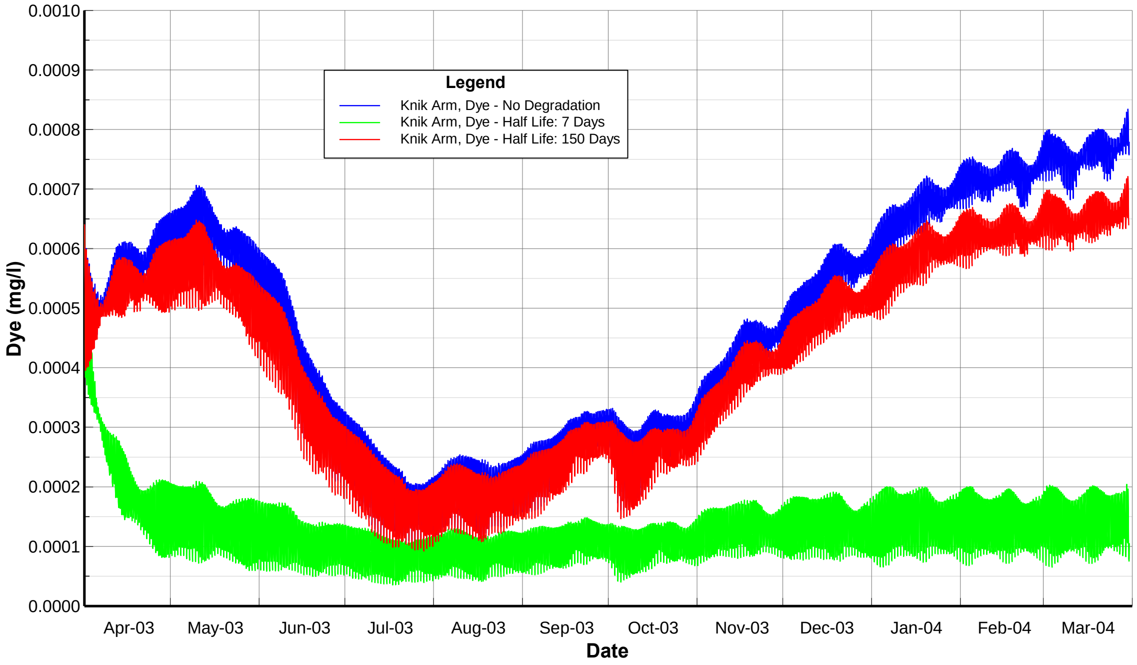

FIGURE F-27. SCENARIO COMPARISON: DYE CONCENTRATION IN KNIK ARM REGION

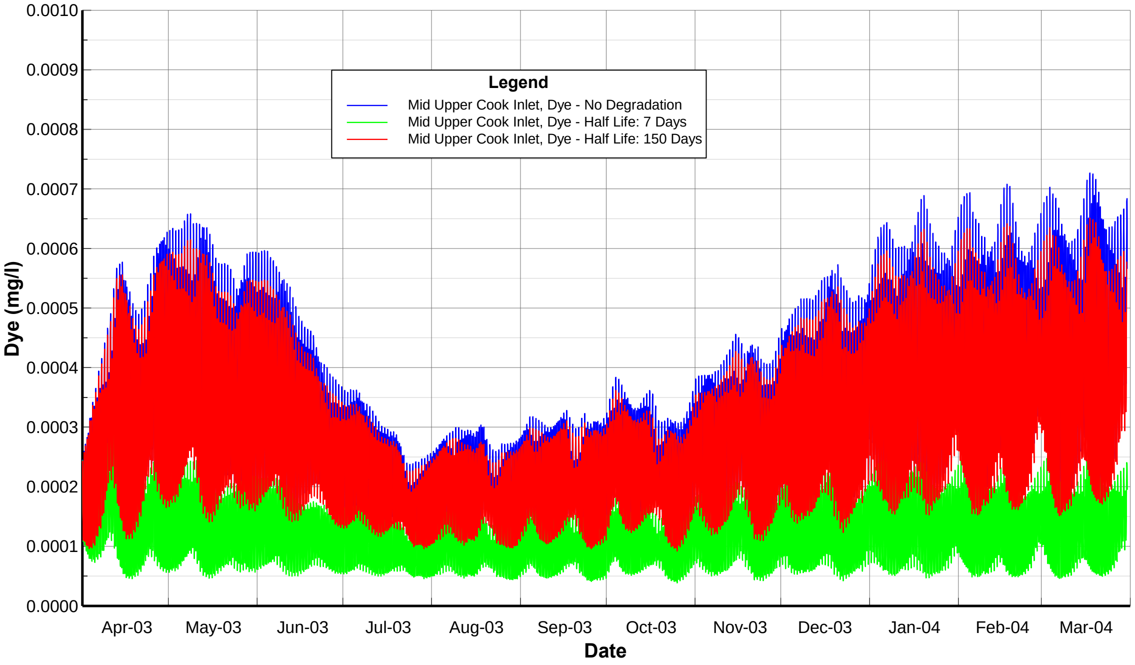

FIGURE F-28. SCENARIO COMPARISON: DYE CONCENTRATION IN MID-UPPER COOK INLET REGION

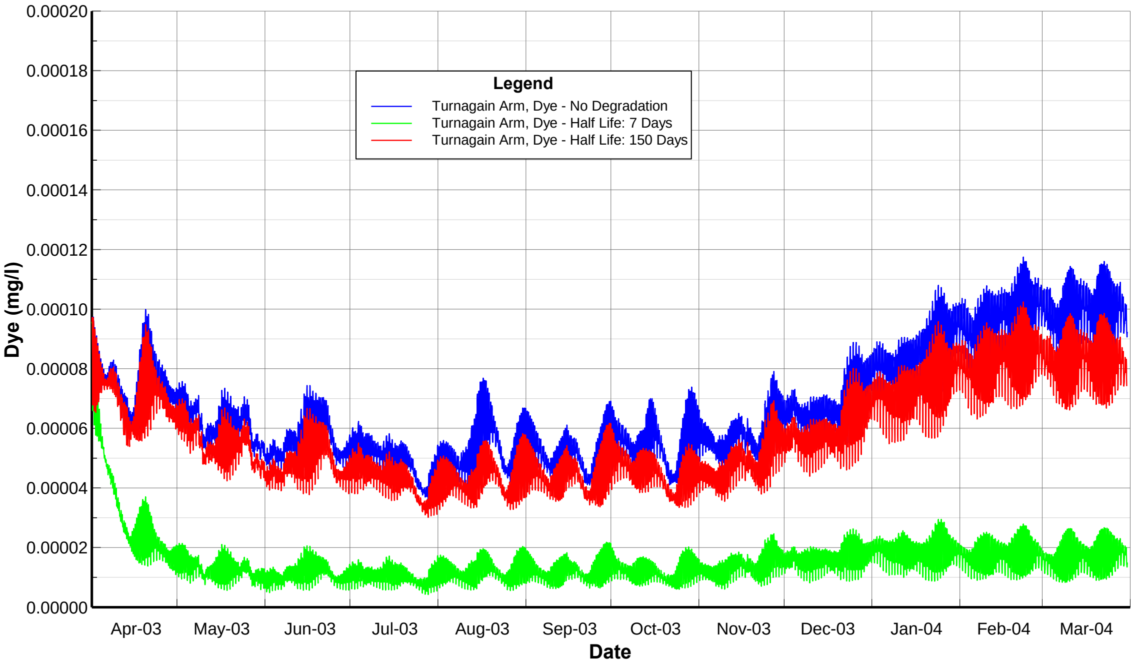

FIGURE F-29. SCENARIO COMPARISON: DYE CONCENTRATION IN TURNAGAIN ARM REGION

Table F-6. Summary of Water Column Concentrations for the Dye Degradation Scenarios

Date	Number of Records	Average Dye-tracer Concentrations (mg/L)								
		No Degradation			Half Life: 150 Days			Half Life: 7 Days		
		Mid-Upper CI	Knik Arm	Turnagain Arm	Mid-Upper CI	Knik Arm	Turnagain Arm	Mid-Upper CI	Knik Arm	Turnagain Arm
3-Apr	720	0.000311	0.000557	0.000075	0.000297	0.000530	0.000071	0.000154	0.000233	0.000032
3-May	744	0.000382	0.000615	0.000062	0.000353	0.000555	0.000055	0.000138	0.000140	0.000013
3-Jun	720	0.000326	0.000413	0.000056	0.000298	0.000369	0.000049	0.000124	0.000112	0.000012
3-Jul	744	0.000213	0.000206	0.000049	0.000199	0.000192	0.000043	0.000101	0.000088	0.000011
3-Aug	745	0.000200	0.000201	0.000053	0.000185	0.000188	0.000043	0.000099	0.000092	0.000012
3-Sep	720	0.000213	0.000268	0.000051	0.000199	0.000251	0.000044	0.000103	0.000108	0.000012
3-Oct	743	0.000236	0.000282	0.000054	0.000217	0.000260	0.000045	0.000107	0.000106	0.000012
3-Nov	720	0.000275	0.000415	0.000058	0.000256	0.000379	0.000049	0.000121	0.000131	0.000014
3-Dec	744	0.000336	0.000543	0.000068	0.000310	0.000490	0.000060	0.000130	0.000137	0.000017
4-Jan	744	0.000395	0.000659	0.000085	0.000360	0.000583	0.000074	0.000138	0.000143	0.000019
4-Feb	696	0.000406	0.000723	0.000097	0.000365	0.000630	0.000083	0.000134	0.000142	0.000018
4-Mar	720	0.000423	0.000761	0.000099	0.000375	0.000654	0.000083	0.000137	0.000146	0.000017

F.5.1.5 Nikiski Boundary Dye Flux

As described above, the EFDC open boundary was set a sufficient distance downinlet from the critical habitat area of interest to avoid significant or meaningful tidal reflux effects. To validate this approach, an analysis of dye-tracer flux (and thus effluent) leaving the model domain at the downstream boundary, located near the Forelands, was conducted. Figure F-30 plots the dye mass leaving the model domain at the open boundary (the flux signs indicate direction only). Although there is definitely a flux of dye from the model domain, the corresponding concentrations in the water leaving the model were generally on the order of 10^{-6} mg/L or lower (i.e., one to two orders of magnitude lower than the concentrations in the area of interest). This analysis clearly demonstrates that the model domain was sufficient to evaluate the Asplund WPCF effluent concentrations within the designated critical habitat area.

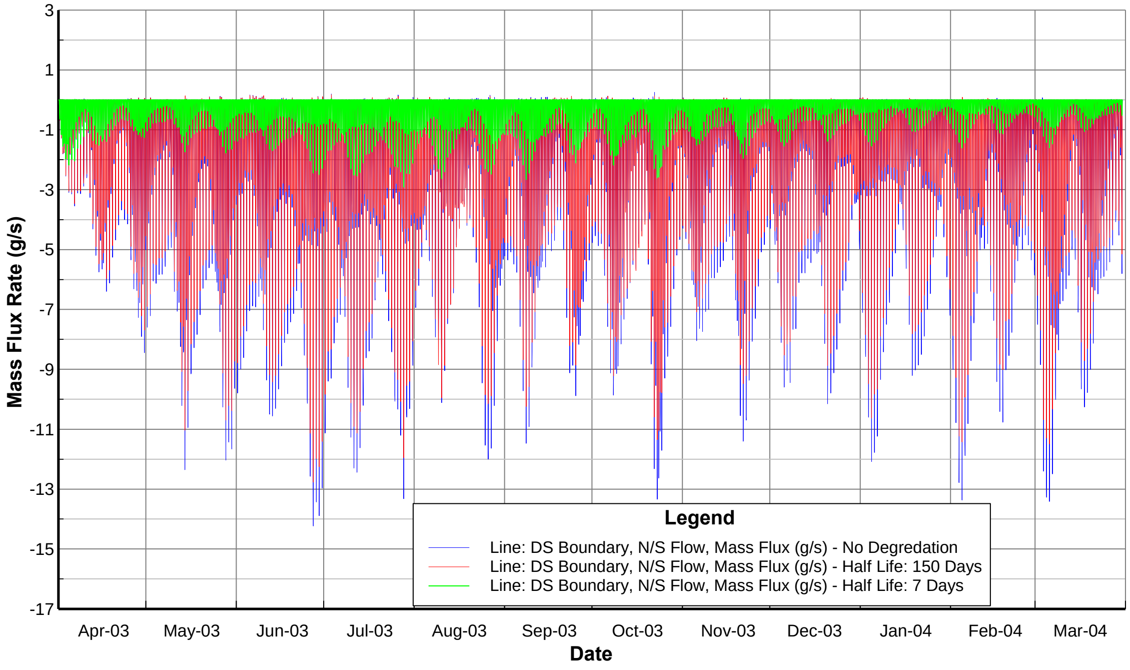

FIGURE F-30. SCENARIO COMPARISON: DYE MASS FLUX LEAVING DOMAIN AT DOWNSTREAM BOUNDARY (WHERE POSITIVE VALUES ARE NORTHWARD AND NEGATIVE VALUES ARE SOUTHWARD)

F.5.2 Suspended Solids

The TSS concentrations for the Asplund WPCF sediment classes (TSS_{AWWU}) for each region are plotted on Figure F-31. The figure clearly shows that the AWWU fraction of solids in the Upper CI is well below 1/10,000 of the total solids in the water column. Table F-7 summarizes the TSS_{AWWU} mass fraction in the water column by month and region.

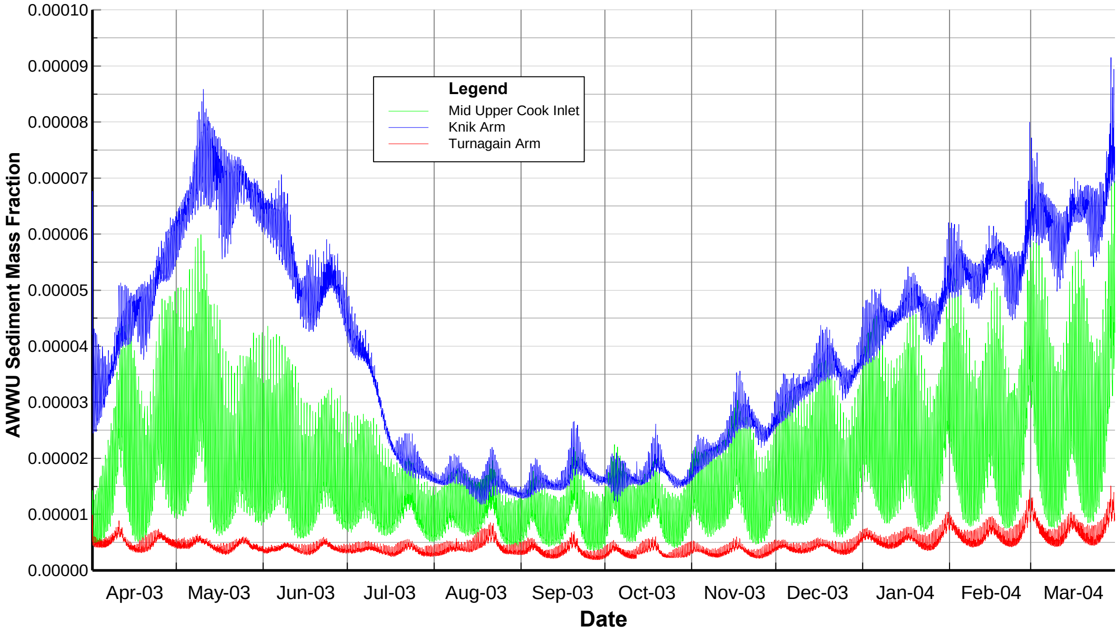

FIGURE F-31. TIME SERIES OF AWWU SUSPENDED SEDIMENT MASS FRACTION BY REGION

Table F-7. Water Column Concentration Summary: AWWU Suspended Solids Mass Fraction

		Average AWWU Mass Fractions by Region		
		Knik Arm	Mid-Upper CI	Turnagain Arm
Date	Number of Records	(%)	(%)	(%)
3-Apr	720	0.0000436	0.0000168	0.0000048
3-May	744	0.0000680	0.0000198	0.0000043
3-Jun	720	0.0000527	0.0000159	0.0000038
3-Jul	744	0.0000259	0.0000122	0.0000035
3-Aug	745	0.0000154	0.0000097	0.0000040
3-Sep	720	0.0000161	0.0000086	0.0000030
3-Oct	743	0.0000166	0.0000102	0.0000031
3-Nov	720	0.0000234	0.0000128	0.0000032
3-Dec	744	0.0000335	0.0000167	0.0000039
4-Jan	744	0.0000454	0.0000202	0.0000052
4-Feb	696	0.0000538	0.0000213	0.0000060
4-Mar	720	0.0000635	0.0000239	0.0000065

F.5.3 Sediment Deposition

After 1 year of simulation, the total sediment deposition (natural plus effluent-derived) may reach as much as 3 meters at certain limited locations shown on Figure F-32. These locations are typically in shallow water on or adjacent to the mud flats. The deposition over most of the study area is negligible.

Most Asplund WPCF sediment deposition occurred at shallow locations, as shown on Figure F-33. The greatest thickness was about 0.001 meter at the mudflat between Fire Island and Point Woronzof, as well as at some locations near both banks of upper Knik Arm.

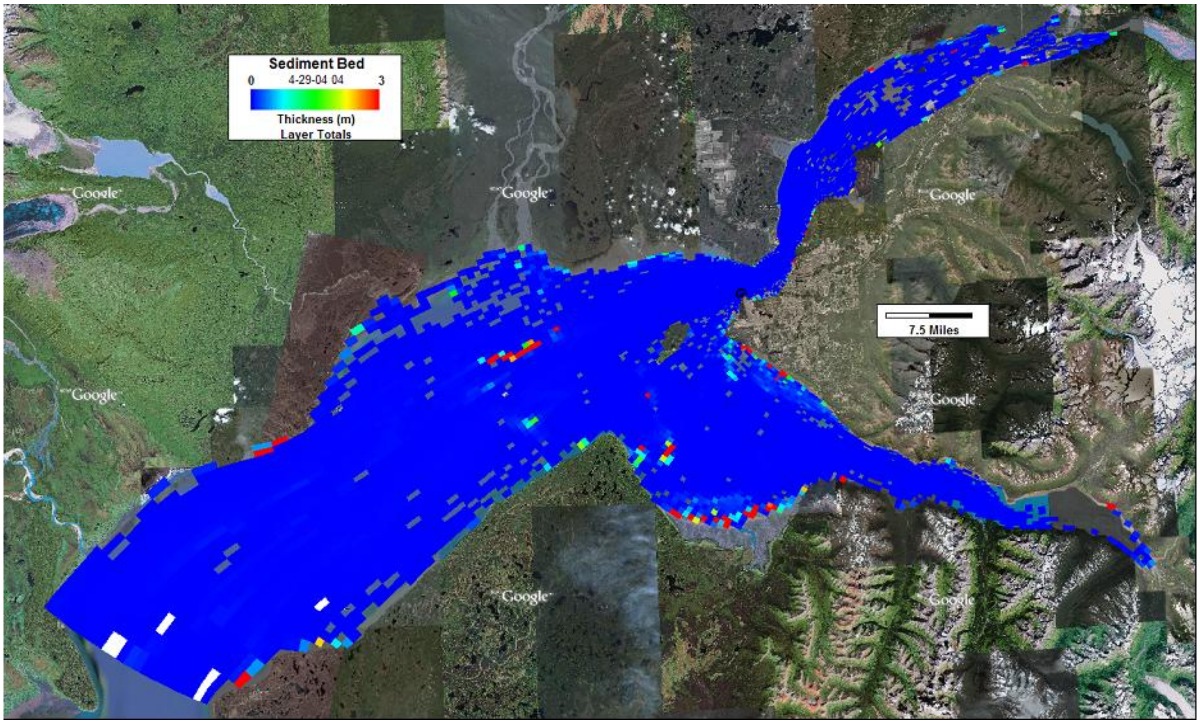

FIGURE F-32. TOTAL SEDIMENT DEPOSITION MAP AFTER 1 YEAR: TOTAL SEDIMENT THICKNESS

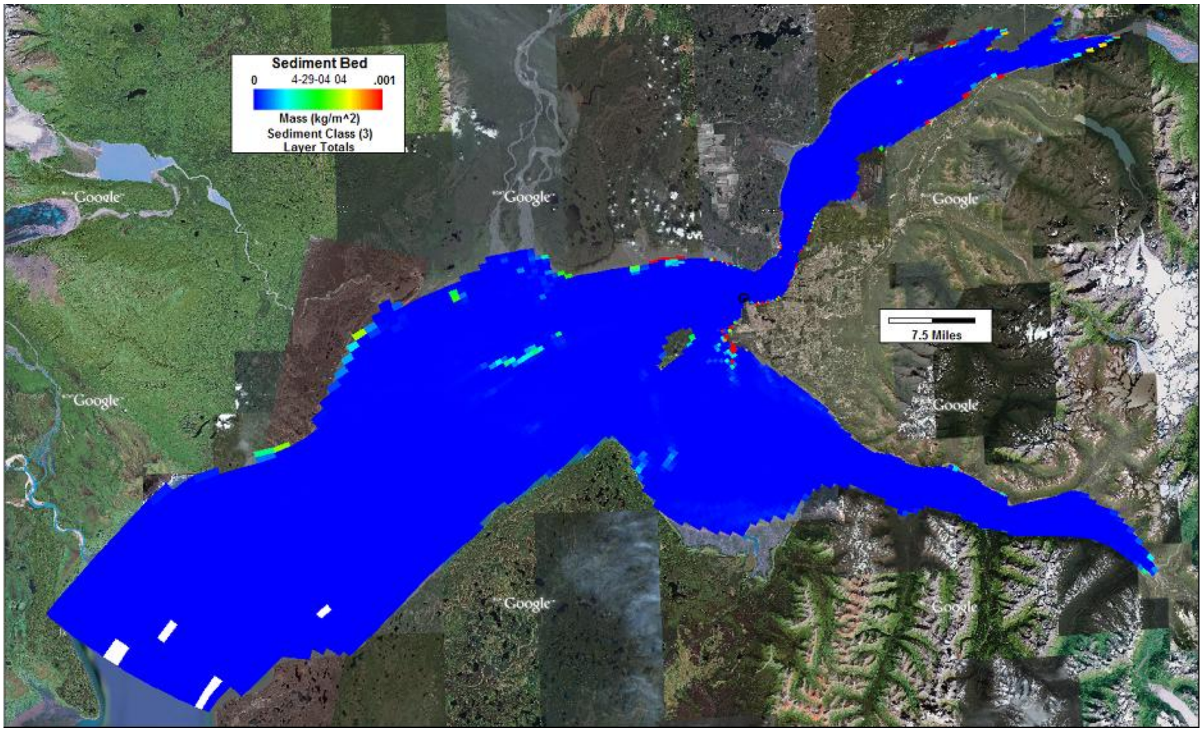

FIGURE F-33. SEDIMENT DEPOSITION MAP AFTER 1 YEAR: NON-COHESIVE CLASS 1 (AWWU MARKER CLASS) SEDIMENT MASS

F.6 Conclusions

The following summarizes the results of the modeling study:

- A 3D hydrodynamic/transport EFDC model was developed for Upper CI.
- The model was calibrated against available data, which indicated that the model simulations are realistic, accurate, and appropriate for the purposes of this BE.
- The model simulations reproduce the general circulation and transport patterns of the Upper CI and provide a sound technical basis to evaluate the transport and distribution of Asplund WPCF discharge constituents in the modeled area.
- The model results clearly show the geographic and seasonal variability of effluent distribution. The effects of degradation on the distribution of effluent constituents were well demonstrated.
- The model-predicted concentrations of a dye-tracer and effluent-derived TSS were, as expected, extremely low as follows:
  - Average dilutions of whole effluent over the modeled regions range from over 1,000:1 to approximately 20,000:1 for conservative substances that do not degrade rapidly with time.

  - The concentration of effluent-derived suspended sediments is more than six orders of magnitude smaller than the concentration of natural sediments.
  - The deposition of effluent-derived sediments will occur in only limited areas and comprise an extremely small fraction of the total sediment deposits.
- The model will be used as the basis for predicting distribution and concentration of POCs in the Asplund WPCF effluent.

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Attachment F-1
EFDC Description

ATTACHMENT F1

EFDC Description

Governing Physics of EFDC

The EFDC hydrodynamic model is a variable-density, unsteady-flow model that uses the Boussinesq approximation, hydrostatic pressure field, and internal solutions of vertical eddy viscosity and diffusivity. The EFDC model solves the vertically hydrostatic, free-surface, turbulent-averaged equations of motions for a variable density fluid.

Dynamically-coupled transport equations for turbulent kinetic energy, turbulent length scale, salinity, and temperature are solved. The two turbulence parameter transport equations implement the Mellor-Yamada level ‘2.5’ turbulence closure scheme (Mellor and Yamada, 1982; Galperin et al., 1988). The bottom stress formulation for friction, accounting for the rate of momentum loss at the sediment bed/water interface, is represented using a turbulent boundary layer formulation based on a quadratic function of near-bottom velocity. Water temperature is solved as an integral part of the hydrodynamic model, with heat transport simulated using the atmospheric heat exchange model developed by Rosati and Miyakoda (1988), in which solar radiation at the water surface is reduced as a function of depth in the water column.

The state equations and numerical solution methods used in the EFDC hydrodynamic model are given in Hamrick (1992; 1996), Blumberg and Mellor (1987), and Martin and McCutcheon (1999). The interested reader is referred to these sources since the equations of the model are not presented in this report.

Numerical Solution Schemes of EFDC

The spatial domain of a water body can be represented in EFDC using (a) Cartesian, or curvilinear orthogonal coordinates in the horizontal (x,y) domain; and (b) a stretched, or sigma, coordinate scheme in the vertical (z) domain. The numerical scheme used in EFDC to solve the equations of motion uses a second-order accurate, spatial finite difference scheme on a staggered or C grid. The model's time integration uses a second-order accurate, two time-level, finite difference scheme, with an internal/external mode splitting procedure to separate the internal shear from the external free surface gravity wave. The external mode solution is semi-implicit and simultaneously computes the two-dimensional surface elevation field by a preconditioned conjugate gradient procedure. The external solution is completed by the calculation of the depth-averaged velocities using the new surface elevation field. The model's semi-implicit external solution allows large time steps that are constrained only by the stability criteria of the explicit central difference or high-order upwind advection scheme (Smolarkiewicz and Margolin, 1993) used for the nonlinear accelerations.

Horizontal boundary conditions for the external mode solution include options for simultaneously specifying the surface elevation only, the characteristic of an incoming wave (Bennett and McIntosh, 1982), free radiation of an outgoing wave (Bennett, 1976;

Blumberg and Kantha, 1985), or the normal volumetric flux on arbitrary portions of the boundary. The EFDC model's internal momentum equation solution, at the same time step as the external solution, is implicit with respect to vertical diffusion. The internal solution for the momentum equations is defined in terms of the vertical profile of shear stress and velocity shear. Time-splitting inherent in the two time-level scheme is controlled by periodic insertion of a second-order accurate two-time level trapezoidal step. In addition to the general 3D (x,y,z) spatial domain, the EFDC model can also be readily configured as a two-dimensional model in either the horizontal (2D: x,y) or vertical (2D: x,z) planes.

The EFDC model implements a second-order accurate in space and time, mass conservation fractional-step solution scheme for the Eulerian transport equations for salinity, temperature, suspended sediment, water quality constituents, and toxic contaminants. The transport equations are temporally integrated at the same time step or twice the time step of the momentum equation solution (Smolarkiewicz and Margolin, 1993). The advective step of the transport solution uses either the central difference scheme used in the Blumberg-Mellor (1987) model or a hierarchy of positive definite upwind difference schemes. The highest accuracy upwind scheme, second-order accurate in space and time, is based on a flux-corrected transport version of Smolarkiewicz's multidimensional positive definite advection transport algorithm (Smolarkiewicz and Clark, 1986; Smolarkiewicz and Grabowski, 1990), which is monotonic and minimizes numerical diffusion. The horizontal diffusion step, if required, is explicit in time, while the vertical diffusion step is implicit. Horizontal boundary conditions include time-variable material inflow concentrations, upwind outflow, and a damping relaxation specification of climatological boundary concentrations.

Enhancements to EFDC

The version of EFDC used for this project incorporates a number of enhancements to the base EPA EFDC code[10]. These enhancements have been made to assist model development and application. Key enhancements to the EFDC code include the following:

- Dynamic memory allocation allows the user to use the same executable code for applications to different water bodies. This eliminates the need to re-compile the EFDC code for different applications because of different maximum array sizes required to specify the computational grid domain and time series input data sets. Dynamic allocation also helps prevent inadvertent errors and provides better traceability for source code development.
- Lagrangian particle tracking, with particle inputs assuming neutrally buoyant/zero mass particles or fixed depth drogues.
- Wind-generated wave bed shear stress.
- Enhanced heat exchange options that use equilibrium temperatures for the water and atmospheric interface and spatially variable sediment bed temperatures.

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[10] (www.epa.gov/ceampubl/swater/efdc/index.htm)

- New output snapshot controls for targeting specific periods for high frequency output within the standard regular output frequency.
- Streamlining the code for quicker execution times.
- Customizing linkage of model results for the Windows-based EFDC_Explorer graphical pre- and post-processor.

State Variables and Computed Output Variables of EFDC

Hydrodynamic models simulate velocity and transport fields, elevation of the free water surface, and bottom stress. The EFDC state variables include stage height or free water surface elevation, salinity, water temperature, and velocity. A three-dimensional application of EFDC simulates velocity in three-dimensions (x,y,z) as the 'u' and 'v' horizontal (x,y) components and the 'w' vertical (z) component. Turbulent kinetic energy and turbulent macroscale length scale parameters are also included as state variables. Water density is computed as a function of water temperature and salinity. EFDC computes horizontal diffusivity as an output variable of the model from horizontal turbulent closure methods. EFDC also computes vertical eddy viscosity and vertical eddy diffusivity from vertical turbulence closure schemes as output variables of the model.

EFDC_Explorer Description

The availability and capabilities of pre- and post-processing tools are critical to cost-effective and successful setup, calibration, and application of an EFDC model. The EFDC_Explorer pre- and post processor is Windows-based graphical user interface (GUI) public-domain software designed to support model setup, Cartesian and curvilinear grid generation, testing, calibration, and data visualization, including plots and animation of model results (Craig, 2008). EFDC_Explorer currently supports the following EFDC applications:

- Hydrodynamics
- Density dependent flow state variables: i.e., salinity and temperature
- Sediment transport (including the latest SEDFlume implementation)
- Particle/drogue tracks
- Toxics
- Water quality with sediment diagenesis
- Tracers

EFDC_Explorer is currently being used by EPA, USGS, USACE, Oklahoma Department of Environmental Quality, Texas Commission on Environmental Quality, Southwest Florida Water Management District, St. Johns River Water Management District, Suwannee River Water Management District, and private consulting firms in the US and other countries.

Attachment F2
Boundary Condition Time Series

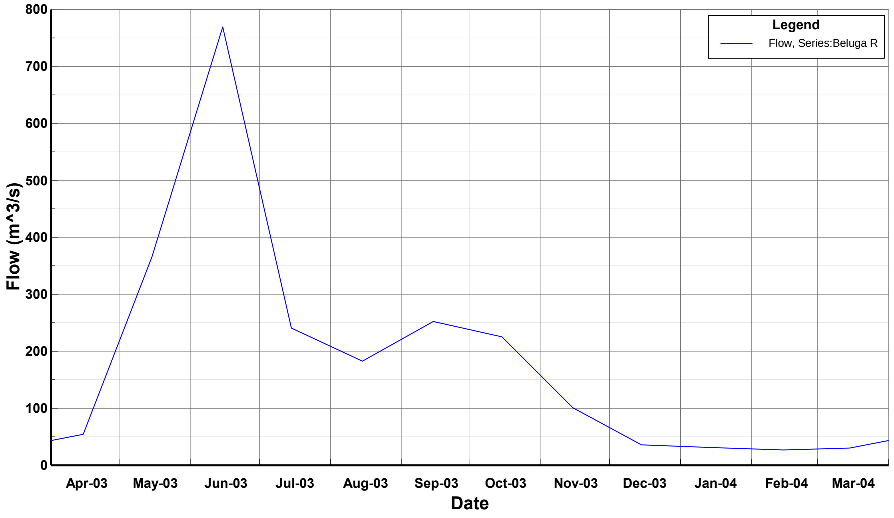


Figure II-1: BC_Flow_Beluga

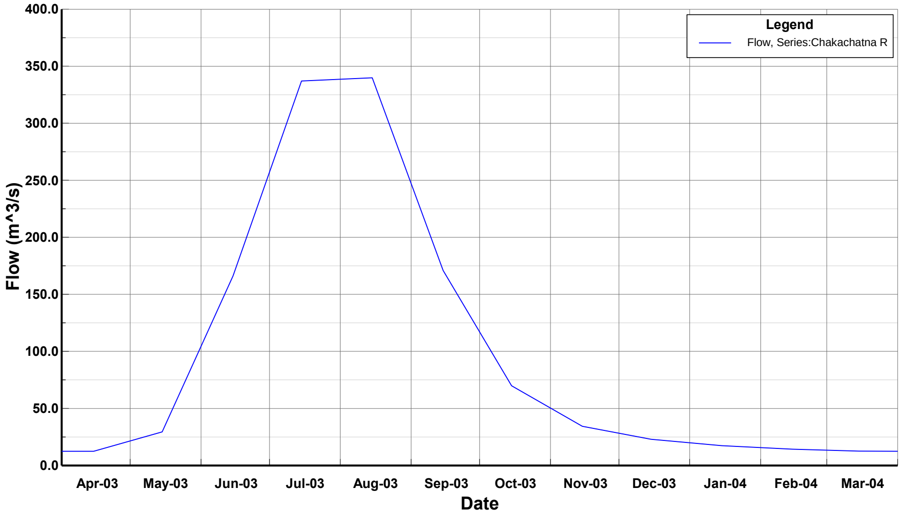


Figure II-2: BC_Flow_Chakachatna R

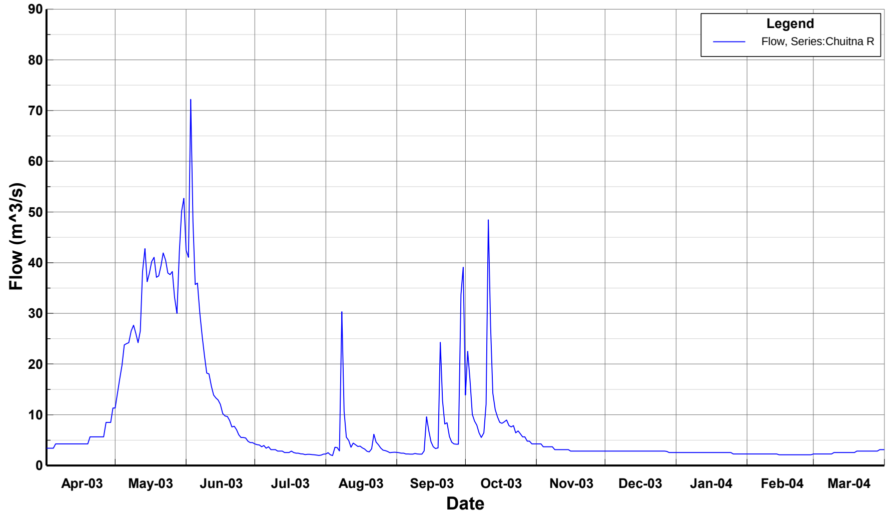


Figure II-3: BC_Flow_Chuitna R

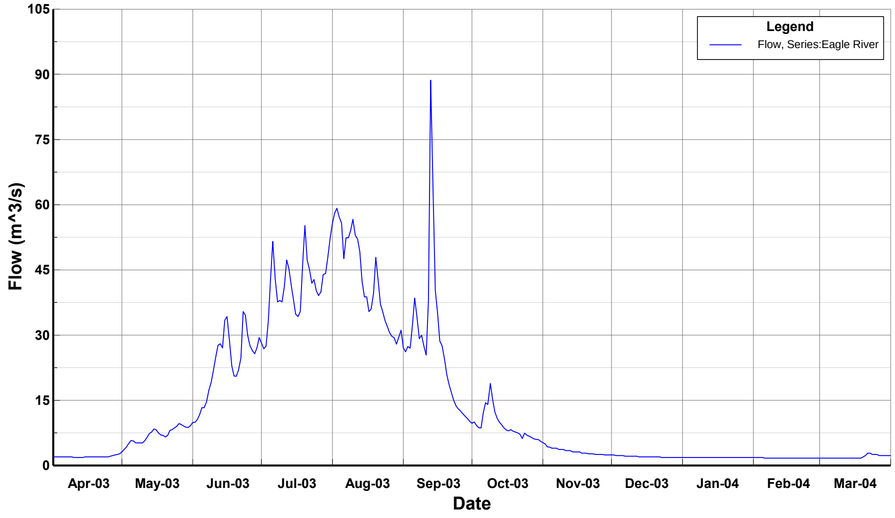


Figure II-4: BC_Flow_Eagle R

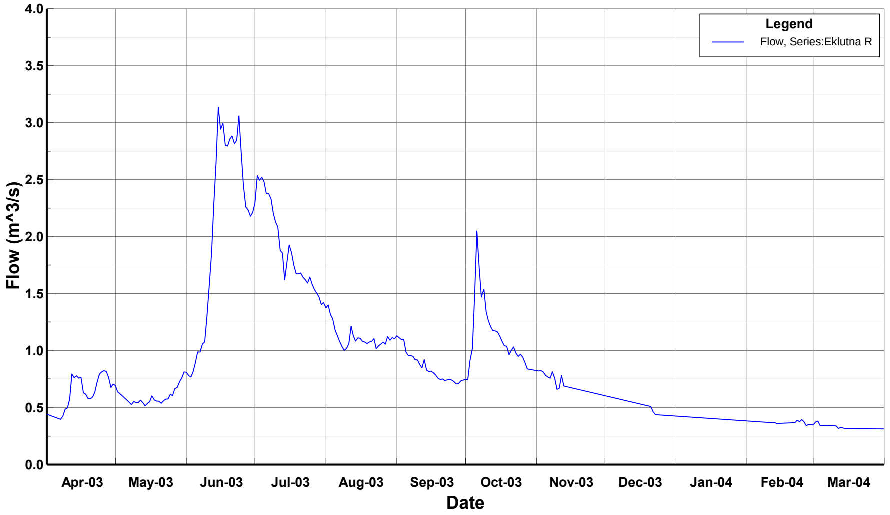


Figure II-5: BC_Flow_Eklutna R

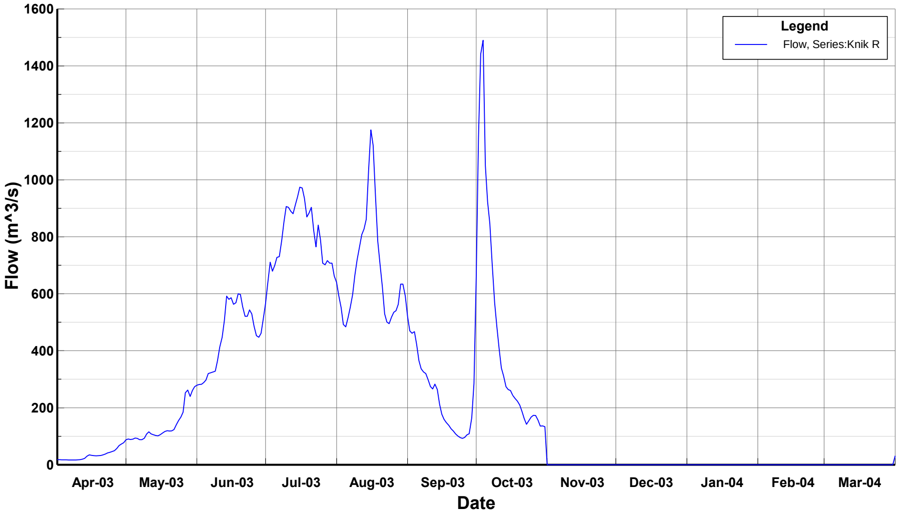


Figure II-6: BC_Flow_Knik R

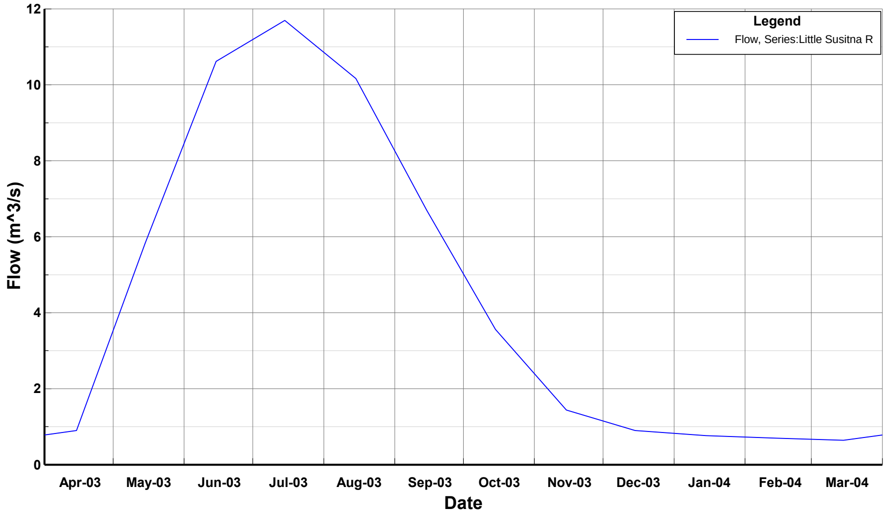


Figure II-7: BC_Flow_Little Susitna R

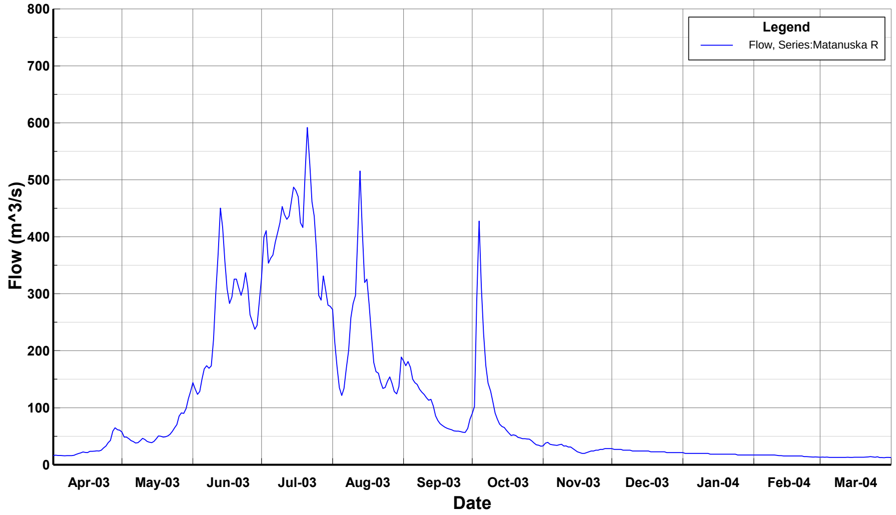


Figure II-8: BC_Flow_Matanuska R

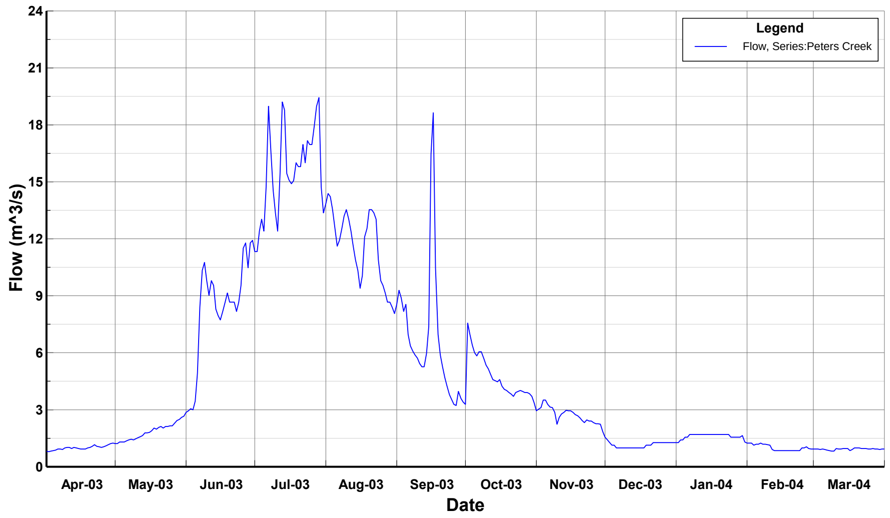


Figure II-9: BC_Flow_Peters Creek

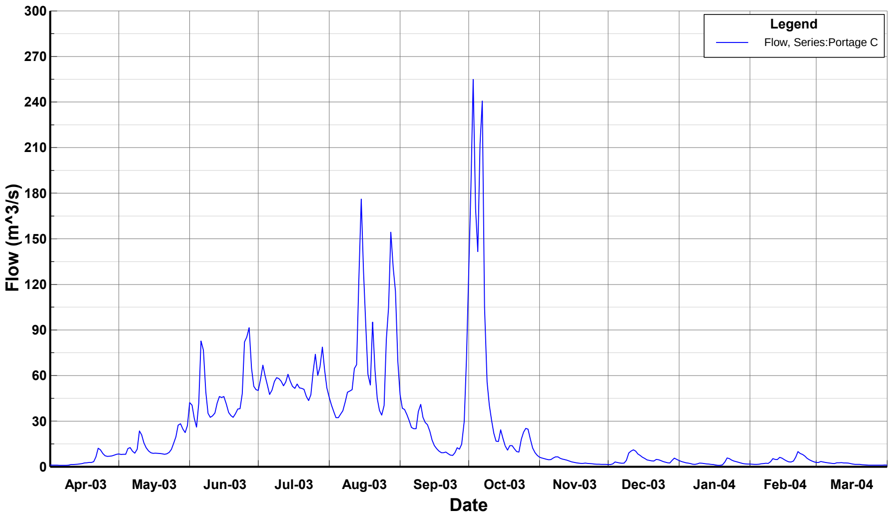


Figure II-10: BC_Flow_Portage C

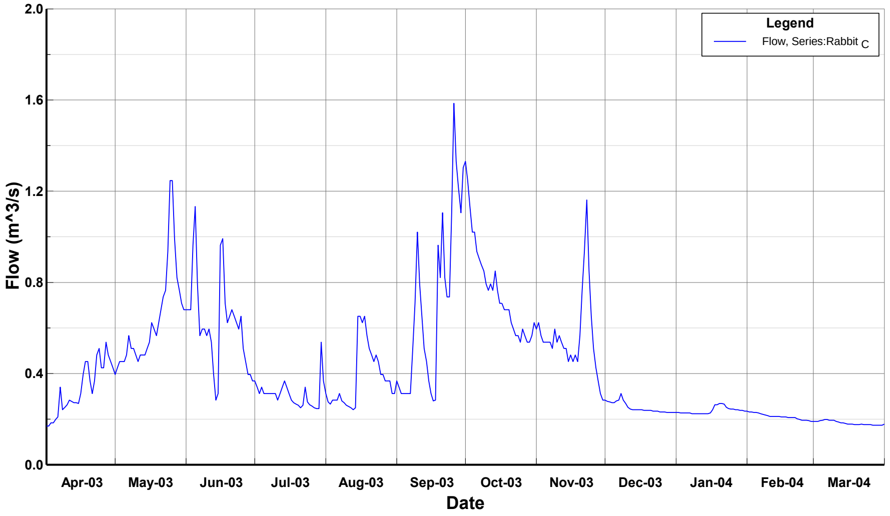


Figure II-11: BC_Flow_Rabbit C

Figure II-12: BC_Flow_Resurrection C

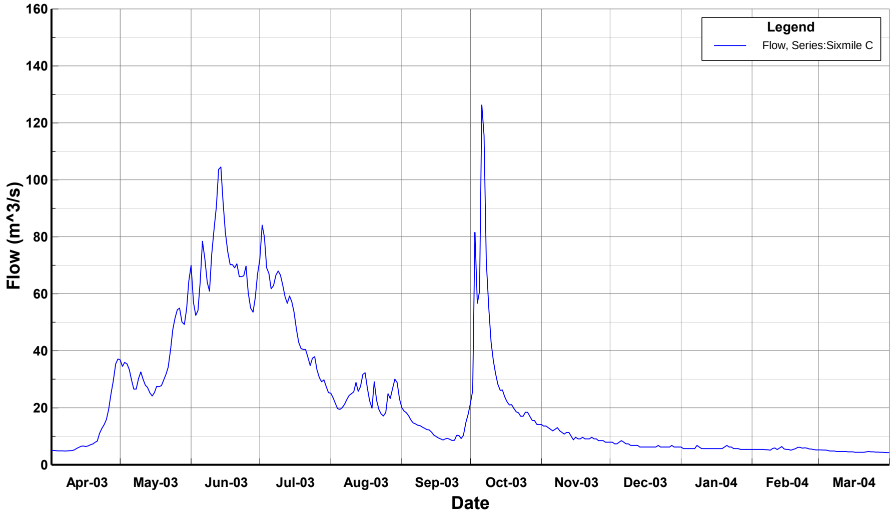


Figure II-13: BC_Flow_Sixmile C

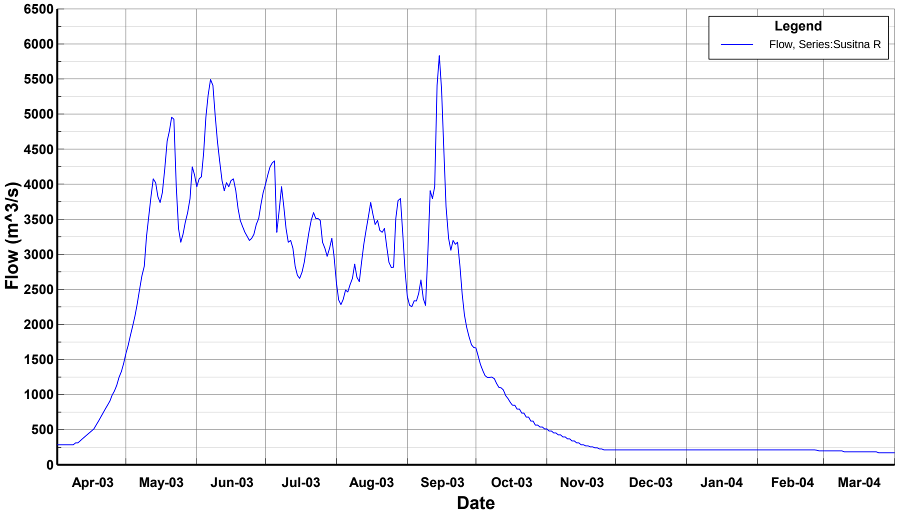


Figure II-14: BC_Flow_Susitna R

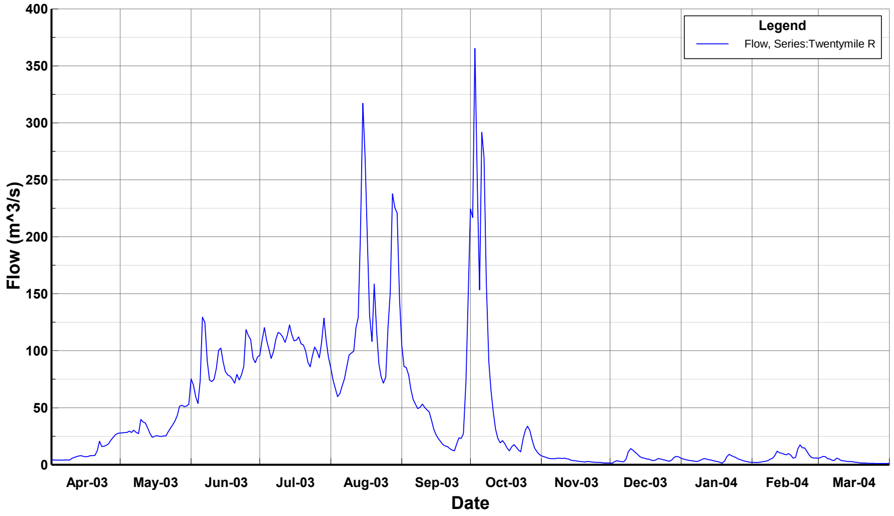


Figure II-15: BC_Flow_Twentymile R

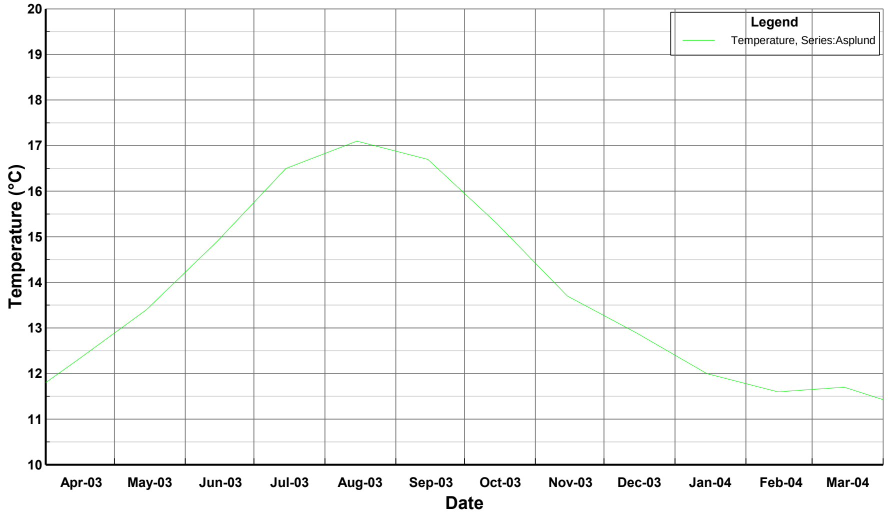


Figure II-16: Temperature_Asplund

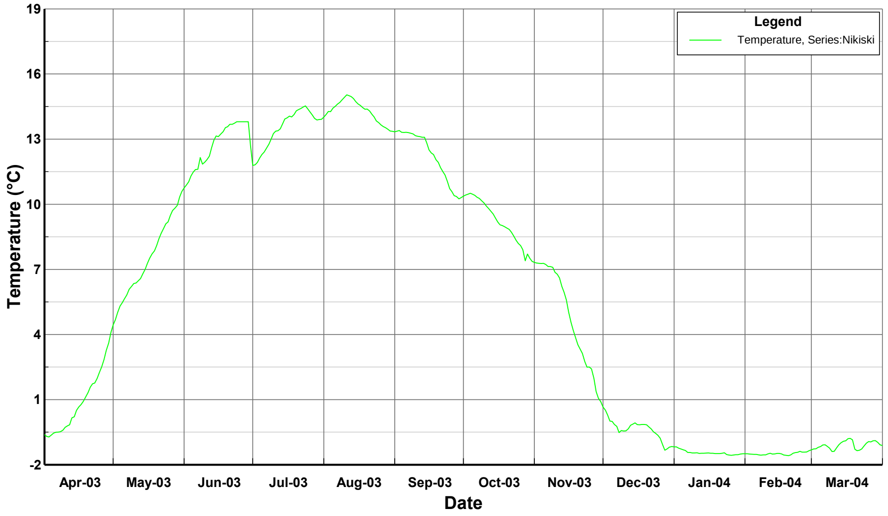


Figure II-17: Temperature_Nikiski

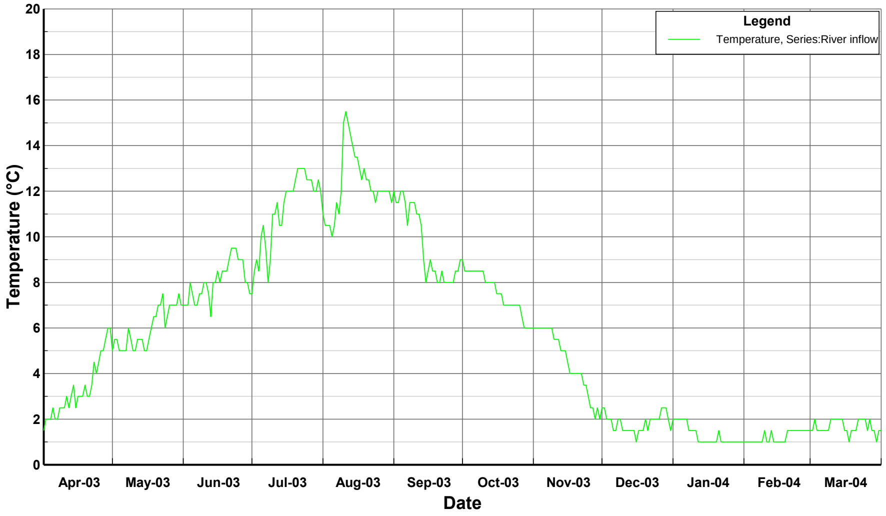


Figure II-18: Temperature_River inflow

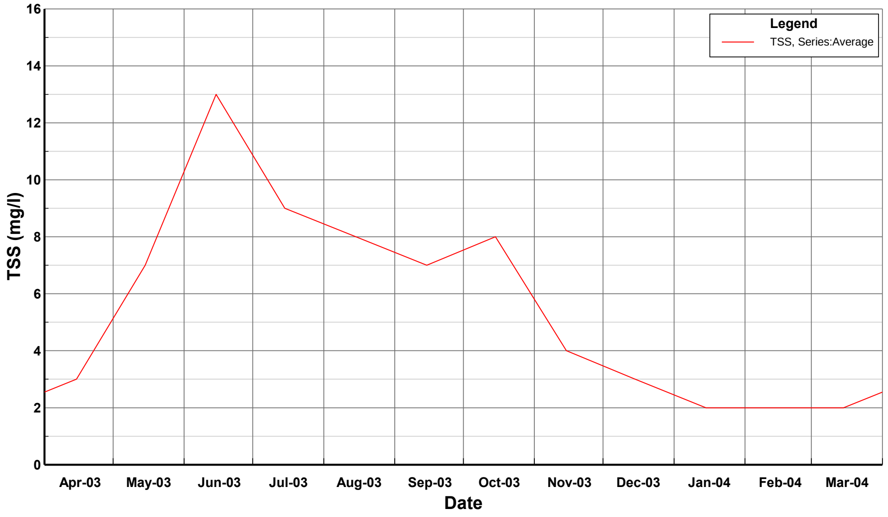


Figure II-19: TSS_Average

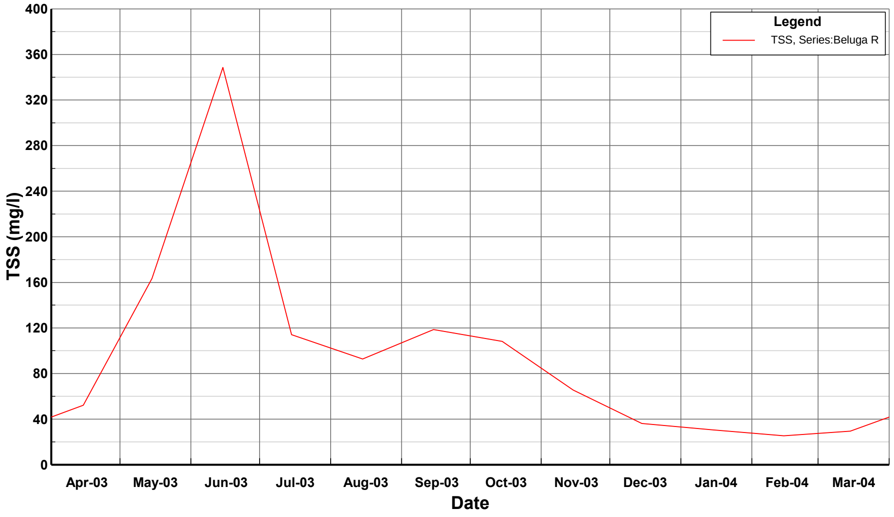


Figure II-20: TSS_Beluga R

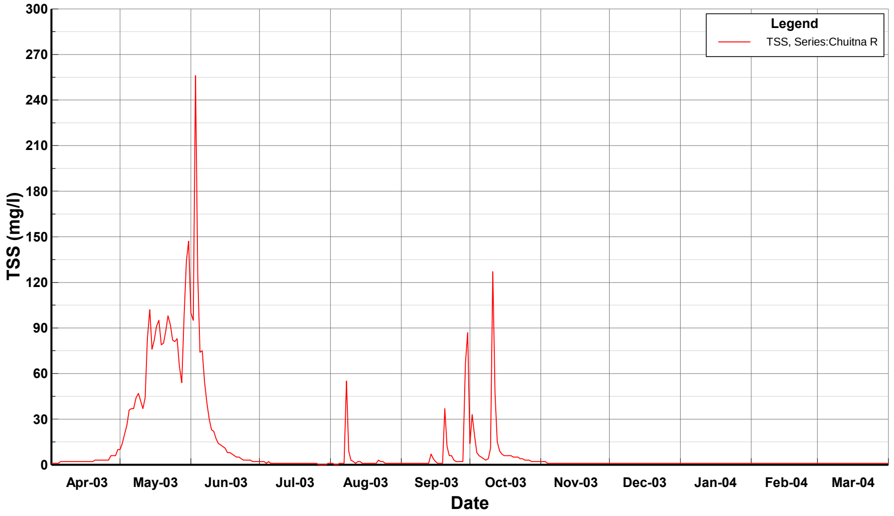


Figure II-21: TSS_Chuitna R

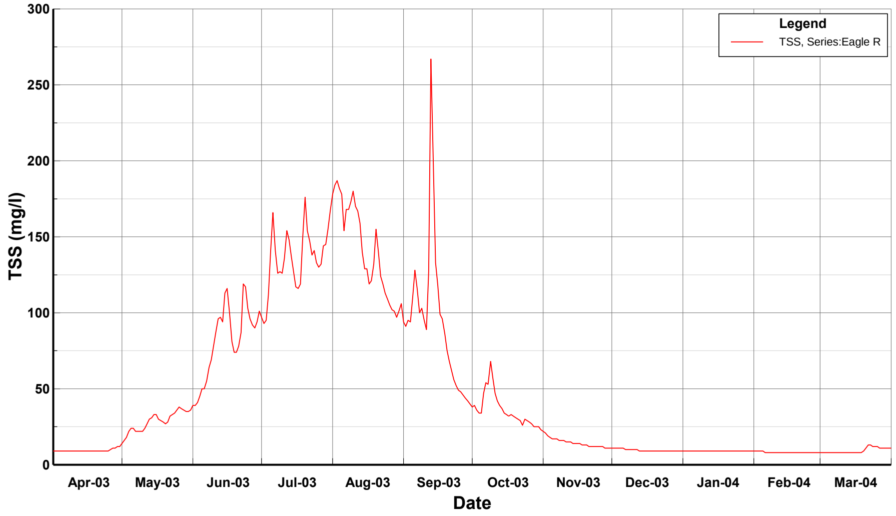


Figure II-22: TSS_Eagle R

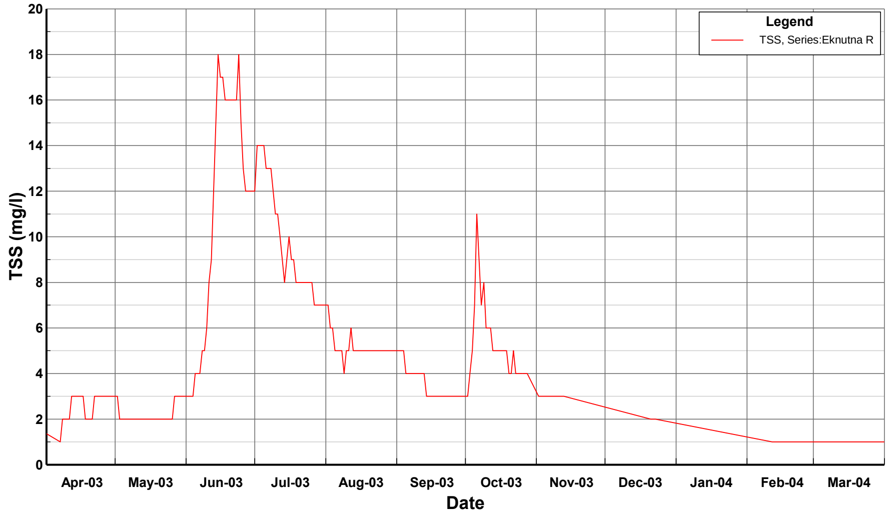


Figure II-23: TSS_Eknutna R

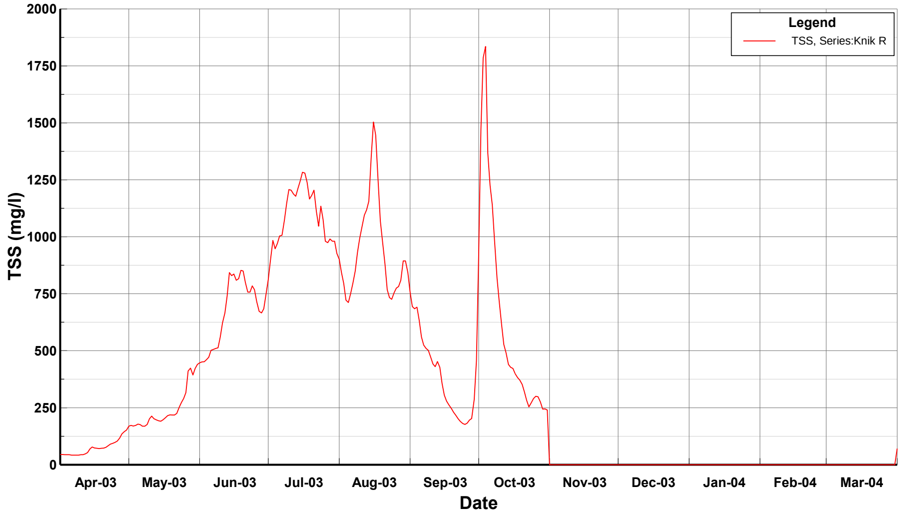


Figure II-24: TSS_Knik R

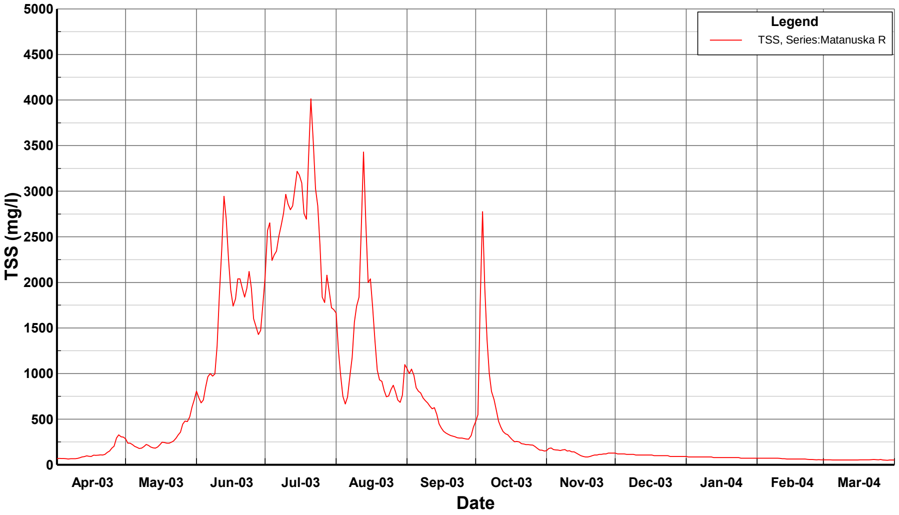


Figure II-25: TSS_Matanuska R

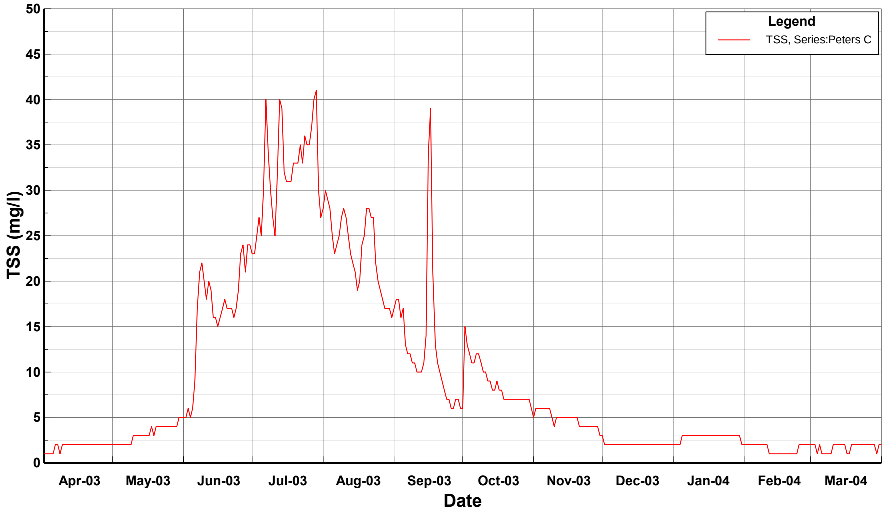
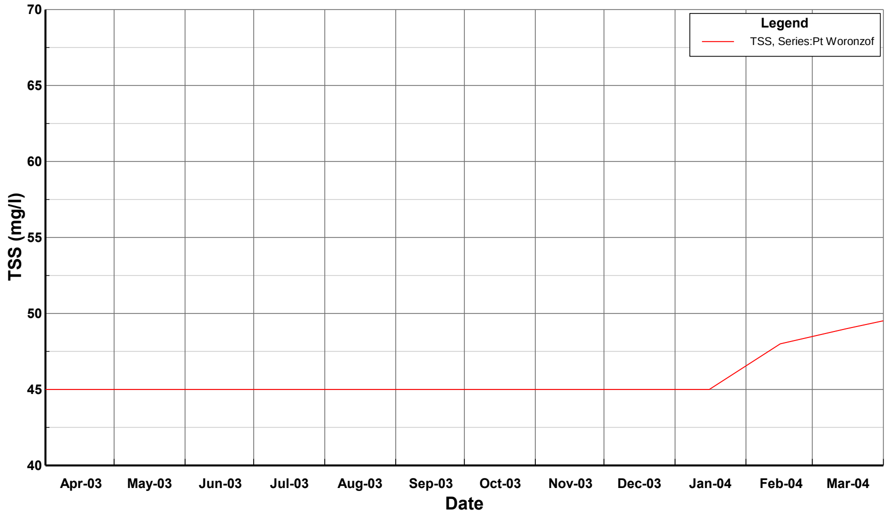


Figure II-26: TSS_Peters C



Fi

gure II-27: TSS_Pt Woronzof

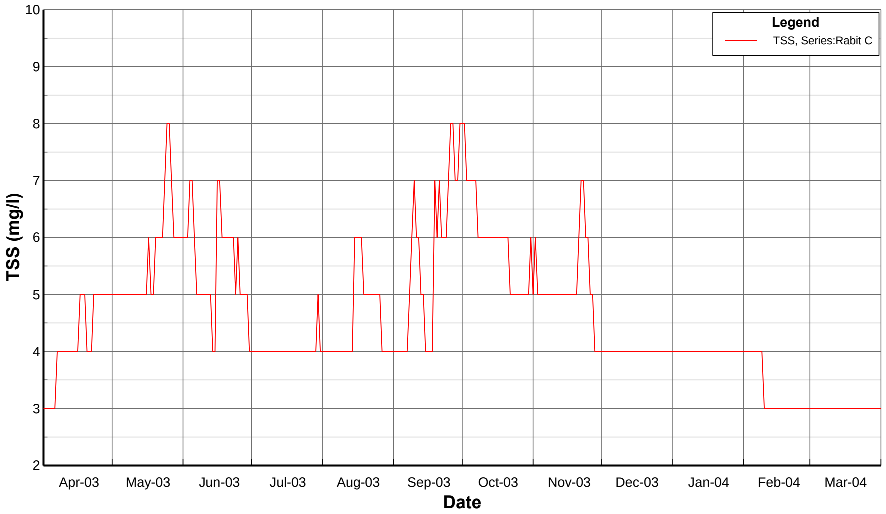


Figure II-28: TSS_Rabit C

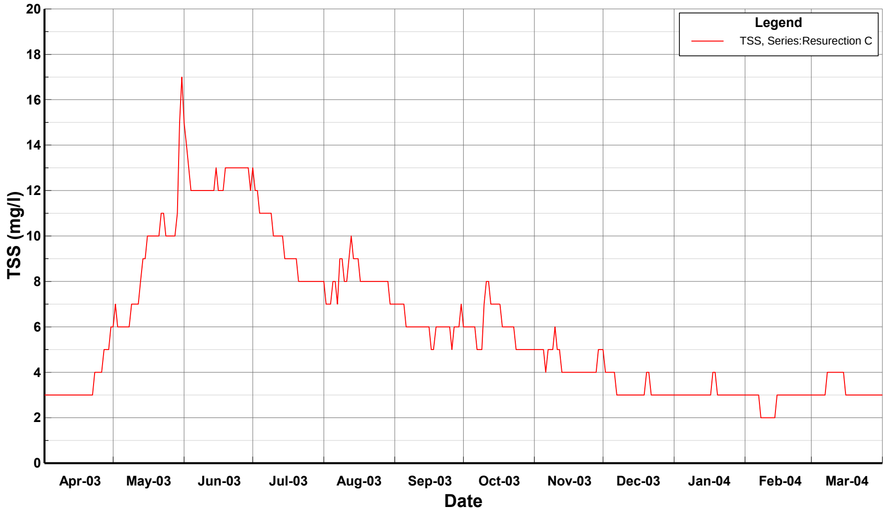


Figure II-29: TSS_Resurection C

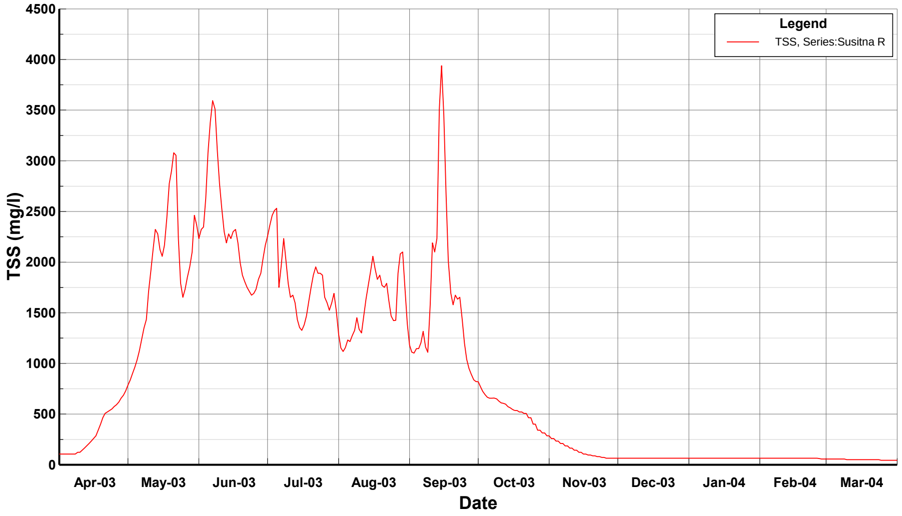


Figure II-30: TSS_Susitna R

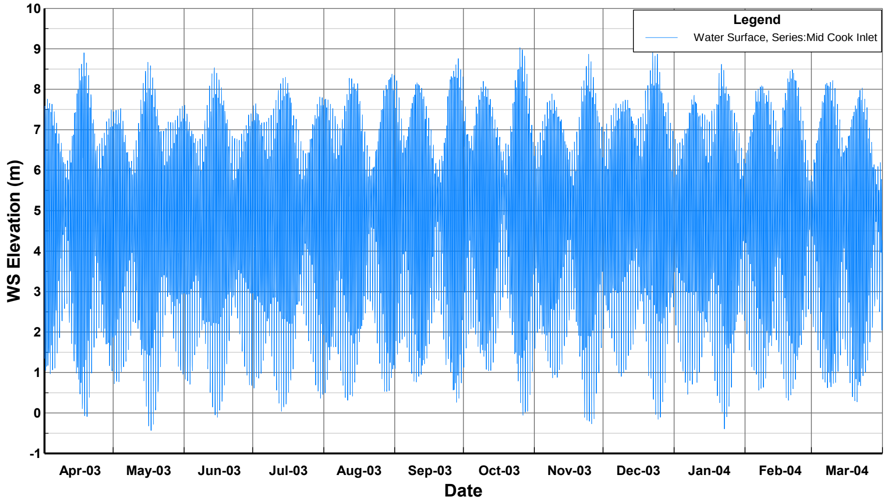
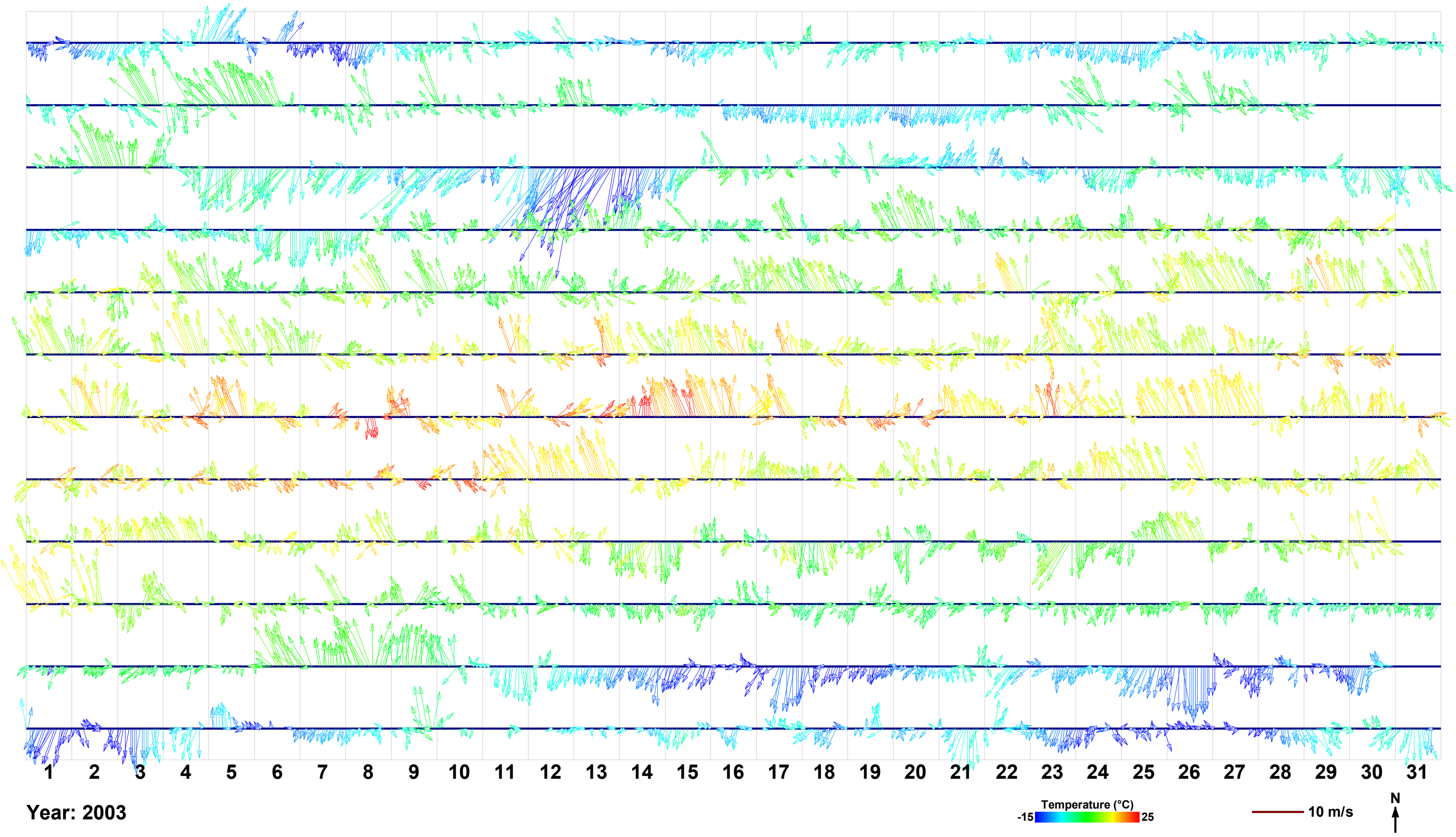


Figure II-31: WS_Mid Cook Inlet

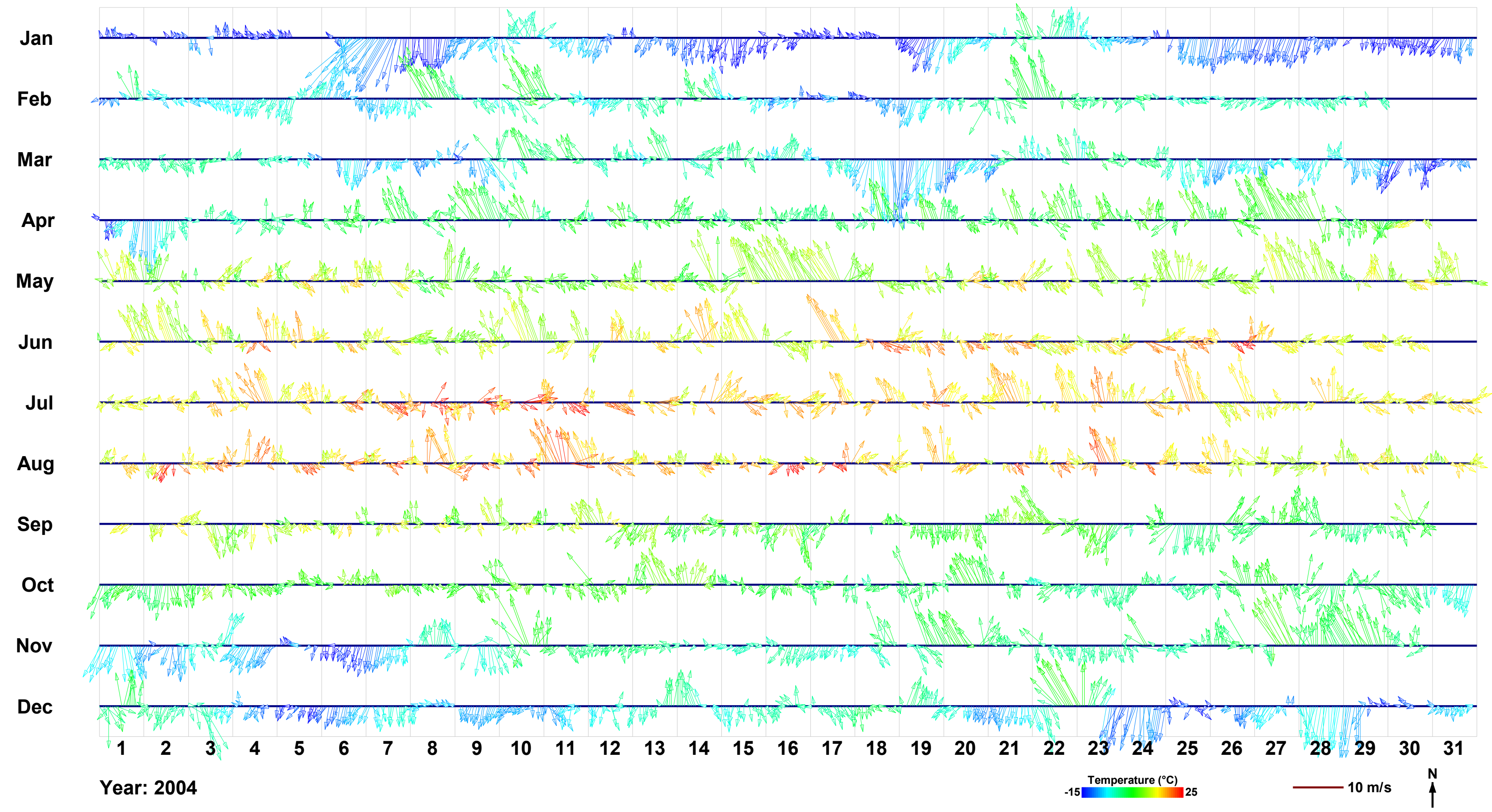
Attachment F3

Anchorage Meteorological Data Stick Plots

Anchorage Airport Wind Vector Stick Plot: 2003



Anchorage Airport Wind Vector Stick Plot: 2004



Attachment F4
Dye Water Column Summary Statistics by Region

No Degradation Case

Block Statistics for: Mid Upper Cook Inlet, Dye

Date	N	Avg	Std Dev	Min	Low Qtile	Median	Up Qtile	Max	Std Err	95% Confid Int
Apr-03	720	3.11E-04	3.39E-04	9.89E-05	2.03E-04	2.83E-04	3.46E-04	6.28E-04	1.26E-05	2.52E-05
May-03	744	3.82E-04	4.07E-04	1.55E-04	2.51E-04	3.67E-04	4.47E-04	6.58E-04	1.49E-05	2.98E-05
Jun-03	720	3.26E-04	3.46E-04	1.45E-04	2.25E-04	3.09E-04	3.60E-04	5.96E-04	1.29E-05	2.58E-05
Jul-03	744	2.13E-04	2.23E-04	1.03E-04	1.56E-04	2.03E-04	2.33E-04	3.63E-04	8.18E-06	1.64E-05
Aug-03	745	2.00E-04	2.08E-04	1.07E-04	1.49E-04	1.97E-04	2.27E-04	3.04E-04	7.63E-06	1.53E-05
Sep-03	720	2.13E-04	2.22E-04	1.05E-04	1.56E-04	2.09E-04	2.44E-04	3.28E-04	8.28E-06	1.66E-05
Oct-03	743	2.36E-04	2.47E-04	9.88E-05	1.77E-04	2.33E-04	2.69E-04	3.84E-04	9.05E-06	1.81E-05
Nov-03	720	2.75E-04	2.90E-04	1.19E-04	1.96E-04	2.66E-04	3.18E-04	4.56E-04	1.08E-05	2.16E-05
Dec-03	744	3.36E-04	3.56E-04	1.36E-04	2.26E-04	3.26E-04	3.94E-04	5.73E-04	1.31E-05	2.61E-05
Jan-04	744	3.95E-04	4.19E-04	1.71E-04	2.66E-04	3.79E-04	4.63E-04	6.89E-04	1.54E-05	3.07E-05
Feb-04	696	4.06E-04	4.32E-04	1.74E-04	2.74E-04	3.91E-04	4.70E-04	7.08E-04	1.64E-05	3.27E-05
Mar-04	720	4.23E-04	4.49E-04	1.75E-04	2.92E-04	4.09E-04	4.87E-04	7.27E-04	1.67E-05	3.35E-05

No Degradation Case

Block Statistics for: Knik Arm, Dye

Date	N	Avg	Std Dev	Min	Low Qtile	Median	Up Qtile	Max	Std Err	95% Confid Int
Apr-03	720	5.57E-04	5.60E-04	3.96E-04	5.19E-04	5.62E-04	5.77E-04	6.61E-04	2.09E-05	4.17E-05
May-03	744	6.15E-04	6.17E-04	4.80E-04	5.89E-04	6.15E-04	6.26E-04	7.06E-04	2.26E-05	4.52E-05
Jun-03	720	4.13E-04	4.26E-04	2.01E-04	3.32E-04	4.08E-04	4.50E-04	5.98E-04	1.59E-05	3.17E-05
Jul-03	744	2.06E-04	2.13E-04	9.83E-05	1.68E-04	2.03E-04	2.19E-04	3.26E-04	7.82E-06	1.56E-05
Aug-03	745	2.01E-04	2.05E-04	1.15E-04	1.69E-04	2.09E-04	2.24E-04	2.54E-04	7.49E-06	1.50E-05
Sep-03	720	2.68E-04	2.71E-04	1.58E-04	2.43E-04	2.74E-04	2.85E-04	3.30E-04	1.01E-05	2.02E-05
Oct-03	743	2.82E-04	2.85E-04	1.60E-04	2.63E-04	2.92E-04	3.02E-04	3.55E-04	1.04E-05	2.09E-05
Nov-03	720	4.15E-04	4.18E-04	2.71E-04	3.83E-04	4.26E-04	4.42E-04	4.92E-04	1.56E-05	3.12E-05
Dec-03	744	5.43E-04	5.45E-04	4.38E-04	5.16E-04	5.49E-04	5.62E-04	6.16E-04	2.00E-05	3.99E-05
Jan-04	744	6.59E-04	6.60E-04	5.56E-04	6.37E-04	6.65E-04	6.74E-04	7.37E-04	2.42E-05	4.84E-05
Feb-04	696	7.23E-04	7.24E-04	6.67E-04	7.09E-04	7.24E-04	7.30E-04	7.81E-04	2.74E-05	5.49E-05
Mar-04	720	7.61E-04	7.62E-04	6.82E-04	7.45E-04	7.62E-04	7.68E-04	8.34E-04	2.84E-05	5.68E-05

No Degradation Case

Block Statistics for: Turnagain Arm, Dye

Date	N	Avg	Std Dev	Min	Low Qtile	Median	Up Qtile	Max	Std Err	95% Confid Int
Apr-03	720	7.47E-05	7.53E-05	5.65E-05	6.94E-05	7.46E-05	7.66E-05	9.99E-05	2.80E-06	5.61E-06
May-03	744	6.15E-05	6.18E-05	4.91E-05	5.63E-05	6.15E-05	6.40E-05	7.57E-05	2.27E-06	4.53E-06
Jun-03	720	5.61E-05	5.65E-05	4.51E-05	5.10E-05	5.42E-05	5.61E-05	7.44E-05	2.11E-06	4.21E-06
Jul-03	744	4.93E-05	4.97E-05	3.61E-05	4.52E-05	5.02E-05	5.21E-05	6.24E-05	1.82E-06	3.64E-06
Aug-03	745	5.31E-05	5.38E-05	3.86E-05	4.66E-05	5.15E-05	5.42E-05	7.69E-05	1.97E-06	3.94E-06
Sep-03	720	5.12E-05	5.16E-05	3.99E-05	4.66E-05	5.03E-05	5.25E-05	6.91E-05	1.92E-06	3.85E-06
Oct-03	743	5.42E-05	5.48E-05	4.10E-05	4.87E-05	5.38E-05	5.60E-05	7.38E-05	2.01E-06	4.02E-06
Nov-03	720	5.77E-05	5.81E-05	4.62E-05	5.34E-05	5.64E-05	5.83E-05	7.91E-05	2.17E-06	4.33E-06
Dec-03	744	6.82E-05	6.86E-05	5.30E-05	6.34E-05	6.63E-05	6.82E-05	8.89E-05	2.52E-06	5.03E-06
Jan-04	744	8.50E-05	8.56E-05	6.52E-05	7.90E-05	8.43E-05	8.72E-05	1.08E-04	3.14E-06	6.27E-06
Feb-04	696	9.71E-05	9.75E-05	7.63E-05	9.09E-05	9.78E-05	1.01E-04	1.17E-04	3.70E-06	7.39E-06
Mar-04	720	9.91E-05	9.95E-05	8.14E-05	9.36E-05	9.96E-05	1.02E-04	1.16E-04	3.71E-06	7.42E-06

150 Day Half Life Case

Block Statistics for: Mid Upper Cook Inlet, Dye

Date	N	Avg	Std Dev	Min	Low Qtile	Median	Up Qtile	Max	Std Err	95% Confid Int
Apr-03	720	2.97E-04	3.23E-04	9.63E-05	1.94E-04	2.71E-04	3.31E-04	5.90E-04	1.20E-05	2.41E-05
May-03	744	3.53E-04	3.77E-04	1.41E-04	2.31E-04	3.39E-04	4.13E-04	6.14E-04	1.38E-05	2.76E-05
Jun-03	720	2.98E-04	3.17E-04	1.32E-04	2.04E-04	2.84E-04	3.30E-04	5.47E-04	1.18E-05	2.36E-05
Jul-03	744	1.99E-04	2.09E-04	9.59E-05	1.44E-04	1.91E-04	2.19E-04	3.39E-04	7.65E-06	1.53E-05
Aug-03	744	1.85E-04	1.92E-04	9.74E-05	1.34E-04	1.81E-04	2.11E-04	2.81E-04	7.06E-06	1.41E-05
Sep-03	720	1.99E-04	2.09E-04	9.56E-05	1.44E-04	1.94E-04	2.30E-04	3.11E-04	7.77E-06	1.55E-05
Oct-03	744	2.17E-04	2.27E-04	9.20E-05	1.60E-04	2.12E-04	2.48E-04	3.62E-04	8.33E-06	1.67E-05
Nov-03	720	2.56E-04	2.70E-04	1.10E-04	1.77E-04	2.49E-04	2.98E-04	4.27E-04	1.01E-05	2.01E-05
Dec-03	744	3.10E-04	3.30E-04	1.23E-04	2.05E-04	3.01E-04	3.63E-04	5.35E-04	1.21E-05	2.42E-05
Jan-04	744	3.60E-04	3.83E-04	1.53E-04	2.39E-04	3.47E-04	4.22E-04	6.32E-04	1.40E-05	2.81E-05
Feb-04	696	3.65E-04	3.89E-04	1.52E-04	2.44E-04	3.53E-04	4.23E-04	6.42E-04	1.48E-05	2.95E-05
Mar-04	717	3.75E-04	3.99E-04	1.51E-04	2.55E-04	3.63E-04	4.35E-04	6.51E-04	1.49E-05	2.98E-05

150 Day Half Life Case

Block Statistics for: Knik Arm, Dye

Date	N	Avg	Std Dev	Min	Low Qtile	Median	Up Qtile	Max	Std Err	95% Confid Int
Apr-03	720	5.30E-04	5.32E-04	3.96E-04	5.01E-04	5.30E-04	5.45E-04	6.41E-04	1.98E-05	3.97E-05
May-03	744	5.55E-04	5.57E-04	4.17E-04	5.27E-04	5.54E-04	5.66E-04	6.48E-04	2.04E-05	4.09E-05
Jun-03	720	3.69E-04	3.81E-04	1.80E-04	3.00E-04	3.63E-04	4.00E-04	5.38E-04	1.42E-05	2.84E-05
Jul-03	744	1.92E-04	1.99E-04	9.22E-05	1.56E-04	1.92E-04	2.05E-04	3.01E-04	7.28E-06	1.46E-05
Aug-03	744	1.88E-04	1.91E-04	1.08E-04	1.58E-04	1.98E-04	2.10E-04	2.39E-04	7.01E-06	1.40E-05
Sep-03	720	2.51E-04	2.54E-04	1.46E-04	2.26E-04	2.56E-04	2.66E-04	3.10E-04	9.47E-06	1.89E-05
Oct-03	744	2.60E-04	2.62E-04	1.47E-04	2.41E-04	2.70E-04	2.79E-04	3.27E-04	9.61E-06	1.92E-05
Nov-03	720	3.79E-04	3.82E-04	2.43E-04	3.49E-04	3.89E-04	4.03E-04	4.49E-04	1.42E-05	2.85E-05
Dec-03	744	4.90E-04	4.91E-04	3.91E-04	4.67E-04	4.94E-04	5.04E-04	5.55E-04	1.80E-05	3.60E-05
Jan-04	744	5.83E-04	5.85E-04	4.81E-04	5.63E-04	5.88E-04	5.99E-04	6.54E-04	2.14E-05	4.29E-05
Feb-04	696	6.30E-04	6.30E-04	5.67E-04	6.13E-04	6.30E-04	6.39E-04	6.83E-04	2.39E-05	4.78E-05
Mar-04	717	6.54E-04	6.55E-04	5.96E-04	6.36E-04	6.54E-04	6.63E-04	7.21E-04	2.45E-05	4.89E-05

150 Day Half Life Case

Block Statistics for: Turnagain Arm, Dye

Date	N	Avg	Std Dev	Min	Low Qtile	Median	Up Qtile	Max	Std Err	95% Confid Int
Apr-03	720	7.13E-05	7.18E-05	5.40E-05	6.50E-05	7.08E-05	7.36E-05	9.73E-05	2.68E-06	5.35E-06
May-03	744	5.51E-05	5.55E-05	4.23E-05	5.01E-05	5.50E-05	5.72E-05	6.99E-05	2.03E-06	4.07E-06
Jun-03	720	4.89E-05	4.93E-05	3.77E-05	4.41E-05	4.73E-05	4.91E-05	6.67E-05	1.84E-06	3.68E-06
Jul-03	744	4.28E-05	4.32E-05	3.01E-05	3.88E-05	4.34E-05	4.53E-05	5.51E-05	1.58E-06	3.17E-06
Aug-03	744	4.34E-05	4.38E-05	3.27E-05	3.89E-05	4.27E-05	4.48E-05	5.82E-05	1.61E-06	3.21E-06
Sep-03	720	4.44E-05	4.48E-05	3.36E-05	3.99E-05	4.35E-05	4.56E-05	6.17E-05	1.67E-06	3.34E-06
Oct-03	744	4.52E-05	4.56E-05	3.34E-05	4.06E-05	4.57E-05	4.76E-05	5.98E-05	1.67E-06	3.34E-06
Nov-03	720	4.85E-05	4.90E-05	3.55E-05	4.40E-05	4.73E-05	4.89E-05	6.92E-05	1.83E-06	3.65E-06
Dec-03	744	5.97E-05	6.02E-05	4.39E-05	5.51E-05	5.83E-05	6.02E-05	8.01E-05	2.21E-06	4.41E-06
Jan-04	744	7.43E-05	7.49E-05	5.48E-05	6.88E-05	7.40E-05	7.70E-05	9.58E-05	2.74E-06	5.49E-06
Feb-04	696	8.34E-05	8.39E-05	6.31E-05	7.75E-05	8.43E-05	8.66E-05	1.02E-04	3.18E-06	6.36E-06
Mar-04	717	8.30E-05	8.34E-05	6.62E-05	7.77E-05	8.34E-05	8.58E-05	9.85E-05	3.11E-06	6.23E-06

7 Day Half Life Case

Block Statistics for: Mid Upper Cook Inlet, Dye

Date	N	Avg	Std Dev	Min	Low Qtile	Median	Up Qtile	Max	Std Err	95% Confid Int
Apr-03	720	1.54E-04	1.67E-04	4.54E-05	9.76E-05	1.49E-04	1.79E-04	2.98E-04	6.21E-06	1.24E-05
May-03	744	1.38E-04	1.49E-04	4.64E-05	8.57E-05	1.36E-04	1.67E-04	2.44E-04	5.48E-06	1.10E-05
Jun-03	720	1.24E-04	1.32E-04	4.98E-05	8.03E-05	1.21E-04	1.46E-04	2.15E-04	4.92E-06	9.84E-06
Jul-03	744	1.01E-04	1.07E-04	4.56E-05	6.82E-05	9.91E-05	1.19E-04	1.68E-04	3.92E-06	7.85E-06
Aug-03	744	9.94E-05	1.05E-04	4.37E-05	6.66E-05	9.73E-05	1.17E-04	1.60E-04	3.86E-06	7.71E-06
Sep-03	720	1.03E-04	1.09E-04	4.10E-05	6.93E-05	1.01E-04	1.22E-04	1.67E-04	4.07E-06	8.13E-06
Oct-03	744	1.07E-04	1.13E-04	3.83E-05	7.40E-05	1.06E-04	1.25E-04	1.81E-04	4.14E-06	8.29E-06
Nov-03	720	1.21E-04	1.30E-04	4.25E-05	7.88E-05	1.20E-04	1.46E-04	2.08E-04	4.84E-06	9.67E-06
Dec-03	744	1.30E-04	1.40E-04	4.20E-05	8.12E-05	1.28E-04	1.56E-04	2.26E-04	5.14E-06	1.03E-05
Jan-04	745	1.38E-04	1.49E-04	4.70E-05	8.55E-05	1.35E-04	1.67E-04	2.44E-04	5.47E-06	1.09E-05
Feb-04	696	1.34E-04	1.45E-04	4.83E-05	8.21E-05	1.30E-04	1.62E-04	2.48E-04	5.50E-06	1.10E-05
Mar-04	720	1.37E-04	1.48E-04	4.59E-05	8.62E-05	1.35E-04	1.66E-04	2.47E-04	5.53E-06	1.11E-05

7 Day Half Life Case

Block Statistics for: Knik Arm, Dye

Date	N	Avg	Std Dev	Min	Low Qtile	Median	Up Qtile	Max	Std Err	95% Confid Int
Apr-03	720	2.33E-04	2.52E-04	8.13E-05	1.69E-04	2.07E-04	2.42E-04	6.41E-04	9.39E-06	1.88E-05
May-03	744	1.40E-04	1.46E-04	5.93E-05	1.01E-04	1.46E-04	1.63E-04	2.09E-04	5.34E-06	1.07E-05
Jun-03	720	1.12E-04	1.17E-04	4.95E-05	7.99E-05	1.16E-04	1.29E-04	1.75E-04	4.35E-06	8.71E-06
Jul-03	744	8.75E-05	9.15E-05	3.51E-05	6.31E-05	9.21E-05	1.03E-04	1.36E-04	3.35E-06	6.71E-06
Aug-03	744	9.22E-05	9.57E-05	4.11E-05	7.01E-05	9.65E-05	1.09E-04	1.30E-04	3.51E-06	7.02E-06
Sep-03	720	1.08E-04	1.11E-04	5.23E-05	8.62E-05	1.13E-04	1.24E-04	1.48E-04	4.13E-06	8.27E-06
Oct-03	744	1.06E-04	1.09E-04	4.01E-05	8.41E-05	1.12E-04	1.23E-04	1.46E-04	3.98E-06	7.97E-06
Nov-03	720	1.31E-04	1.35E-04	6.77E-05	1.04E-04	1.37E-04	1.49E-04	1.78E-04	5.02E-06	1.00E-05
Dec-03	744	1.37E-04	1.41E-04	7.52E-05	1.03E-04	1.44E-04	1.58E-04	1.91E-04	5.18E-06	1.04E-05
Jan-04	745	1.43E-04	1.48E-04	6.55E-05	1.06E-04	1.50E-04	1.68E-04	2.00E-04	5.43E-06	1.09E-05
Feb-04	696	1.42E-04	1.47E-04	6.77E-05	1.07E-04	1.50E-04	1.67E-04	2.01E-04	5.57E-06	1.11E-05
Mar-04	720	1.46E-04	1.51E-04	6.53E-05	1.08E-04	1.54E-04	1.71E-04	2.04E-04	5.62E-06	1.12E-05

7 Day Half Life Case

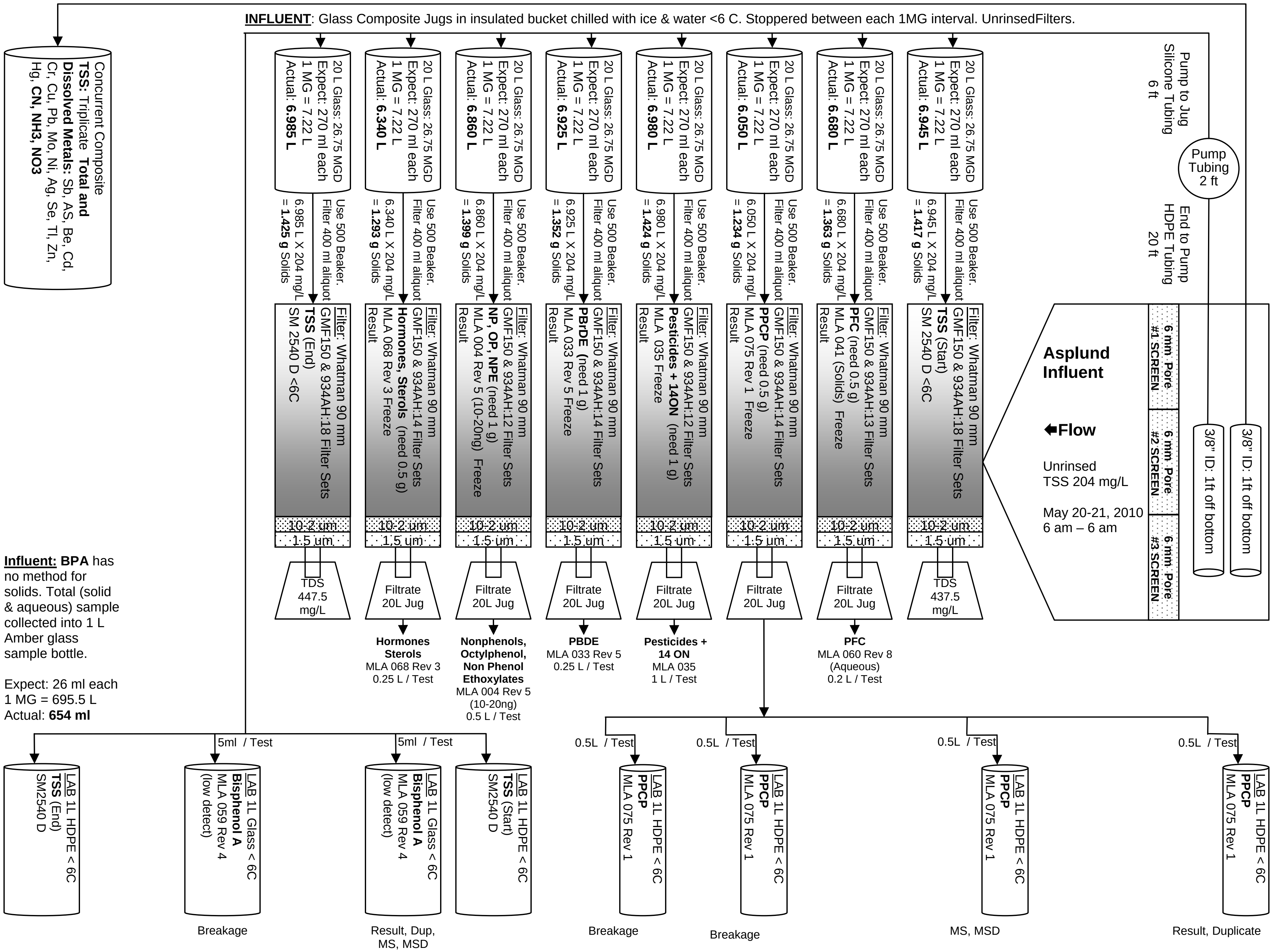
Block Statistics for: Turnagain Arm, Dye

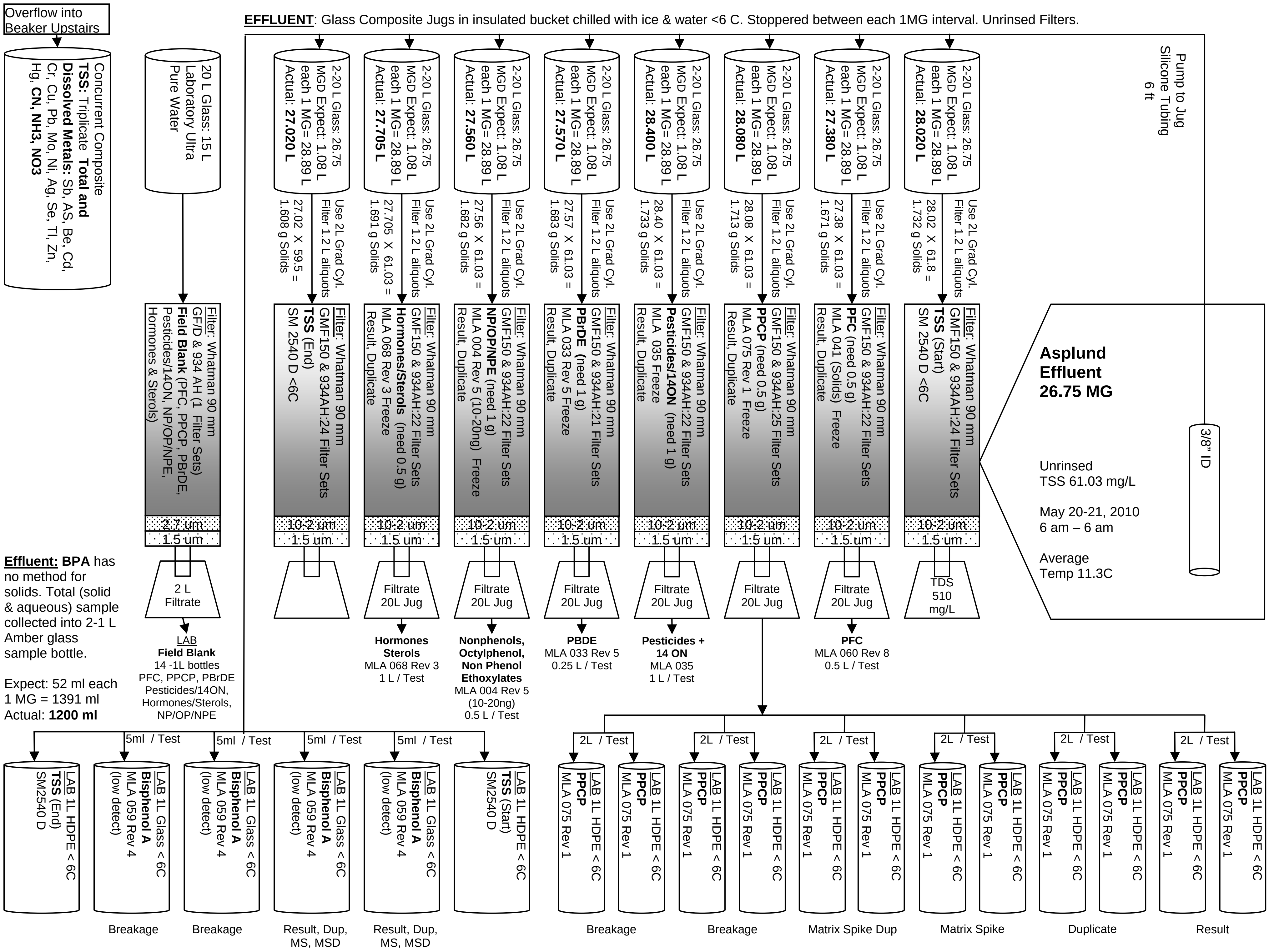
Date	N	Avg	Std Dev	Min	Low Qtile	Median	Up Qtile	Max	Std Err	95% Confid Int
Apr-03	720	3.23E-05	3.67E-05	1.09E-05	1.95E-05	2.60E-05	3.17E-05	9.61E-05	1.37E-06	2.73E-06
May-03	744	1.30E-05	1.34E-05	5.61E-06	1.06E-05	1.27E-05	1.38E-05	2.14E-05	4.91E-07	9.82E-07
Jun-03	720	1.15E-05	1.19E-05	4.84E-06	9.15E-06	1.11E-05	1.21E-05	2.06E-05	4.45E-07	8.90E-07
Jul-03	744	1.06E-05	1.09E-05	4.18E-06	8.43E-06	1.04E-05	1.18E-05	1.72E-05	4.01E-07	8.02E-07
Aug-03	744	1.23E-05	1.27E-05	5.56E-06	9.74E-06	1.18E-05	1.30E-05	2.04E-05	4.67E-07	9.35E-07
Sep-03	720	1.23E-05	1.28E-05	6.19E-06	9.78E-06	1.17E-05	1.30E-05	2.18E-05	4.78E-07	9.57E-07
Oct-03	744	1.22E-05	1.27E-05	5.98E-06	9.68E-06	1.20E-05	1.32E-05	2.02E-05	4.64E-07	9.28E-07
Nov-03	720	1.39E-05	1.44E-05	6.02E-06	1.13E-05	1.36E-05	1.45E-05	2.47E-05	5.35E-07	1.07E-06
Dec-03	744	1.68E-05	1.72E-05	8.14E-06	1.41E-05	1.70E-05	1.79E-05	2.63E-05	6.30E-07	1.26E-06
Jan-04	745	1.90E-05	1.95E-05	8.71E-06	1.59E-05	1.97E-05	2.08E-05	2.95E-05	7.14E-07	1.43E-06
Feb-04	696	1.80E-05	1.85E-05	9.00E-06	1.45E-05	1.82E-05	1.96E-05	2.79E-05	7.01E-07	1.40E-06
Mar-04	720	1.73E-05	1.79E-05	8.32E-06	1.38E-05	1.75E-05	1.89E-05	2.67E-05	6.69E-07	1.34E-06

Appendix G
Hydrodynamic Model Results
(CD in pocket inside back cover)

Appendix H

Sampling and Analysis of Asplund WPCF Influent and Effluent


INFLUENT: Glass Composite Jugs in insulated bucket chilled with ice & water <6 C. Stoppered between each 1MG interval. UnrinsedFilters.
Concurrent Composite
TSS: Triplicate Total and
Dissolved Metals: Sb, AS, Be, Cd,
Cr, Cu, Pb, Mo, Ni, Ag, Se, Tl, Zn,
Hg, CN, NH3, NO3
20 L Glass: 26.75 MGD
Expect: 270 ml each
1 MG = 7.22 L
Actual: 6.985 L
Use 500 Beaker.
Filter 400 ml aliquot
6.985 L X 204 mg/L
= 1.425 g Solids
Filter: Whatman 90 mm
GMF150 & 934AH:18 Filter Sets
TSS (End)
SM 2540 D <6C
10-2 um
1.5 um
TDS
447.5
mg/L
20 L Glass: 26.75 MGD
Expect: 270 ml each
1 MG = 7.22 L
Actual: 6.340 L
Use 500 Beaker.
Filter 400 ml aliquot
6.340 L X 204 mg/L
= 1.293 g Solids
Filter: Whatman 90 mm
GMF150 & 934AH:14 Filter Sets
Hormones, Sterols (need 0.5 g)
MLA 068 Rev 3 Freeze
Result
10-2 um
1.5 um
Filtrate
20L Jug
Hormones
Sterols
MLA 068 Rev 3
0.25 L / Test
20 L Glass: 26.75 MGD
Expect: 270 ml each
1 MG = 7.22 L
Actual: 6.860 L
Use 500 Beaker.
Filter 400 ml aliquot
6.860 L X 204 mg/L
= 1.399 g Solids
Filter: Whatman 90 mm
GMF150 & 934AH:12 Filter Sets
NP, OP, NPE (need 1 g)
MLA 004 Rev 5 (10-20ng) Freeze
Result
10-2 um
1.5 um
Filtrate
20L Jug
Nonphenols,
Octylphenol,
Non Phenol
Ethoxylates
MLA 004 Rev 5
(10-20ng)
0.5 L / Test
20 L Glass: 26.75 MGD
Expect: 270 ml each
1 MG = 7.22 L
Actual: 6.925 L
Use 500 Beaker.
Filter 400 ml aliquot
6.925 L X 204 mg/L
= 1.352 g Solids
Filter: Whatman 90 mm
GMF150 & 934AH:14 Filter Sets
PBrDE (need 1 g)
MLA 033 Rev 5 Freeze
Result
10-2 um
1.5 um
Filtrate
20L Jug
PBDE
MLA 033 Rev 5
0.25 L / Test
20 L Glass: 26.75 MGD
Expect: 270 ml each
1 MG = 7.22 L
Actual: 6.980 L
Use 500 Beaker.
Filter 400 ml aliquot
6.980 L X 204 mg/L
= 1.424 g Solids
Filter: Whatman 90 mm
GMF150 & 934AH:12 Filter Sets
Pesticides + 14ON (need 1 g)
MLA 035 Freeze
Result
10-2 um
1.5 um
Filtrate
20L Jug
Pesticides +
14 ON
MLA 035
1 L / Test
20 L Glass: 26.75 MGD
Expect: 270 ml each
1 MG = 7.22 L
Actual: 6.050 L
Use 500 Beaker.
Filter 400 ml aliquot
6.050 L X 204 mg/L
= 1.234 g Solids
Filter: Whatman 90 mm
GMF150 & 934AH:14 Filter Sets
PPCP (need 0.5 g)
MLA 075 Rev 1 Freeze
Result
10-2 um
1.5 um
Filtrate
20L Jug
20 L Glass: 26.75 MGD
Expect: 270 ml each
1 MG = 7.22 L
Actual: 6.680 L
Use 500 Beaker.
Filter 400 ml aliquot
6.680 L X 204 mg/L
= 1.363 g Solids
Filter: Whatman 90 mm
GMF150 & 934AH:13 Filter Sets
PFC (need 0.5 g)
MLA 041 (Solids) Freeze
Result
10-2 um
1.5 um
Filtrate
20L Jug
PFC
MLA 060 Rev 8
(Aqueous)
0.2 L / Test
20 L Glass: 26.75 MGD
Expect: 270 ml each
1 MG = 7.22 L
Actual: 6.945 L
Use 500 Beaker.
Filter 400 ml aliquot
6.945 L X 204 mg/L
= 1.417 g Solids
Filter: Whatman 90 mm
GMF150 & 934AH:18 Filter Sets
TSS (Start)
SM 2540 D <6C
10-2 um
1.5 um
TDS
437.5
mg/L
Pump to Jug
Silicone Tubing
6 ft
Pump
Tubing
2 ft
End to Pump
HDPE Tubing
20 ft
Asplund
Influent
Flow
Unrinsed
TSS 204 mg/L
May 20-21, 2010
6 am – 6 am
6 mm Pore
#1 SCREEN
6 mm Pore
#2 SCREEN
6 mm Pore
#3 SCREEN
3/8" ID: 1ft off bottom
3/8" ID: 1ft off bottom
Influent: BPA has no method for solids. Total (solid & aqueous) sample collected into 1 L Amber glass sample bottle.
Expect: 26 ml each
1 MG = 695.5 L
Actual: 654 ml
5ml / Test
5ml / Test
LAB 1L HDPE < 6C
TSS (End)
SM2540 D
LAB 1L Glass < 6C
Bisphenol A
MLA 059 Rev 4
(low detect)
Breakage
LAB 1L Glass < 6C
Bisphenol A
MLA 059 Rev 4
(low detect)
Result, Dup,
MS, MSD
LAB 1L HDPE < 6C
TSS (Start)
SM2540 D
0.5L / Test
0.5L / Test
0.5L / Test
0.5L / Test
LAB 1L HDPE < 6C
PPCP
MLA 075 Rev 1
Breakage
LAB 1L HDPE < 6C
PPCP
MLA 075 Rev 1
Breakage
LAB 1L HDPE < 6C
PPCP
MLA 075 Rev 1
MS, MSD
LAB 1L HDPE < 6C
PPCP
MLA 075 Rev 1
Result, Duplicate


EFFLUENT: Glass Composite Jugs in insulated bucket chilled with ice & water <6 C. Stoppered between each 1MG interval. Unrinsed Filters.
Overflow into Beaker Upstairs
Concurrent Composite
TSS: Triplicate Total and Dissolved Metals: Sb, AS, Be, Cd, Cr, Cu, Pb, Mo, Ni, Ag, Se, Tl, Zn, Hg, CN, NH3, NO3
20 L Glass: 15 L Laboratory Ultra Pure Water
Filter: Whatman 90 mm GF/D & 934 AH (1 Filter Sets) Field Blank (PFC, PPCP, PBrDE, Pesticides/14ON, NP/OP/NPE, Hormones & Sterols)
2.7 um
1.5 um
2 L Filtrate
LAB Field Blank 14 -1L bottles PFC, PPCP, PBrDE Pesticides/14ON, Hormones/Sterols, NP/OP/NPE
2-20 L Glass: 26.75 MGD Expect: 1.08 L each 1 MG= 28.89 L Actual: 27.020 L
Use 2L Grad Cyl. Filter 1.2 L aliquots 27.02 X 59.5 = 1.608 g Solids
Filter: Whatman 90 mm GMF150 & 934AH:24 Filter Sets TSS (End) SM 2540 D <6C
2-20 L Glass: 26.75 MGD Expect: 1.08 L each 1 MG= 28.89 L Actual: 27.705 L
Use 2L Grad Cyl. Filter 1.2 L aliquots 27.705 X 61.03 = 1.691 g Solids
Filter: Whatman 90 mm GMF150 & 934AH:22 Filter Sets Hormones/Sterols (need 0.5 g) MLA 068 Rev 3 Freeze Result, Duplicate
2-20 L Glass: 26.75 MGD Expect: 1.08 L each 1 MG= 28.89 L Actual: 27.560 L
Use 2L Grad Cyl. Filter 1.2 L aliquots 27.56 X 61.03 = 1.682 g Solids
Filter: Whatman 90 mm GMF150 & 934AH:22 Filter Sets NP/OP/NPE (need 1 g) MLA 004 Rev 5 (10-20ng) Freeze Result, Duplicate
2-20 L Glass: 26.75 MGD Expect: 1.08 L each 1 MG= 28.89 L Actual: 27.570 L
Use 2L Grad Cyl. Filter 1.2 L aliquots 27.57 X 61.03 = 1.683 g Solids
Filter: Whatman 90 mm GMF150 & 934AH:21 Filter Sets PBrDE (need 1 g) MLA 033 Rev 5 Freeze Result, Duplicate
2-20 L Glass: 26.75 MGD Expect: 1.08 L each 1 MG= 28.89 L Actual: 28.400 L
Use 2L Grad Cyl. Filter 1.2 L aliquots 28.40 X 61.03 = 1.733 g Solids
Filter: Whatman 90 mm GMF150 & 934AH:22 Filter Sets Pesticides/14ON (need 1 g) MLA 035 Freeze Result, Duplicate
2-20 L Glass: 26.75 MGD Expect: 1.08 L each 1 MG= 28.89 L Actual: 28.080 L
Use 2L Grad Cyl. Filter 1.2 L aliquots 28.08 X 61.03 = 1.713 g Solids
Filter: Whatman 90 mm GMF150 & 934AH:25 Filter Sets PPCP (need 0.5 g) MLA 075 Rev 1 Freeze Result, Duplicate
2-20 L Glass: 26.75 MGD Expect: 1.08 L each 1 MG= 28.89 L Actual: 27.380 L
Use 2L Grad Cyl. Filter 1.2 L aliquots 27.38 X 61.03 = 1.671 g Solids
Filter: Whatman 90 mm GMF150 & 934AH:22 Filter Sets PFC (need 0.5 g) MLA 041 (Solids) Freeze Result, Duplicate
2-20 L Glass: 26.75 MGD Expect: 1.08 L each 1 MG= 28.89 L Actual: 28.020 L
Use 2L Grad Cyl. Filter 1.2 L aliquots 28.02 X 61.8 = 1.732 g Solids
Filter: Whatman 90 mm GMF150 & 934AH:24 Filter Sets TSS (Start) SM 2540 D <6C
10-2 um
1.5 um
Filtrate 20L Jug
TDS 510 mg/L
Hormones Sterols MLA 068 Rev 3 1 L / Test
Nonphenols, Octylphenol, Non Phenol Ethoxylates MLA 004 Rev 5 (10-20ng) 0.5 L / Test
PBDE MLA 033 Rev 5 0.25 L / Test
Pesticides + 14 ON MLA 035 1 L / Test
PFC MLA 060 Rev 8 0.5 L / Test
Pump to Jug Silicone Tubing 6 ft
3/8" ID
Asplund Effluent 26.75 MG
Unrinsed TSS 61.03 mg/L
May 20-21, 2010 6 am – 6 am
Average Temp 11.3C
Effluent: BPA has no method for solids. Total (solid & aqueous) sample collected into 2-1 L Amber glass sample bottle.
Expect: 52 ml each 1 MG = 1391 ml Actual: 1200 ml
5ml / Test
LAB 1L HDPE < 6C TSS (End) SM2540 D
LAB 1L Glass < 6C Bisphenol A MLA 059 Rev 4 (low detect)
LAB 1L HDPE < 6C TSS (Start) SM2540 D
Breakage
Result, Dup, MS, MSD
2L / Test
LAB 1L HDPE < 6C PPCP MLA 075 Rev 1
Matrix Spike Dup
Matrix Spike
Duplicate
Result

SAMPLING & ANALYSIS PLAN FOR EMERGING POLLUTANTS OF CONCERN

ANCHORAGE WATER AND WASTEWATER UTILITY (AWWU)
JOHN M. ASPLUND WATER POLLUTION CONTROL FACILITY
ANCHORAGE, ALASKA

Prepared for:

MUNICIPALITY OF ANCHORAGE
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Anchorage, Alaska

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May 2010

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Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
BE	biological evaluation
BPA	bisphenol-A
°C	degrees Celsius
CEC's	contaminants of emerging concerns
COC	chain-of-custody
DQO	data quality objective
EDC	endocrine disruptor chemicals
FD	field duplicate
HDPE	high density polyethylene
ID	identifier
MDL	method detection limit(s)
MQO	measurement quality objective
MS	matrix spike
MSD	matrix spike duplicate
NP	nonyl phenols
PBDE	polybrominated diphenyl ether
POTW	publicly owned treatment works
PPCP	pharmaceuticals and personal care products
PFC	perfluorinated compounds
QA/QC	quality assurance/quality control
SAP	Sampling and Analysis Plan
SPE	solid phase extraction
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
WET	whole effluent toxicity

SECTION 1

Introduction and Background

This Sampling and Analysis Plan (SAP) was prepared on behalf of the Anchorage Water and Wastewater Utility (AWWU), Anchorage, Alaska. AWWU is developing a biological evaluation (BE) of the effects of reauthorization of its National Pollution Discharge Elimination System (NPDES) permit for the John M. Asplund Water Pollution Control Facility's (Asplund WPCF) discharge into the Knik Arm of Cook Inlet. The BE will allow U.S. Environmental Protection Agency (USEPA) to determine, in consultation with federal resource management services, whether adverse effects on endangered species or critical habitat can occur as a result of permit reauthorization.

As part of the BE, analytical data will be gathered on the occurrence of unregulated trace contaminants in the Asplund WPCF influent and final effluent (after treatment and prior to discharge to Cook Inlet), with the focus on emerging pollutants of concern, especially polybrominated diphenyl ethers (PBDEs), endocrine disruptors, and pharmaceuticals and personal care products (PPCP).

The purpose of this SAP is to provide direction for sampling and analytical procedures to characterize the wastewater system for emerging pollutants of concern. The resulting data may be used in modeling for risk analysis in support of the BE.

1.1. Site Description and Background

Anchorage Water and Wastewater Utility discharges treated wastewater from the Asplund WPCF into Cook Inlet at Point Woronzof in Anchorage, Alaska, in accordance with the NPDES permit (No. AK-002251-1) administered by the USEPA as prescribed by the Clean Water Act for this facility.

The discharge is authorized by an NPDES permit issued by the USEPA Region 10, and approved by state regulatory agencies. The NPDES permit requires extensive influent, effluent, and biosolids monitoring, as well as extensive physical, chemical, and biological monitoring of the receiving waters. This comprehensive monitoring program has been actively documenting Asplund WPCF wastewater performance and receiving water conditions in Cook Inlet since 1986.

Asplund WPCF influent is primarily of domestic origin, although a limited industrial component is included. AWWU has established local limits for sewer discharge in the local sewer use ordinance and conducts an active Pretreatment and Non-Industrial Source Control Program. AWWU permits and monitors Significant Industrial Users. There are no combined sewers in the Anchorage sewer system. The existing facility provides treatment for a design average flow of 58 million gallons per day (mgd) and a maximum hourly flow of 158 mgd. The annual average daily discharge is approximately 28 mgd.

Existing treatment units provide screening, grit removal, sedimentation, skimming, and chlorination. The treatment process achieves removal rates that are much higher than typical primary treatment facilities, and higher than typical advanced (chemical) primary treatment. Sludge from the primary clarifiers is thickened and dewatered. The dewatered sludge and skimmings are incinerated and the ash disposed of in a sanitary landfill.

Chlorinated primary effluent is discharged through a 120-inch diameter chlorine contact tunnel and then through an 84-inch diameter outfall to the Knik Arm of Cook Inlet. The Point Woronzof outfall extends 804 feet from the shore at Point Woronzof and terminates as a trifurcated diffuser.

1.2 Project Objective

The objective of this sampling program is to obtain sample results of unregulated trace contaminants in the sewage influent and final effluent, with a focus on seven distinct classes of pollutants of emerging concern and endocrine disruptors, (PPCPs, Sterols/Hormones, Pesticides, PBDEs, PFC's, NP's and BPA), with results to be used in support of the BE. To provide temporal representativeness, twenty-four hour composite samples of both influent and effluent aqueous/dissolved fractions are proposed to be taken at the Asplund WPCF as flow proportioned grabs using ISCO compositing samplers. Solid phase fractions will be composited on 1.5µ glass microfiber filters for separate analysis and comparison to dissolved phase concentrations. Sampling will target days when normal influent/effluent quality is anticipated, to capture both commercial/industrial and domestic input.

The USEPA has recently completed a survey of the Occurrence of Contaminants of Emerging Concern in Wastewater from Nine Publicly Owned Treatment Works (POTWs): USEPA, Office of Water. August 2009 [EPA-821-R-09-009. AXYS Analytical Services, LTD. of Sidney, British Columbia worked with USEPA to refine this study and develop appropriate test methods. Although analytical methods have evolved slightly to incorporate improvements it is expected that the results from this investigation will be comparable to the Nine POTW USEPA study of 2009.

SECTION 2

Field Sampling Procedure

2.1 Influent and Effluent Sampling

AWWU will collect 24-hour flow-proportional composite influent and effluent samples using ISCO samplers and grabs. Sampling will take place on a weekday to be representative of influent or effluent averages. Recommended sample containers, preservation, and holding times are summarized in Tables 1 and 2. The sampling locations will be routine NPDES sampling points at the Asplund Water Pollution Control Facility (WPCF) as required in the NPDES permit.

Sampling is scheduled to be performed once during May 2010 in conjunction with regularly scheduled annual second quarter Whole Effluent Toxicity (WET) sampling and testing. There are seven discrete sample extractions and analyses to be performed for both influent and effluent filtered aqueous phase samples in the cumulative sample program. Suspended solids for six analyses will be filter concentrated on 1.5 µm filters and analyzed. The purpose of the split-sampling and analysis is to identify what fraction of the detected concentrations in influents and final effluent may be associated with suspended solids versus the portion that is in the dissolved aqueous phase that is considered biologically available.

The calibrated effluent/TRC contact time return line which is the designated sample point for NPDES compliance sampling (i.e.: summer-wet and summer-dry sampling, pretreatment metals, and WET testing) will be “pigged” for cleaning. The regular dedicated ISCO 4500 sampler will collect a flow based composite for the scheduled quarterly WET test. A second sample line will tee off to another ISCO or similar peristaltic pump sampling for chemistry. This pump will be utilized to collect flow based discrete grabs that will be dechlorinated then composited in 20 L jugs prior to filtration. All filtering apparatus, sampling equipment, and sample lines [High Density Polyethylene, (HDPE) or silicon as required] will be precleaned by Kinnetic Laboratories Inc. at their Santa Cruz, California facility.

Beginning at 06:00am water quality analysts will sample and then begin observing plant flow rates and sample after one million gallons of throughput; continuing after every subsequent 1 million gallons for 24 hours; collecting a true flow based composite sample incorporating one full day. Plant effluent stream averages 28 million gallons per day (mgd) so samples will need to be collected approximately every hour probably as often as every 45 minutes during peak volume flow for the two usual peak flows (mid morning and mid afternoon). Due to the labor intensive sample method it may be necessary to use at least a two man crew, one for influent works and one for effluent works. Though influent and effluent rates vary during the course of the day operators will sample according to effluent flow meter data.

Sampling will suspend at 06:00am the subsequent day and the final plant effluent volumes recorded. It is not necessary to include a fraction from the last partial million gallons of plant flow.

Solid phase extracts will be collected on discrete glass-fiber filter sets for both influents and effluents. AXYS has requested sample masses of 0.5 -1.0 grams for solid phase extractions. Effluent TSS is typically 40 – 60 mg/liter and plant throughput is on the order of 28 MGD. An effluent composite volume of approximately 30L should provide a filterable solids sample of approximately 1.2 grams retained on the filter matrix. Influent TSS averages ~250 mg/L, a composite sample volume of ~ 8.5 liters should yield a filterable solids sample of ~2.0 grams. Samples will be deposited on the filters by vacuum filtration of the flow based composites across the filters. It is anticipated that as many as 15 glass-fiber filter sets will be necessary to filter the required 30 liters of effluent and 8.5 liters of influent called for in this sampling program. Multiple filters will then be deposited into pre-cleaned, analyte appropriate sample containers.

Aqueous phase samples from influent and effluent composites will be collected after filtration into 1-l amber glass or HDPE sample bottles, (except for Bisphenol-A which has no separate solid phase analysis and will be shipped whole to AXYS for examination). Flow composites as described for influent and effluent should provide enough sample volume for sample extractions, duplicate and MS/MSD as appropriate for each of the seven requested sample analysis groups.

Except for the larger volume and dechlorination of the effluent composite and different extraction volumes requested for some analytes, influent and effluent sampling methods will be identical.

2.2 Effluent Sampling

Over the 24 hour period, the water quality analysts will collect sample aliquots of 540ml effluent after every one million gallons of plant through put. These aliquots will be dispensed into an array of 20-L precleaned glass borosilicate collection jugs encased in wet ice and water; two 20-L jugs for each of six types of sample analyte groups, BPA analysis will only be performed on the aqueous phase and will be shipped to AXYS as whole effluent (unfiltered) thus will be composited directly into two 1L sample containers in aliquots of 26 mls. In addition, four jugs will be dedicated to assembling equivalent composites for TSS analysis. Each of the sixteen 20-L jugs will receive 540ml's of effluent every one million gallons. This will produce twelve comparable flow based ~15 L composites available for sampling into six discrete filterable solid samples and enough volume for six filtered aqueous phase subsamples including their primary extractions, duplicate extraction, Matrix Spike and Matrix Spike Duplicates (MS/MSD), and backup sample volume. All sample composite jugs will have 82 mg of ascorbic acid before sampling as dechlorinating agent.

After collecting the entire 24 hour flow composite series the jugs will be transported to the laboratory positive pressure clean room for filtration. The jugs will be set up on stir plates and agitated. A simple siphon tube will be initiated to enable subsampling from the collection jugs into a graduated cylinder before dispensing into the filtering apparatus. The volume of the sample aliquots filtered must be carefully measured in a graduated cylinder and the total volume recorded to the nearest 5 milliliters (ml). These volumes will be used to determine concentrations within samples based on simultaneously collected TSS samples. Four filter apparatus for effluent filtration will be utilized simultaneously. The solid phase separation will use two layers of glass-fiber filters, a 1.5 µm Whatman model 934 AH, overlain by a coarser prefilter GMF Whatman GMF150 (pore size 2 to 10 um). Both will be precleaned by AXYS Environmental Systems. Note some filters are cleaned specifically for PFC analysis, do not mix. Technicians will run ~30 liters through the filters collecting all solids greater than 1.5 micron on the filter matrix. A final volume of aqueous filtrate will be used to wash residual clinging solids from the sides of the collection jug and the other sampling equipment and then be refiltered. Filters will then be folded into quarters (solids inward) and placed in precleaned wide mouth 500ml jars.

The first 15 L of filtered effluent will be recomposited in a clean borosilicate jug and used to fill labeled, precleaned, sample type specific, 1-L amber glass or HDPE sample containers as specified in Table 1.

All samples are to be immediately put on ice/chilled. Upon completion of sampling, samples along with equipment blank will be packaged for shipment under strict COC procedures to AXYS Analytical, Inc.

Effluent samples for conventional analytes such as Ammonia (NH3), Total Residual Chlorine (TRC), Total Suspended Solids (TSS), and Temperature will be taken as grab samples as per usual plant process monitoring protocols.

2.3 Influent Sampling

For influent, the sampler will use an ISCO peristaltic pump to collect samples on a flow-proportioned basis. Over the 24 hour period, water quality analysts will collect sample aliquots of 270ml influent after every one million gallons of plant through put; the influent samples do not require dechlorination. These aliquots will be dispensed every one million gallons into an array of eight 20-L precleaned glass borosilicate collection jugs with sufficient volume for each of the seven types of sample analyte groups and matrix types and two composites for TSS. Again BPA analysis is only performed on the aqueous phase and will be shipped to AXYS as whole influent (unfiltered) thus will be composited directly into two 1L sample containers in aliquots of 26 mls. This will produce comparable flow based 8.5-L composites available for sampling into six discrete filterable solid samples and enough volume for six filtered (and one unfiltered) aqueous phase subsamples including their primary extractions, Matrix Spike /Spike Duplicates (MS/MSDs), and sample duplicates.

After collecting the entire 24 hour flow composite series the jugs will be transported to the laboratory positive pressure clean room for filtration. The jugs will be set up on stir plates and agitated. A simple siphon tube will be initiated to enable subsampling from the collection jugs into a graduated cylinder before dispensing into the filtering apparatus. The volume of the sample aliquots filtered must be carefully measured in a graduated cylinder and the total volume recorded to the nearest 5 milliliters (ml). These volumes will be used to determine concentrations within samples based on simultaneously collected TSS samples. Two filter apparatus for influent will be employed simultaneously. The solid phase separation will use two layers of glass-fiber filters, a 1.5 µm Whatman model 934 AH, overlain by a coarser prefilter Whatman GMF150 (pore size 2 to10 µm). Both types of filters will be precleaned by AXYS Environmental Systems. Note some filters are cleaned specifically for PFC analysis, do not mix. Water quality analysts will run each of the 8.5 liter influent samples through the filters collecting all solids greater than 1.5 micron on the filter matrix. A final volume of aqueous filtrate will be used to wash residual clinging solids from the sides of the collection jug and the other sampling equipment and then be refiltered.

The filtered influent will be recomposited and representatively subsampled to fill labeled, precleaned, sample type specific, 1-L amber glass or HDPE sample containers as specified in Table 2. Before collection of a particular sample, all the containers needed for the different parameters to be determined should be properly labeled. Sample labels will also include sample time (in military time), initials of sampler(s), parameter for which the particular container is intended. During and immediately after sample collection, composite sample collection jugs will be stored on wet ice. It is presently anticipated that aqueous samples will be chilled and solids samples frozen in AWWU refrigerators and shipped on the following Monday. Samples should be shipped to the laboratory on ice in coolers for overnight delivery.

2.4 Adjunct Sampling

In addition to the CEC sampling program, bimonthly sludge metals analysis and measurements of effluent samples for conventional analytes such as pH, dissolved oxygen, fecal coliforms, total volatile and dissolved solids, biological oxygen demand, ammonia (NH_3), Total Residual Chlorine (TRC), and temperature will be performed as required by regular in plant monitoring. Total Suspended Solids (TSS) samples will be composited in 20 L jugs exactly as influent and effluent samples are composited. The exact volume of each of these TSS composites will be accurately measured as they are filtered in their entirety and the resultant filtrate dried and weighed to determine total suspended solids. The volumes of these TSS composite jugs will be used as the most accurate representation of the volume of effluent and influent contained in the target analyte composite jugs. Second quarter whole effluent toxicity (WET) sampling will also be conducted in parallel with CEC sample collection. A dedicated ISCO 4500 refrigerated sampler will collect a flow based composite sample to be analyzed by ToxScan Laboratories in Watsonville California.

2.5 Field Quality Control Samples

The quality assurance/quality control (QA/QC) for sampling and analyses will be assessed by field blank samples and MS/MSD samples. The following sections describe each of these types of samples.

2.5.1 Field Equipment Blank Samples

The field crew will collect a field equipment blank samples by pumping ultra high purity water through one sample equipment set and one filter apparatus just prior to beginning of the compositing of wastewater samples. The purpose is to determine if contamination might be introduced from the sampling equipment, cleaning procedures, or sampling procedures. The field equipment blank samples will undergo the same analyses as the other samples. AXYS will supply Seastar deionized water for field blanks for the following analyses: PBDEs, MRES, ST/HM, PPCP and Nonylphenols. The field blank for Bisphenol A analyses will use HPLC grade water while the PFCs will need Canadian Springs water. AXYS requests performing the field rinse for PFCs last. AXYS has cleaned and proofed all the filters for this program according to analyte specific methods.

2.5.2 Matrix Spike and Matrix Duplicate Samples

Samples will be provided to AXYS to analyze as matrix spike and matrix spike duplicate samples (MS /MSD) for each individual sample group, to determine accuracy and precision and whether matrix interferences might exist. Analyses will be the same as those required by the parent sample.

TABLE 1- EFFLUENT & INFLUENT

Recommended Sample Containers, Preservation, and Holding Times

Parameter	Method	Matrix	Holding Time	Container	Portion per Analysis	Preservative
Group 1 PPCP	EPA 1694M AXYS MLA-075 Rev.2	Influent	7 days	1-L HDPE	0.5 L	<6ºC. Effluent fixed with ascorbic acid for residual chlorine
		Effluent	7 days	1-L HDPE	2.0 L	
		Filtered solids	Freeze	WM Amber	0.5 g	
Group 2 Sterols and Hormones	EPA1698M AXYS MLA-068 Rev.3	Influent	7 days	1-L Amber Glass	0.25 L	<6ºC. Effluent fixed with ascorbic acid for residual chlorine
		Effluent	7 days	1-L Amber Glass	1.0 L	
		Filtered solids	40 days	WM Amber	0.5 g	
Group 3 Current use pesticides	EPA1699 AXYS MLA-035 Rev.5	Influent	7 days	1 L Amber Glass	1.0 L	<6ºC. Effluent fixed with ascorbic acid for residual chlorine
		Effluent	7 days	1 L Amber Glass	1.0 L	
		Filtered solids	Freeze	WM Amber	1 g	
Group 4 PBDE's	EPA1614 AXYS MLA-033 Rev.6	Influent	1 year	1-L Amber Glass	0.25 L	<6ºC. Effluent fixed with ascorbic acid for residual chlorine
		Effluent	1 year	1-L Amber Glass	0.25 L	
		Filtered solids	Freeze	WM Amber	1 g	
Group 5 PFC's	AXYS MLA-060 Solids - Rev.8 Aqueous - Rev.9	Influent	60 days	1-L HDPE	0.2 L	<6ºC. Effluent fixed with ascorbic acid for residual chlorine
		Effluent	60 days	1-L HDPE	0.5 L	
		Filtered solids	Freeze	WM Amber	0.5 g	
Group 6 Nonphenols, ethoxylates, octophenol	AXYS MLA-004 Rev.6	Influent	14 days	1-L Amber Glass	0.5 L	<6ºC. Effluent fixed with ascorbic acid for residual chlorine
		Effluent	28 days	1-L Amber Glass	0.5 L	
		Filtered solids	Freeze	WM Amber	1 g	
Group 7 Bisphenol A	AXYS MLA-075 Rev.2 AXYS MLA-059 (Low Level) Rev.4	Influent	There are no known maximum hold times for properly stored samples	1-L Amber Glass	0.005 L	<6ºC. Effluent fixed with ascorbic acid for residual chlorine
		Effluent		1-L Amber Glass	0.005 L	
		Filtered solids		Not sampled	NA	

Notes:

°C = degrees Celsius.

Extra sample volume required for sample duplicate, matrix spike, matrix spike duplicate, and equipment blank analyses.

Portion analyzed includes minimum weight necessary for filters, actual weight analyzed will be entire solids portion captured by the filter.

TABLE 2- SAMPLE SCHEDULE

Analysis	Frequency	Procedure	Preservation	Total	Handling
Effluent Sampling					
Group 1 PPCP EPA 1694M AXYS MLA-075 Rev.2 Solid phase & Aqueous phase	Every one million gallons of plant flow	540ml dechlorinated and added to each of 2 EFF composite jugs	Chilled & Chlorine quenched with ascorbic acid	Approximately 30L EFF, based on 540ml x 28mgd. At ~40mg/L = 1.2g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 2 Sterols and Hormones EPA1698M AXYS MLA-068 Rev.3 Solid phase & Aqueous phase	Every one million gallons of plant flow	540ml dechlorinated and added to each of 2 EFF composite jugs	Chilled & Chlorine quenched with ascorbic acid	Approximately 30L EFF, based on 540ml x 28mgd. At ~40mg/L = 1.2g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 3 Current Use Pesticides EPA1699 AXYS MLA-035 Rev.5 Solid phase & Aqueous phase	Every one million gallons of plant flow	540ml dechlorinated and added to each of 2 EFF composite jugs	Chilled & Chlorine quenched with ascorbic acid	Approximately 30L EFF, based on 540ml x 28mgd. At ~40mg/L = 1.2g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 4 PBDE's EPA1614 AXYS MLA-033 Rev.6 Solid phase & Aqueous phase	Every one million gallons of plant flow	540ml dechlorinated and added to each of 2 EFF composite jugs	Chilled & Chlorine quenched with ascorbic acid	Approximately 30L EFF, based on 540ml x 28mgd. At ~40mg/L = 1.2g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 5 PFC's AXYS MLA-060 Solid phase - Rev.8 & Aqueous phase - Rev.9	Every one million gallons of plant flow	540ml dechlorinated and added to each of 2 EFF composite jugs	Chilled & Chlorine quenched with ascorbic acid	Approximately 30L EFF, based on 540ml x 28mgd. At ~40mg/L = 1.2g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 6 Nonphenols, ethoxylates, octophenol AXYS MLA-004 Rev.6 Solid phase & Aqueous phase	Every one million gallons of plant flow	540ml dechlorinated and added to each of 2 EFF composite jugs	Chilled & Chlorine quenched with ascorbic acid	Approximately 30L EFF, based on 540ml x 28mgd. At ~40mg/L = 1.2g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 7 Bisphenol A AXYS MLA-075 Rev.2 AXYS MLA-059 Rev.4 (Low Level) Solid phase & Aqueous phase	Every one million gallons of plant flow	26ml dechlorinated and added to each of 2-1L composite jars	Chilled & Chlorine quenched with ascorbic acid	Approximately 1800mL EFF, based on 26ml x 28mgd	Chill sample bottles immediately <6ºC
Whole Effluent Toxicity. Aqueous aliquots producing flow based composite	TBD	20-L flow based composite for WET test	Chilled	4L to ToxScan	Place immediately on ice or cool to <6ºC

TABLE 2- SAMPLE SCHEDULE (continued)

Analysis	Frequency	Procedure	Preservation	Total	Handling
Influent Sampling –					
Group 1 PPCP EPA 1694M AXYS MLA-075 Rev.2 Solid phase & Aqueous phase	Every one million gallons of plant flow	270ml added to INF composite jug	Chilled & No dechlorinate necessary	Approximately 8.5L INF, based on 2700ml x 28mgd. At ~250mg/L = 2.0g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 2 Sterols and Hormones EPA1698M AXYS MLA-068 Rev.3 Solid phase & Aqueous phase	Every one million gallons of plant flow	270ml added to INF composite jug)	Chilled & No dechlorinate necessary	Approximately 8.5L INF, based on 2700ml x 28mgd. At ~250mg/L = 2.0g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 3 Current Use Pesticides EPA1699 AXYS MLA-035 Rev.5 Solid phase & Aqueous phase	Every one million gallons of plant flow	270ml added to INF composite jug	Chilled & No dechlorinate necessary	Approximately 8.5L INF, based on 2700ml x 28mgd. At ~250mg/L = 2.0g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 4 PBDE's EPA1614 AXYS MLA-033 Rev.6 Solid phase & Aqueous phase	Every one million gallons of plant flow	270ml added to INF composite jug	Chilled & No dechlorinate necessary	Approximately 8.5L INF, based on 2700ml x 28mgd. At ~250mg/L = 2.0g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 5 PFC's AXYS MLA-060 Solid phase - Rev.8 & Aqueous phase - Rev.9	Every one million gallons of plant flow	270ml added to INF composite jug	Chilled & No dechlorinate necessary	Approximately 8.5L INF, based on 2700ml x 28mgd. At ~250mg/L = 2.0g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 6 Nonphenols, ethoxylates, octophenol AXYS MLA-004 Rev.5 Solid phase & Aqueous phase	Every one million gallons of plant flow	270ml added to INF composite jug	Chilled & No dechlorinate necessary	Approximately 8.5L INF, based on 2700ml x 28mgd. At ~250mg/L = 2.0g solid phase. Entire sample volume filtered and aqueous filtrate subsampled as per table 1	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Group 7 Bisphenol A ASTM-D7065-06M AXYS MLA-059 Rev.4 Solid phase	Every one million gallons of plant flow	26ml added to the two INF composite jars	Chilled & No dechlorinate necessary	Approximately 1800mL INF, based on 30ml x 28mgd	Fold filter in quarters, place in jar. Chill filter and sample bottles immediately <6ºC
Concurrent Testing Inf. & Eff.					
Conventionals TSS (Total Suspended Solids) Ammonia Nitrate Total Chlorine Residual Free Chlorine Residual	TSS filter entire 30 L effluent samples collected and 10L influent samples.	Analyze immediately	Chilled	Collect composite samples in conjunction with influent and effluent sampling	Method specific
Note: Concurrent sampling on effluent samples only, except TSS on both influent and effluent.					

SECTION 3

Other Procedures

3.1 Equipment Decontamination

Much of the filtering/sampling equipment will be purchased new such as the vacuum funnel apparatus, graduated cylinders, sample collection hoses and sample containers. For all sampling equipment, including the 20-L borosilicate jugs, connections, funnels or beakers, tongs, stir rods, plugs, fittings; the decontamination process will proceed in the following order. First, soak all equipment thoroughly with dilute phosphate free soap solution. All equipment must then be triple rinsed with the following cleaning reagents; tap water followed by ultra-pure DI water, then reagent-grade acetone, toluene and methanol and allowed to air dry. Disposable equipment is preferred to prevent the possibility of cross contamination. Disposable surgical-style, nitrile gloves will be worn by the sampler personnel to reduce the possibility of sample contamination. After sampling at each location, the gloves will be placed in a trash bag and disposed of as nonhazardous waste.

3.2 Sample Containers and Preservation

The field team will use 1-liter, certified clean, narrow mouth amber glass sample containers for each aqueous effluent sample aliquot collected, as specified in Tables 1 & 2. The sample containers will be provided by AXYS Analytical Services laboratory and shall be prelabeled. Sample containers are to be chilled immediately then held and shipped at <6 degrees Celsius. It is not necessary to acidify samples in the field. (AXYS will acidify at the lab if it is deemed necessary). AXYS has indicated they will supply 1-L bottles and while headspace is evidently not an issue the field crew should completely fill the aqueous sample containers. Extra bottles will be included for quality control samples and spares as needed.

Chlorine demand from effluent TRC can denature certain target analytes. Ascorbic acid for dechlorination will be certified clean below the reporting limit and supplied by AXYS. After filtering each of the 24 hour composite samples, the filters should be placed in the appropriate 500ml amber wide mouth sample containers, labeled, then quickly frozen and shipped at <6 degrees Celsius.

3.3 Documentation

Each sample or field measurement must be accurately and properly documented to facilitate timely and complete analysis. The documentation provides the means to identify, track, and monitor each sample from the point of collection through final data reporting. The principle documents used to identify samples and document possession include chain-of-custody (COC) forms, field data sheets, bench logs and field notebooks. A representative series of photographs will be produced to document and evaluate the various aspects of this project.

3.4 Sample Custody

A sample is physical evidence collected from a site or source. Because of the potential evidentiary nature of samples, possession of samples must be traceable from the time they are collected until they are received by the laboratory for analysis. COC procedures document sample possession for regulatory purposes. The principal documents that identify and track samples include the following:

- COC forms
- Sample data sheets (i.e., computer data sampling tracking form)
- Bills of lading (e.g., Federal Express or UPS)
- Field notebooks
- Photographs of the investigation

Definition of Custody

A sample is in custody if one or more of the following criteria are met:

- It is in possession.
- It is in view after being relinquished.
- It was in possession, and it was locked up to prevent tampering.
- It is in a designated secure area.

Field Custody

The quantity of samples collected shall provide a good representation of the medium being sampled. The quantity and types of samples and sampling locations will be determined before fieldwork begins. The samples will be handled by as few people as possible. The Laboratory Manager is responsible for the care and custody of the samples until they are transferred or dispatched to the analyzing laboratory/s.

Transfer of Custody and Shipment

Samples shipped to AXYS will be accompanied by a COC form. When transferring samples, the individuals relinquishing and receiving the samples shall sign, date, and note the time on the form. The COC form documents sample custody transfer from the sampler, often through another person (e.g., courier), to the analyst at the laboratory. The COC form also includes the following information: Project name, project number, Project manager. Name of laboratory. ID Station/location names. Sample IDs. Sampling dates. sampling times, sample matrices, total number of containers, requested analytical methods, sampling team names, and identity of volumes to be used for matrix spike/matrix spike duplicate (MS/MSD) samples.

Samples shall be properly packaged for shipment to the laboratory for analysis. A separate COC form will be used for each shipment. Courier name(s), and other pertinent information will be entered in the remarks section of the COC form with each shipping container. Shipping containers will be sealed by using custody seals when shipped by a courier or common carrier to the analyzing laboratory.

The original COC form accompanies the shipment, and a copy retained by the site manager. If sent by mail, the package is registered as “Return Receipt Requested.” If sent by common carrier, a bill of lading is used. Freight bills, postal service receipts, and bills of lading are retained as part of the permanent project documentation. Samples shall be shipped to arrive at the laboratory by noon the next business day.

Custody Seals

When samples are shipped by common carrier or a courier to the laboratory, the samples must be placed in padlocked containers or the containers must be sealed by using custody seals (provided by the analytical laboratory). Custody seals must be placed on each shipping container (i.e., cooler) so that the container cannot be opened without breaking one of the seals. Custody seals are not required when sampling staff deliver samples to the laboratory and the samples are in the custody of the field staff at all times.

3.5 Laboratory Custody Procedures

Once samples arrive at the laboratory, the sample ID, or a unique laboratory ID assigned by the laboratory custodian, will be used to track each sample. A designated laboratory custodian will accept custody of the shipped samples and verify that the sample IDs match those on the COC form. Pertinent information regarding shipment, pickup, and courier will be entered in the remarks section of the COC form. The laboratory custodian will record the sample IDs either in a bound logbook that is arranged by project code and station number or in a Laboratory Information Management System (LIMS). The laboratory custodian is responsible for ensuring that all samples are transferred to the proper analyst or stored in the appropriate secure area. Laboratory analysts are responsible for the care and custody of samples from the time they are received from the custodian until the sample is exhausted or returned to the custodian. Laboratory analysts record the date of the sample analysis on the laboratory report form.

After the necessary quality assurance checks have been completed, the unused portion of the samples must be disposed of properly. All identifying data sheets and laboratory records will be retained as part of the permanent documentation. Sample containers must be disposed of appropriately.

SECTION 4

Analytical Methodologies

Laboratory analyses to be performed are listed in Tables 1 and 2. Laboratory quality control procedures will be followed as described in the laboratory's standard operating procedures.

All methods selected utilize labeled isotope standards (either exact matches or related compounds if exact matches are not commercially available) and subsequent quantification through recovery correction. This ensures the highest levels of precision and accuracy. All methods utilize LC MS/MS operated in MRM mode, measuring multiple transition ions where available to ensure positive identification of target analytes, or utilize GC/HRMS. All methods have cleanup processes and chromatographic separation / gradient programs designed to enhance selectivity and chromatographic resolution in POTW matrices. This ensures that detection limits and method QC will be achievable in the matrices expected in this work.

4.1 Method Summaries

A brief summary of the methods is included below. Complete descriptions of extractions, analyses and internal control standards was provided in Section C of the RFP response proffered by AXYS. Information on extractions, analyses, internal control standards, initial demonstration and ongoing precision and recovery, and QA/QC procedures, and QA acceptance criteria, surrogates, method blanks, spikes, standards and duplicates are identified in the detailed method summaries located in Appendix C of AXYS's formal response to AWWU's proposal. That section is deemed confidential and will not be reproduced here. Analyte summaries are in Section 5. All subsequent method modifications/improvements made by AXYS Labs since promulgation of the 1600 series methods by the EPA Office of Water have been reviewed and approved by the EPA for use in this project.

Group 1 - <u>PPCPs</u>

(by LC MS/MS based on EPA 1694)

AXYS SOP MLA 075

AXYS developed this method for the U.S. EPA Office of Water as a reference method for the analysis of PPCPs in all environmental matrices. The method is performance based and as a 1600 series method is written and validated to cover multiple matrices. This includes all water types (surface, groundwater, raw water, agricultural run-off, POTW influent and effluent), all solids types (soils, sediments, and biosolids). The method has two extractions (acidic and basic) and 5 LC MSD/MS runs (referred to as Lists in attached information). The acidic extraction produces 4 LC MS/MS runs (List 1 – ESI positive compounds, List 2 – Tetracyclines, List 3 – ESI Negative compounds, and List 5 – incremental ESI negative compounds). The basic extraction produces 1 LC MS/MS run in the ESI positive mode of operation. The original method EPA 1694, released in December 2007, contained 74 compounds. 2008 work for the U.S. EPA increased the number of compounds to 121 with expansions to List 3 and List 4 and the addition of List 5.

Group 2 - <u>17 Hormones and 10 Sterols</u>

(by LC MS/MS based on EPA 1694)

AXYS SOP MLA 068

AXYS developed and validated this method for the U.S. EPA Office of Water as a reference method for the analysis of Hormones and Sterols in all matrices specified for EPA 1694. The method was completed in 2008 and contains 27 target compounds.

Group 3 - Current Use Pesticides

(by GC/HRMS based on EPA 1699)

AXYS SOP MLA 035

AXYS developed a new high-resolution analytical method to monitor a wide range of pesticides in a single analysis with higher specificity and sensitivity than previously established reference methods. This method was developed into the U.S. EPA Office of Water reference method EPA 1699. The method was completed in 2008 and contains 64 pesticides (35 OC, 20 OP, 7 Triazine, and 3 Pyrethroid pesticides in aqueous, solid environmental, and wastewater samples in a single analytical procedure. In addition to these, 14 ON compounds are also available through the method with an incremental instrument run. Sample size uses a default 1-L. Sample size for influent may need to be reduced based on initial results.

Group 4 - PBDEs

(by GC/HRMS based on EPA 1614)

AXYS SOP MLA 033 – GC / HRMS analysis for the determination of PBDE congeners in environmental samples. The method has the following attributes that are important in the completing the work specified;

The method is highly validated and is the base method that was used to produce EPA Method 1614 for the measurement of PBDE congeners. All QC criteria identified in EPA 1614 or met are exceeded by MLA 033.

The method utilizes C labeled surrogates added to the sample at the commencement of the extraction process. Results are quantified using recovery correction based on the recovery of the labeled surrogates. This process produces very accurate quantification while allowing the extraction efficiency to be monitored on all samples. Losses of surrogate during extraction and clean up are recovery corrected, preventing bias due to surrogate loss.

The method uses HRMS instrumentation which is the highest level of selectivity for commercially available methods. The use of HRMS instrumentation greatly reduces the affect of matrix interferences and potential false positives as the amount of mass resolution is significantly higher than with other approaches (GC-ECD or GC CI MS)

The method measures 46 PBDE congeners and includes all congeners specified in the RFP. The inclusion of the other congeners is recommended for this project. PBDEs generally degrade by debromination to lower molecular weight congeners. In evaluating the removal efficiency of the most prevalent congeners (BDE 28, 47, 99, 100, 153, 154, 209) in various effluent treatments it will be important to answer whether these compounds were converted to other BDE congeners. The congener list included will serve to monitor what debrominated BDEs may be formed through treatment processes.

MDL’s for the BDEs measured by MLA 033 have detection limits ranging from 2 pg/L to 20 pg/L (PBDE 209). This is significantly lower than the contract requirements. Maximum allowable blank levels for MLA 033 are 200 pg/L for PBDE 209 and less than 150 pg/L for all other congeners. All detection limit criteria will be met. Detailed information is provided in the method summary below.

AXYS recommends reporting results based on sample specific detection limits. In this format results are reported to a minimum 2.5:1 signal to noise ratio for each congener in every sample. Each BDE in every sample is provided with its own sample specific detection limit.

Group 5 - PFCs

(by LC MS/MS based on NELAC accredited Lab SOP)

AXYS SOP MLA 060

The matrices involved, effluent and influent will provide significant amounts of matrix interferences and the potential to create false negatives and positives through instrument suppression, overloading of SPE cartridges, or isobaric interferences. AXYS has demonstrated control over these issues through attributes of the method which includes:

Use of labeled surrogates for recovery correction of data;

Use of labeled recovery standards to detect suppression on the instruments;

Monitoring of secondary transitions for compounds where possible, including PFOS and PFOA, to avoid false negatives from suppression or false positives from enhancement or isobaric interferences;

Determination of linearity’s performed at the start of each batch which is processed through the entire method.

Group 6 - Nonylphenols, Octylphenol, and Nonyl Phenol Ethoxylates

(by GC/MS based upon highly validated method published by B. Lee of Environment Canada)

AXYS SOP MLA 004 -Derivatized GC / MS analysis for the determination of Nonyl Phenols, Octyl Phenols, and Nonyl Phenol Ethoxylates (NPEO1, NPEO2) congeners in environmental samples. The method has the following attributes that are important in completing the work specified;

The method is highly validated and in use since 1998. It is based on numerous publications and is aligned to analytical procedures published by B. Lee of Environment Canada.

The method utilizes C labeled surrogates added to the sample at the commencement of the extraction process. Results are quantified using recovery correction based on the recovery of the labeled surrogates. This process produces very accurate quantification while allowing the extraction efficiency to be monitored on all samples. Losses of surrogate during extraction and clean up are recovery corrected, preventing bias due to surrogate loss.

The method uses derivatization prior to GCMS instrumentation. The derivatization process reduces the polarity of the target compounds, creating a much stronger response under GC/MS conditions. This greatly lowers the detection limits and limits the affect of matrix interferences. This, combined with dual ion monitoring in SIM mode greatly reduces the potential for false positives as the amount of mass resolution is significantly higher than with other approaches.

MDL’s for MLA 004 compounds are suitable for use in this contract. Nonyl Phenol and Octyl phenol have expected detection limits of 10 ng/L. NPEO1 and NPEO2 are expected to have sample specific detection limits between 10 and 50 ng/L. In all cases we expect to see actual levels of target analytes at higher levels than detection limits.

AXYS recommends reporting results based on sample specific detection limits. In this format results are reported to a minimum 3:1 signal to noise ratio for each congener in every sample. Each alkyl phenol in every sample is provided with its own sample specific detection limit.

Group 7 - Bisphenol A

(by LC MS/MS)

AXYS SOP MLA 059 -Samples are spiked with labeled BPA internal standards, extracted and cleaned up by solid phase extraction, then analyzed by LC-MS/MS in the MRM mode and quantified by isotope dilution internal standards. Reporting limits for water is 50 ng/L. AXYS has controlled background levels of this ubiquitous compound so that procedural blanks are clean and do not affect reporting limits.

4.2 Reporting Limits and Method Detection Limits

Information on initial demonstration of capability, ongoing precision and recovery, QA/QC procedures, and QA acceptance criteria are identified in the detailed method summaries located in method summaries located in AXYS RFP 10-01, Appendix C.

Information on surrogates, method blanks, spikes, standards and duplicates are identified in the detailed method summaries located in method summaries located in AXYS RFP 10-01, Appendix C.

AXYS calculates MDLs as per EPA guidance found in “Federal Register 40 CFR, Part 136, Appendix B”. The MDL represents the 99% confidence level for positive identification of an analyte based on a minimum of 7 replicate matrix spikes fortified at 1-5 times the estimated detection limit. An MDL study frequency is determined as required based on accreditation, contract and workload requirements.

For LC-MS/MS analyses, AXYS typically reports to the lowest calibration standard (LMCL) in their calibration series, which is typically higher than their MDLs. Reporting to an LMCL value is typically referred to as a “reporting limit” or “practical quantification limit (PQL)” when above the MDL.

LMCL is a more definitive number than reporting to an MDL as the number provided is both a positive identification and a positive quantification as it is within the calibration range. Reporting to an LMCL value is also scalable with sample size. AXYS never assumes linearity for LC MS/MS compounds below the LMCL as this is seldom the case in LC MS/MS analysis. Where matrix effects elevate noise levels above the LMCL AXYS reports to a 3:1 signal to noise ratio providing all other QC specifications are met.

For GCMS analyses, AXYS typically reports to the sample specific detection limit (SDL). An SDL is determined by converting the area equivalent of 3.0 times (2.5 times for EPA 1600 series methods) the estimated chromatographic noise height to a concentration in the same manner that target peak responses are converted to final concentrations. SDLs are determined individually for every sample analysis run. The SDL accounts for any effect of matrix on the detection system and for recovery achieved through the analytical work-up. Linearity below the LMCL can be assumed for GCMS analysis.

4.3 Participation in Performance Testing and Inter-Laboratory Studies

AXYS’ core business is leadership in the measurement of ultra-trace levels of Persistent Organic Pollutants (POPs) and emerging organic contaminants. As a result, many of the tests AXYS performs do not have individual test accreditation available from an accrediting body as regulatory criteria and proficiency testing programs have not been developed. AXYS has participated in 170 performance evaluation and interlaboratory studies since 2000.

SECTION 5

Analytical Summary List, MDL's & RL's

A summary of analytical methods, method analytes, method detection limits, method reporting limits, and analytes for which matrix spikes & matrix spike duplicates will be performed are listed in Tables 3 through 8.

Table 3. EPA Method 1694 - PPCP Analyte List

Analyte List	**Wastewater Influent Minimum Reporting Limit ng/L (based on 0.25L sample)**	**Wastewater Chlorinated Primary Effluent & Influent Matrix Spike**	**Wastewater Method Detection Limit (MDL ng/L), MDL based on 1 L sample of Reagent Water**	**Wastewater Chlorinated Primary Effluent Minimum Reporting Limit ng/L (based on 1L sample)**
List 1 - Acid Extraction in Positive Ionization (Includes items listed originally in table as Antibiotics and Analytical Group 1, Other than Antibiotics				
Acetaminophen	240	x	33.2	60.0
Amplicilin [1] (Although Listed in the Method 1694, ampicillin was not included in either Stage 1 or Stage 2 of the Nine POTW Study.)	6.0	x	NA	1.5
Azithromycin	6.0	x	3.2	1.5
Caffeine	60.0	x	28.5	15.0
Carbadox	6.0	x	4.5	1.5
Carbamazapine	6.0	x	5.3	1.5
Cefotaxime	24.0	x	14.6	6.0
Ciprofloxacin	24.0	x	6.5	6.0
Clarithromycin	6.0	x	1.4	1.5
Clinafloxacin	24.0	x	4.5	6.0
Cloxacillin	12.0	x	6.3	3.0
Dehydronifedipine	2.4	x	1.3	0.6
Digoxigenin	24.0	x	8.5	6.0
Digoxin	60.0	x	50.4	15.0
Diltiazem	1.2	x	1.0	0.3
1,7-Dimethylxanthine	600	x	218	150.0
Diphenhydramine	2.4	x	1.1	0.6
Enrofloxacin	12.0	x	10.2	3.0
Erythromycin-H20	1.2	x	0.4	0.3
Flumequine	6.0	x	3.2	1.5
Fluoxetine	6.0	x	4.4	1.5
Lincomycin	12.0	x	2.0	3.0
Lomefloxacin	12.0	x	4.4	3.0
Miconazole	6.0	x	2.0	1.5
Norfloxacin	60.0	x	19.3	15.0
Norgestimate	12.0	x	5.5	3.0
Ofloxacin	6.0	x	21.7	1.5
Ormetoprim	2.4	x	0.8	0.6
Oxacillin	12.0	x	5.8	3.0
Oxolinic acid	2.4	x	1.3	0.6
Penicillin G	12.0	x	1.7	3.0
Penicillin V	12.0	x	3.6	3.0
Roxithromycin	1.2	x	0.2	0.3
Sarafloxacin	60.0	x	87.6	15.0
Sulfachloropyridazine	6.0	x	1.4	1.5
Sulfadiazine	6.0	x	1.0	1.5
Sulfadimethoxine	1.2	x	0.6	0.3

Analyte List	**Wastewater Influent Minimum Reporting Limit ng/L (based on 0.25L sample)**	**Wastewater Chlorinated Primary Effluent & Influent Matrix Spike**	**Wastewater Method Detection Limit (MDL ng/L), MDL based on 1 L sample of Reagent Water**	**Wastewater Chlorinated Primary Effluent Minimum Reporting Limit ng/L (based on 1L sample)**
Sulfamerazine	2.4	x	0.3	0.6
Sulfamethazine	2.4	x	1.0	0.6
Sulfamethizole	2.4	x	0.8	0.6
Sulfamethoxazole	2.4	x	0.5	0.6
Sulfanilamide	60.0	x	8.9	15.0
Sulfathiazole	6.0	x	1.5	1.5
Thiabendazole	6.0	x	0.2 4	1.5
Trimethoprim	6.0	x	2.3	1.5
Tylosin	24.0	x	NA	6.0
Virginiamycin	12.0	x	3.6	3.0
List 2 - Tetracyclines in Positive Ionization (items listed originally in table as Antibiotics)				
Anhydrochlortetracycline	60.0	x	12.2	15.0
Anhydrotetracycline	60.0	x	10.7	15.0
Chlortetracycline	24.0	x	15.5	6.0
Demeclocycline	60.0	x	12.7	15.0
Doxycycline	24.0	x	4.0	6.0
4-Epianhydrochlortetracycline	60.0	x	7.6	15.0
4-Epianhydrotetracycline	240	x	5.5	60.0
4-Epichlortetracycline	60.0	x	31.6	15.0
4-Epioxytetracycline	24.0	x	6.9	6.0
4-Epitetracycline	24.0	x	4.8	6.0
Isochlortetracycline	24.0	x	5.2	6.0
Minocycline	240	x	17.9	60.0
Oxytetracycline	24.0	x	4.7	6.0
Tetracycline	24.0	x	7.1	6.0
List 3 - Acid Extraction in Negative Ionization (includes items listed originally in table as Analytical Group 3)				
Bisphenol A	10000	x	3502	2500.0
Furosemide	160	x	27	40.0
Gemfibrozil	6	x	1.6	1.5
Glipizide	24	x	5.7	6.0
Glyburide	12	x	5.2	3.0
Hydroclorothiazide	80	x	51	20.0
2-hydroxy-ibuprofen	320	x	171	80.0
Ibuprofen	60	x	17	15.0
Naproxen	12	x	10	3.0
Triclocarban	12	x	2.2	3.0
Triclosan	240	x	65	60.0
Warfarin	6	x	2.2	1.5
List 4 - Basic Extraction in Positive Ionization (includes items listed originally in table as Analytical Group 4)				
Albuterol	1.2	x	0.72	0.3
Amphetamine	6	x	2.1	1.5
Atenolol	2.4	x	1.0	0.6
Atorvastatin	6	x	0.76	1.5
Cimetidine	2.4	x	0.67	0.6
Clonidine	6	x	3.2	1.5

Analyte List	**Wastewater Influent Minimum Reporting Limit ng/L (based on 0.25L sample)**	**Wastewater Chlorinated Primary Effluent & Influent Matrix Spike**	**Wastewater Method Detection Limit (MDL ng/L), MDL based on 1 L sample of Reagent Water**	**Wastewater Chlorinated Primary Effluent Minimum Reporting Limit ng/L (based on 1L sample)**
Codeine	12	x	3.9	3.0
Cotinine	6	x	1.4	1.5
Enalapril	1.2	x	0.26	0.3
Hydrocodone	6	x	1.4	1.5
Metformin	120	x	47	30.0
Oxycodone	2.4	x	0.63	0.6
Ranitidine	2.4	x	1.0	0.6
Triamterene	1.2	x	0.33	0.3
List 5 - Acid Extraction in Positive Ionization				
Alprazolam	1.2	x	0.52	0.3
Amitriptyline	1.2	x	0.71	0.3
Amlodipine	6	x	1.44	1.5
Benzoylecgonine	1.2	x	0.33	0.3
Benztropine	1.2	x	0.35	0.3
Betamethasone	6	x	8.80	1.5
Cocaine	0.6	x	0.17	0.2
DEET	0.6	x	0.20	0.2
Desmethyldiltiazem	0.6	x	0.60	0.2
Diazepam	1.2	x	0.28	0.3
Fluocinonide	24	x	25.7	6.0
Fluticasone propionate	8	x	3.26	2.0
Hydrocortisone	240	x	357	60.0
10-hydroxy-amitriptyline	0.6	x	0.15	0.2
Meprobamate	16	x	7.88	4.0
Methylprednisolone	16	x	57.3	4.0
Metoprolol	6	x	2.83	1.5
Norfluoxetine	6	x	1.07	1.5
Norverapamil	0.6	x	0.10	0.2
Paroxetine	16	x	2.85	4.0
Prednisolone	24	x	19.6	6.0
Prednisone	80	x	42.4	20.0
Promethazine	1.6	x	0.15	0.4
Propoxyphene	1.2	x	0.40	0.3
Propranolol	8	x	1.04	2.0
Sertraline	1.6	x	0.30	0.4
Simvastatin	80	x	NA	20.0
Theophylline	240	x	536	60.0
Trenbolone	16	x	6.39	4.0
Trenbolone acetate	1.2	x	0.31	0.3
Valsartan	16	x	9.66	4.0
Verapamil	0.6	x	0.15	0.2

Table 4. EPA Method 1698 - Steroids and Hormones Analyte List

Analyte List	Wastewater Influent Reporting Limit ng/L (based on 0.25L sample)	Wastewater Chlorinated Primary Effluent & Influent Matrix Spike	Wastewater Method Detection Limit (MDL ng/L), MDL based on 1 L sample of Reagent Water	Wastewater Chlorinated Primary Effluent Reporting Limit ng/L (based on 1L sample)
Sterols				
Beta Sitosterol	400,000[1]	x	5.0	1000 1
Beta Stigmastanol	25000	x	5.0	62.5
Campesterol	10000	x	2.0	25.0
Cholestanol	10000	x	2.0	25.0
Cholesterol	400,000 1	x	5.0	1000 1
Coprostanol	25000	x	5.0	62.5
Desmosterol	25000	x	5.0	62.5
Epi-coprostanol	25000	x	5.0	62.5
Ergosterol	25000	x	5.0	62.5
Stigmasterol	10000	x	2.0	25.0
Hormones				
Alpha-Zearalanol (NA in Stage 2)	Not measured	Not measured	Not measured	Not measured
17 Alpha-Dihydroequilin	150	x	3.0	7.5
17 Alpha-Estradiol	150	x	3.0	7.5
17 Alpha-Ethinyl Estradiol (Ethynylestradiol)	150	x	3.0	7.5
17 Beta-Estradiol	150	x	3.0	7.5
Androstenedione	375	x	7.5	18.75
Androsterone	150	x	3.0	7.5
Beta-Estradiol-3-Benzoate	150	x	3.0	7.5
Desogestrel	150	x	3.0	7.5
Equilenin	150	x	3.0	7.5
Equilin	150	x	3.0	7.5
Estriol	150	x	3.0	7.5
Estrone	150	x	3.0	7.5
Mestranol	150	x	3.0	7.5
Norethindrone	150	x	3.0	7.5
Norgestrel	150	x	3.0	7.5
Progesterone	375	x	7.5	18.75
Testosterone	150	x	3.0	7.5

Notes: Samples will generally be reported below the LMCL levels above.

Table 5. EPA Method 1699 - Pesticides Analyte List

Analyte List	Wastewater Influent Reporting Limit ng/L (based on 1L sample)	Wastewater Chlorinated Primary Effluent & Influent Matrix Spike	Wastewater Method Detection Limit (MDL ng/L), MDL based on 1 L sample of Reagent Water	Wastewater Chlorinated Primary Effluent Reporting Limit ng/L (based on 1L sample)
Organochlorine				
2,4'-DDD	0.03	x	0.5	0.03
2,4'-DDE	0.05	x	0.1	0.05
2,4'-DDT	0.07	x	0.1	0.07
4,4'-DDD	0.04	x	0.5	0.04
4,4'-DDE	0.01	x	0.1	0.01
4,4'-DDT	0.06	x	0.039	0.06
Aldrin	0.02	x	0.3	0.02
Alpha-BHC	0.02	x	0.2	0.02
Alpha-chlordane	0.07	x	0.2	0.07
Beta-BHC	0.02	x	0.2	0.02
Captan	1.22	x	2.4	1.22
Chlorothalonil	0.01	x	0.4	0.01
Cis-nonachlor	0.05	x	0.1	0.05
Dacthal	0.01	x	0.2	0.01
Delta-BHC	0.02	x	0.2	0.02
Dieldrin	0.04	x	0.1	0.04
Endosulfan I	0.10	x	0.2	0.10
Endosulfan II	0.30	x	0.4	0.30
Endosulfan sulfate	0.11	x	0.4	0.11
Endrin	0.03	x	0.1	0.03
Endrin Ketone	0.18	x	1.1	0.18
Gamma-BHC	0.05	x	0.2	0.05
Gamma-chlordane	0.07	x	0.2	0.07
Heptachlor	0.03	x	0.5	0.03
Heptachlor Epoxide	0.05	x	0.1	0.05
Hexachlorobenzene	0.030	x	0.033	0.030
Methoxychlor	0.42	x	0.1	0.42
Mirex	0.02	x	0.6	0.02
Octachlorostyrene	0.05	x	0.2	0.05
Oxychlordane	0.05	x	0.3	0.05
Pentachloronitrobenzene (Quintozene)	0.10	x	1.1	0.10
Perthane	1.56	x	5.7	1.56
Tecnazene	0.07	x	0.3	0.07
Trans-nonachlor	0.07	x	0.2	0.07
Organophosphorus				
Azinphos-methyl	0.96	x	1.0	0.96
Chlorpyriphos	0.13	x	1.3	0.13
Chlorpyriphos-oxon	0.08	x	1.4	0.08
Diazinon	0.63	x	0.4	0.63
Diazinon-oxon	0.28	x	2.2	0.28
Disulfoton	0.08	x	2.2	0.08
Disulfoton sulfone	0.67	x	3.2	0.67
Ethyl-parathion	0.51	x	1.3	0.51
Fenitrothion	0.21	x	1.4	0.21
Fonofos	0.11	x	0.2	0.11
Malathion	2.72	x	16	2.72
Methamidophos	8.57	x	1.4	8.57
Methyl-chlorpyriphos	0.050	x	1.5	0.050
Methyl-parathion	1.43	x	3.9	1.43
Phorate	0.20	x	1.8	0.20
Phosmet	0.70	x	5.5	0.70
Pirimiphos-methyl	0.07	x	1.2	0.07
Pyrethroid				

Analyte List	Wastewater Influent Reporting Limit ng/L (based on 1L sample)	Wastewater Chlorinated Primary Effluent & Influent Matrix Spike	Wastewater Method Detection Limit (MDL ng/L), MDL based on 1 L sample of Reagent Water	Wastewater Chlorinated Primary Effluent Reporting Limit ng/L (based on 1L sample)
Cis-permethrin	NA	x	NA	NA
Cypermethrins	0.35	x	0.3	0.35
Permethrin	0.31	x	2.7	0.31
Trans-permethrin	NA	x	NA	NA
Triazine				
Ametryn	0.14	x	1.1	0.14
Atrazine	1.10	x	0.3	1.10
Cyanazine	1.36	x	2.4	1.36
Desethyl atrazine	0.07	x	0.2	0.07
Hexazinone	0.29	x	4.0	0.29
Metribuzin	0.55	x	0.4	0.55
Simazine	0.64	x	0.5	0.64
Other Organophosphorus analytes				
Dimethoate	0.99	x	6.5	0.99
Ethion	0.11	x	0.5	0.11
Terbufos	0.15	x	0.5	0.15
Organonitrogen analytes				
Alachlor	0.24	x	0.24	0.24
Butralin	0.34	x	1.52	0.34
Butylate	0.06	x	0.42	0.06
Dimethenamid	0.01	x	0.61	0.01
Ethalfluralin	0.04	x	5.82	0.04
Flufenacet	0.00	x	1.48	0.09
Flutriafol	0.10	x	9.41	0.10
Linuron	0.70	x	1.31	0.70
Methoprene	7.66	x	2.70	7.66
Metolachlor	0.11	x	0.18	0.11
Pendimethalin	0.21	x	5.41	0.21
Tebuconazol	0.18	x	4.68	0.18
Triallate	0.02	x	0.47	0.02
Trifluralin	0.01	x	0.53	0.01

Note: Due to the conversion of disulfoton to disulfoton sulfone, disulfoton was not recovered in some of the MDL experiments. In addition notably high recovery value was observed for disulfoton sulfone.

Table 6. EPA Method 1614 - PBDE Analyte List

Analyte List	Number	Wastewater Influent Reporting Limit pg/L (based on 0.25 L sample)	Wastewater Chlorinated Primary Effluent & Influent Matrix Spike	Wastewater Method Detection Limit (MDL pg/L), MDL based on 1 L sample of Reagent Water	Wastewater Chlorinated Primary Effluent Reporting Limit pg/L (based on 0.25L sample)
2,4,4'-Tribromodiphenyl ether plus 2',3,4-Tribromodiphenyl ether	PBDE-28 + PBDE33*	40.0	x	9.2	40.0
2,2',4,4'-Tetrabromodiphenyl ether	PBDE-47	40.0	x	16.5 1	40.0
2,2',4,4',5-Pentabromodiphenyl ether	PBDE-99	40.0	x	18.6 1	40.0
2,2',4,4',6-Pentabromodiphenyl ether	PBDE-100	40.0	x	6.6	40.0
2,2',4,4',5,5'-Hexabromodiphenyl ether	PBDE-153	40.0	x	6.7	40.0
2,2',4,4',5',6-Heptabromodiphenyl ether	PBDE-154	40.0	x	8.3	40.0
2,2',3,4,4',5',6-Heptabromodiphenyl ether	PBDE-183	80.0	x	7.7	80.0
Decabromodiphenyl ether	PBDE-209	800	x	569	800
Additional Analytes					
2,4-Dibromodiphenyl ether	PBDE-7	40.0	x	8.8	40.0
2,4’-Dibromodiphenyl ether plus 3,3’-Dibromodiphenyl ether	PBDE-8 + PBDE-11*	40.0	x	10.5	40.0
2,6-Dibromodiphenyl ether	PBDE-10	40.0	x	5.4	40.0
3,4-Dibromodiphenyl ether plus 3,4’-Dibromodiphenyl ether	PBDE-12 + PBDE-13*	40.0	x	17.0	40.0
4,4’-Dibromodiphenyl ether	PBDE-15	40.0	x	5.5	40.0
2,2’,4-Tribromodiphenyl ether plus 2,3’,4-Tribromodiphenyl ether	PBDE-17 + PBDE-25*	40.0	x	12.7	40.0
2,4,6-Tribromodiphenyl ether	PBDE-30	40.0	x	9.6	40.0
2,4’,6-Tribromodiphenyl ether	PBDE-32	40.0	x	5.5	40.0
3,3’,4-Tribromodiphenyl ether	PBDE-35	40.0	x	9.7	40.0
3,4,4’-Tribromodiphenyl ether	PBDE-37	40.0	x	5.5	40.0
2,2’,4,5’-Tetrabromodiphenyl ether	PBDE-49	40.0	x	7.3	40.0
2,2’,4,6’-Tetrabromodiphenyl ether	PBDE-51	40.0	x	4.8	40.0
2,3’,4,4’-Tetrabromodiphenyl ether	PBDE-66	40.0	x	4.7	40.0
2,3’,4’,6-Tetrabromodiphenyl ether	PBDE-71	40.0	x	6.2	40.0
2,4,4’,6-Tetrabromodiphenyl ether	PBDE-75	40.0	x	7.8	40.0
3,3’,4,4’-Tetrabromodiphenyl ether	PBDE-77	40.0	x	5.6	40.0
3,3’,4,5’-Tetrabromodiphenyl ether	PBDE-79	40.0	x	6.7	40.0
2,2’,3,4,4’-Pentabromodiphenyl ether	PBDE-85	40.0	x	6.2	40.0
2,3,3’,4,4’-Pentabromodiphenyl ether	PBDE-105	40.0	x	8.2	40.0
2,3,4,5,6-Pentabromodiphenyl ether	PBDE-116	40.0	x	14.9	40.0
2,3’,4,4’,6-Pentabromodiphenyl ether plus 2,3’,4,5,5’-Pentabromodiphenyl ether	PBDE-119 PBDE-120	40.0	x	4.6	40.0
2,3’,4,5,5’-Pentabromodiphenyl ether	PBDE-126	40.0	x	4.0	40.0
3,3’,4,4’,5-Pentabromodiphenyl ether	PBDE-128	40.0	x	9.8	40.0
2,2’,3,4,4’,5’-Hexabromodiphenyl ether plus 2,3,4,4’,5,6-Hexabromodiphenyl ether	PBDE-138 PBDE-166	40.0	x	8.9 1	40.0
2,2’,3,4,4’,6’-Hexabromodiphenyl ether	PBDE-140	40.0	x	10.0	40.0
2,2’,4,4’,6,6’-Hexabromodiphenyl ether	PBDE-155	40.0	x	5.3	40.0
2,2’,3,4,4’,5,6-Heptabromodiphenyl ether	PBDE-181	80.0	x	8.5	80.0
2,3,3’,4,4’,5,6-Heptabromodiphenyl ether	PBDE-190	80.0	x	10.1	80.0
2,2’,3,4,4’,5,5’,6-Octabromodiphenyl ether	PBDE-203	80.0	x	14.9	80.0
2,2’,3,3’,4,4’,5,5’,6-Nonabromodiphenyl ether	PBDE-206	400	x	100 2	400
2,2’3,3’,4,4’,5,6,6’-Nonabromodiphenyl ether	PBDE-207	400	x	100 2	400
2,2’,3,3’,4,5,5’,6,6’-Nonabromodiphenyl ether	PBDE-208	400	x	100 2	400

Notes: *PBDE 28 and PBDE 33 (and other noted coeluting congeners) have the same retention time on the DB-5HT gas chromatography column and cannot be quantified separately. For this reason, the concentration of PBDE 28 + PBDE 33 represents the total concentration for these two TrBDE congeners. MDLs are <1/10 spiking level and are maximum estimates.

MDLs for the following BDE are estimates only. Analysis of BDE 208, 207, and 206 are for informational values only due to contribution of target analytes from on-column degradation of BDE 209. Values represent sum of actual analyte plus contribution from BDE 209 thermal degradation.

Table 7. AXYS Recommended Method - PFC Analyte List

Analyte List	Wastewater Influent Reporting Limit ng/L (based on 0.2L sample)	Wastewater Chlorinated Primary Effluent & Influent Matrix Spike	Wastewater Method Detection Limit (MDL ng/L), MDL based on 0.5 L sample of Reagent Water	Wastewater Chlorinated Primary Effluent Reporting Limit ng/L (based on 0.5L sample)
Perfluorobutanoate (PFBA)	2.5	x	0.35	1.0
Perfluoropentanoate (PFPeA)	2.5	x	0.40	1.0
Perfluorohexanoate (PFHxA)	2.5	x	0.38	1.0
Perfluoroheptanoate (PFHpA)	2.5	x	0.29	1.0
Perfluorooctanoate (PFOA)	2.5	x	0.51	1.0
Perfluorononanoate (PFNA)	2.5	x	0.52	1.0
Perfluorodecanoate (PFDA)	2.5	x	0.42	1.0
Perfluoroundecanoate (PFUnA)	2.5	x	0.28	1.0
Perfluorododecanoate (PFDoA)	2.5	x	0.27	1.0
Perfluorobutanesulfonate (PFBS)	5.0	x	0.70	2.0
Perfluorohexanesulfonate (PFHxS)	5.0	x	1.00	2.0
Perfluorooctanesulfonate (PFOS)	5.0	x	0.85	2.0
Perfluorooctane sulfonamide (PFOSA)	2.5	x	0.28	1.0

Table 8. ASTM-D7065 - Alkylphenols, APEs, and BPA Analyte List

Analyte List	Wastewater Influent Reporting Limit ng/L (based on 0.5L sample)	Wastewater Chlorinated Primary Effluent & Influent Matrix Spike	Wastewater Typically Achieved Sample Specifc Detection Limit (ng/L)	Wastewater Chlorinated Primary Effluent Reporting Limit ng/L (based on 0.5L sample)
Nonylphenols*	10.0 -20.0	x	10.0 -20.0	10.0 -20.0
Nonylphenol Monoethoxylates*	10.0 -20.0	x	10.0 -20.0	10.0 -20.0
Nonylphenol Diethoxylates*	10.0 -20.0	x	10.0 -20.0	10.0 -20.0
Octylphenol	10.0 -20.0	x	10.0 -20.0	10.0 -20.0
Bisphenol A	50.0	x	40.0	50.0

Note: Nonylphenols, nonylphenol monoethoxylates, and nonylphenol diethoxylates are mixtures of branched isomers. Additional Analytes have been incorporated into the table above Notes: 1 Due to instability accuracy of Ampicillin data is unknown. 2 Determined MDL value is slightly above the spiking amount. 3 Determined MDL value exceeds the spiking level and is an estimated value.4 MDL results is < 1/10 spiking level.

SECTION 6

References

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Appendix I
AWWU Industrial and Commercial Source Pretreatment and Control

AWWU Pretreatment AWWU Industrial and Commercial Source Pretreatment and Control

Submitted to
U.S. Environmental Protection Agency, Region 10
Seattle, Washington

Submitted by
Anchorage Water and Wastewater Utility

Prepared by
CH2M HILL

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Tables

Acronyms and Abbreviations

AFFF	aqueous film-forming foams
AWWU	Anchorage Water and Wastewater Utility
BAT	Best Available Technology Economically Achievable
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
FOG	fats, oils, and grease
FSS	Food Safety and Sanitation
gal	gallons
gpd	gallons per day
MAHL	maximum allowable headworks loading
NPDES	National Pollutant Discharge Elimination System
POC	parameters of concern
POTW	Publicly Owned Treatment Works
SUO	Sewer Use Ordinance
WPCF	Water Pollution Control Facility

APPENDIX I

AWWU Industrial and Commercial Source Pretreatment and Control

I.1 Pretreatment Program and Source Control

Industry discharges can have a significant impact on wastewater treatment facilities such as the John M. Asplund Water Pollution Control Facility (WPCF). In response to a nationwide need, the Environmental Protection Agency (EPA) instituted the National Pretreatment Program. Pretreatment programs have since been put in place in treatment facilities across the United States to help control pollutants from industrial or commercial users, which could interfere with treatment processes, contaminate waste sludge, or flow through the WPCF and affect the environment at the outfall.

I.1.1 Pretreatment Program Description

To industrial dischargers, “pretreatment” is more than treating waste before it is sent to the treatment facility. The EPA defines pretreatment as “the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a Publicly Owned Treatment Works (POTW)” (see EPA Introduction to Pretreatment). Pretreatment programs are monitored and enforced by the EPA but administered at the local level. A pretreatment program has the following six minimum elements:

- Legal authority to enforce limits
- Procedures to ensure compliance
- Sufficient resources to carry out those procedures
- Established local limits
- An Enforcement Response Plan
- An updated list of Significant Industrial Users

The National Pretreatment Program is a core part of the EPA National Pollutant Discharge Elimination System (NPDES) program, under which the Municipality of Anchorage is permitted to discharge wastewater.

I.1.2 Program Background

The idea of the pretreatment program dates back to passage of the Clean Water Act (CWA), adopted in 1972. The first pretreatment regulations were promulgated by the EPA in 1978 and have since been reviewed and revised to better serve the public and the environment.

The EPA has established basic rules for all industrial users to follow, instituted some categories for specific industries, and then POTWs that discharge more than

5 million gallons per day or have significant industrial dischargers to develop their own pretreatment programs and set their own local limits. The EPA requires annual reporting by POTWs and may audit the pretreatment program periodically to ensure compliance.

I.1.2.1 U.S. Environmental Protection Agency Requirements

The following three types of discharge standards are enforced under the National Pretreatment Program:

- Prohibited discharge standards
- Categorical standards
- Local limits

Prohibited discharge standards were created to protect the POTW, worker health and safety and prevent interference with treatment. They include, in part, the following:

- Pollutants that can create a fire or explosion hazard
- Pollutants that would cause corrosive structural damage
- Solids or thick liquids that would cause obstruction to flow
- Pollutants that would result in the presence of toxic gases, vapors, or fumes and could adversely affect worker health and safety
- Conventional pollutants released in concentrations greater than the POTW was designed to accommodate

The EPA has developed industrial categories to identify those industries that are most likely to contribute toxic pollutants. Categorical Pretreatment Standards were then set by the EPA and must be followed by all dischargers that fall into these industrial categories. They compel industrial users to implement technology-based controls to limit pollutants and achieve water pollution control nationwide. As such, 126 priority pollutants are controlled by the Categorical Pretreatment Standards. Additional pretreatment standards can be added to the pretreatment program for removal of toxic constituents. If it is determined that (secondary) treatment or Best Available Technology Economically Achievable (BAT) cannot remove a pollutant, it may be added to categorical standards for pretreatment.

Given the wide range of industries and areas monitored by the EPA, such broad limits may not fully cover the needs of each treatment facility. Therefore, EPA regulations call for specific requirements be set by treatment facilities to account for the unique nature of each area water supply, types of discharge, and receiving water traits. The EPA has developed guidelines for facilities to assist in local limit development and must approve local limits as part of an NPDES permit. Monitoring of plant influent and effluent provides information for determining the need for additional pretreatment requirements. AWWU is currently sampling and analyzing influent and effluent for emerging parameters of concern (EPOC). This information may be used to make decisions regarding the need for additional pretreatment requirements. The EPA also recommends reviewing other wastewater sources such as septage haulers and landfill leachates (*Supplemental Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program*).

Local limits are created by the local approved authority and cover the needs of the POTW and its receiving waters. Each potential pollutant is considered against the most stringent effluent discharge criteria to establish the maximum allowable headworks loading (MAHL) for that pollutant. When issuing permits for industrial dischargers in their communities, POTWs must keep track of the cumulative loading from all dischargers to avoid overloading the treatment works. POTWs are also required, as part of the NPDES permit, to regularly analyze whether they are approaching the MAHL. Local limits are to be revised if found inadequate after such an analysis.

Whether or not industrial dischargers fall into an EPA industrial category, they must follow the most stringent of either the EPA-promulgated rules or local limits.

I.1.2.2 Non-industrial Source Control

EPA requires local programs to manage pollutants that may make their way to the sewer from areas other than industrial users. Potential sources include runoff into combined sewers and household disposal of chemicals into sanitary sewers. (AWWU system is a separated system prohibiting runoff water from entering the sewer.) These pollutants are also handled at the local level through sewer overflow abatement programs, urban or agricultural chemical management practices, and public education programs. Individual NPDES permits address specific control requirements, and local facilities are required to report annually to EPA on their non-industrial source control program.

I.1.3 AWWU Authority to Operate Program

Pretreatment requirements for the Asplund WPCF are written into the NPDES permit. If a locally approved pretreatment program were not in place, the EPA would administer the industrial user discharge program directly.

AWWU developed its pretreatment program to meet EPA requirements and ensure compliance with Alaska water quality standards. The program was approved by the EPA in April 1982. The first NPDES permit issued to AWWU after the acceptance of this pretreatment program required that AWWU develop and adopt its own ordinances to control discharges into the municipal sewer system. Accordingly, the Anchorage Municipal Code includes regulatory language in Title 26, Chapter 26.50 – Sewer Service, also known as the Sewer Use Ordinance (SUO).

The SUO defines specific limits on some conventional constituents; no discharges with pH lower than 5.0 or higher than 12.5 are allowed nor are oils or viscous substances. Specific total metal concentration limits for discharges into the AWWU system can be found in Table I-1. Other limits include no stormwater, no solids over 1 inch dimension, no radioactive substances, and no medical wastes. The SUO includes language allowing the AWWU general manager to impose additional limitations and specifies that the most stringent federal categorical pretreatment standards or local limits shall apply. Most importantly, the SUO requires all significant industrial users to obtain a wastewater discharge permit from the AWWU before discharging wastewater into the municipal sewerage system. It should be noted that simple dilution of concentrated discharges does not satisfy Anchorage's pretreatment requirements. It is also unlawful to discharge at a location that has not been specifically designated by the utility.

Table I-1. AWWU SUO Pollutant Limits

Pollutant	Limitation (mg/L)
Arsenic	3.7
Beryllium	14.5
Cadmium	0.69
Chromium	2.77
Copper	3.38
Cyanide	1.7
Lead	0.69
Mercury	0.2
Nickel	3.88
Oil or Grease of Animal or Vegetable Origin	250
Silver	2.5
Total Aromatic Hydrocarbons	5.0
Zinc	5.62

Source: AWWU

Note: All concentrations for metallic substances are for total metals

mg/L = milligrams per liter

Under the NPDES permit, Anchorage is responsible for implementing ordinances to control pollutants from non-industrial sources. Other specific controls include developing and publishing disposal guidelines, proposing alternative disposal methods, and creating a hazardous waste management program. AWWU must submit annual reports of the non-industrial source control program to the EPA.

I.1.3.1 Fines and Enforcement

Because local limits are prescribed under the National Pretreatment Program and the CWA, the EPA can take enforcement actions against an industrial user that violates a local limit. The CWA also has citizen suit provisions that can be used to against industrial users or a POTW with an approved pretreatment program for violating local limits.

Within Anchorage, violating industrial user permit requirements could result in the suspension or revocation of a wastewater service or discharge permit, fines of $75 to $1,000 per day per violation, and cost-recovery obligations for costs incurred by the AWWU for damages. The AWWU may also require pretreatment at the expense of the discharger.

Pretreatment regulations also require that significant industrial users that cause treatment problems or discharge violations for the WPCF or are chronic violators are to be published in any Anchorage newspaper that provides “meaningful public notice.” AWWU publishes a list of significant non-compliers in the Anchorage Daily News annually.

The current NPDES permit requirements call for an annual report of the AWWU Pretreatment Program and Nonindustrial Source Control Program to the EPA. With this report, EPA may determine whether any source is contributing constituents in violation of the ordinance or user permit. If a violation is found, the EPA will notify AWWU that it has 30 days to commence an appropriate enforcement action or the EPA will commence enforcement action against both the source and AWWU.

I.1.4 Sources

In the Anchorage SUO, industrial users are grouped as Categorical, Significant, and Non-Significant. Categorical users are those that are subject to EPA categorical pretreatment standards. Significant industrial users (SIU) meet one of the following criteria:

- Discharges an average of 25,000 gallons per day (gpd) or more of wastewater to the municipal sewerage system (excluding sanitary, noncontact cooling, and boiler blowdown wastewater)
- Contributes a waste stream that makes up five percent or more of the average dry weather hydraulic capacity of the treatment plant or contains more than 1,000 pounds/day (daily maximum) or 500 pounds/day (monthly average) of biochemical oxygen demand or suspended solids
- Is designated as such by the municipality for a reasonable potential to adversely affect the municipal sewerage system’s operation or for violating any pretreatment standard or requirement (AWWU SUO)

A user meeting one or more of these criteria may be considered non-significant by AWWU in accordance with federal regulation 40 CFR 403.8(f)(6), if there is no reasonable potential to adversely affect the treatment process or violate pretreatment or water quality standards.

Once an industrial user has met one of these criteria, it may not discharge wastewater into the municipal system without obtaining a permit from the utility. Ten industrial users are currently permitted to discharge to the Anchorage municipal sewer system and two have undergone pre-permitting inspections. The AWWU may also require other users to obtain permits for wastewater discharge, as needed, to maintain the WPCF health and effluent standards.

I.1.4.1 Significant Sources

Industrial dischargers that are subject to EPA categorical pretreatment standards are called categorical industrial users (CIU) and are listed in Table I-2.

Table I-2. AWWU Categorical Industrial Users

Permitted Industrial User	Industrial Classification	Average Wastewater Flow in 2009 (gpd)
Emerald Alaska	Centralized Waste Treatment (CIU)	180,000(gal)/326 days = 552 gpd
Municipal Light and Power	Steam Electric Power Generator (CIU)	286,000(gal)/326 days = 877 gpd

Source: AWWU

Significant users contributing heavy flow or loads are shown in Table I-3.

Table I-3. AWWU Significant Industrial Users

Permitted Industrial User	Industrial Classification	Average WastewaterFlow in 2009 (gpd)
10th & M Seafoods	Fish Processor (SIU)	391,871(gal)/80 days = 898 gpd
Alaska Seafood Ventures dba Copper River Seafoods	Fish Processor (SIU)	6,310,353(gal)/217 days = 29,080 gpd
Anchorage Regional Landfill MOA – Solid Waste Services	Landfill (SIU)	33,829 gpd based on 187 discharge days
Elmendorf Air Force Base	Military Installation (SIU)	2,003,560 gpd
Fort Richardson Army Garrison	Military Installation (SIU)	1,069,665 gpd
Great Pacific Seafoods	Fish Processor (SIU)	1,921,121(gal)/128 days = 15,009 gpd

Source: AWWU

I.1.4.2 Non-significant Sources

Permitted non-significant users contributing heavy flow or loads are shown in Table I-4.

Table I-4. AWWU Permitted Non-significant Industrial users

Permitted Industrial User	Industrial Classification	Average WastewaterFlow in 2009 (gpd)
ALSCO	Industrial Laundry (non-SIU)	18,657,000 (gal)/295 days = 63,244 gpd
Merrill Field Landfill MOA – Solid Waste Services	Closed Landfill (non-SIU)	285,268 gpd

Source: AWWU

I.1.4.3 Other Sources

AWWU issues temporary discharge permits to users with intermittent or occasional discharges to the system. Monitoring data are reviewed and conditions can be placed in the temporary permit appropriate to the discharge. AWWU also monitors septage haulers at two dump locations in the municipality.

AWWU uses several sources to find new permittees. The Pretreatment staff review a monthly printout of construction permits issued and check building permits and business licenses quarterly. They also review high-water usage reports from AWWU Customer Service monthly. AWWU is currently surveying Anchorage businesses to identify additional users who might be eligible for inclusion in the pretreatment program.

I.1.5 Source Control

I.1.5.1 Industrial Pretreatment

Several of the permitted sources in the Anchorage area are pretreating their waste prior to discharging to the municipal sewer system. The permitted fish processors are required to grind their waste prior to disposal to avoid solids over 1 inch diameter. The military bases are required to have oil/water separators in all vehicle shops. ML&P neutralizes its cooling tower blowdown, which equates to a pH adjustment. Emerald Alaska is a company that takes ballast water from boats, petroleum-contaminated waste, and recycles antifreeze and other contaminants. It treats waste and removes contaminants for treatment elsewhere or recycling. The wastewater left over after pretreatment is sent to Asplund WPCF.

I.1.5.2 Non-industrial Source Controls and BMPs

AWWU instituted a Fats, Oils, and Grease (FOG) Program and developed a brochure/guidance document that is specific to Alaska. Pretreatment staff have been working with the Department of Health and Human Services, Food Safety and Sanitation (FSS) program to educate food service facilities. FSS staff have begun distributing the AWWU FOG brochure during their annual food service facility inspections. AWWU maintenance staff also hand out the brochure when they respond to sewer blockages.

AWWU pays for a portion of the Solid Waste Services program to collect household hazardous wastes. The household hazaround waste program is aimed at keeping toxics out of the landfill and subsequent leachate, and from being discarded into the sewer system.

I.1.5.3 Outreach Program

Pretreatment staff answer many questions from the general public about where to dispose of substances. If disposal in the sewer is not allowed, they make every effort to find an alternate location for the public. In response to these questions, pretreatment staff have worked to create Waste Disposal Guidance documents for the general public. Such documents are currently available for antifreeze and formalin.

Taking the FOG program a step further than just the public sector, AWWU's Customer Service Section sent a Pretreatment Program bill stuffer to all residential customer accounts. It identified actions customers could take to prevent sewer line blockages. AWWU reports that owners of multi-residential dwellings have requested additional copies of the brochure to distribute to tenants.

I.1.5.4 Monitoring and Sampling Program Description

The SUO states that industrial users must allow AWWU access to inspect their monitoring facilities at any time to confirm compliance with their discharge permit. Inspections may include sampling, visual inspection, compliance monitoring, or metering operations.

In the most recent annual report to the EPA, AWWU determined that pollutant loadings did not approach the MAHL, the maximum allowable effluent concentration, or the local sludge loading limits. Influent, effluent, and sludge were monitored and an independent laboratory concluded that the NPDES permit requirements and the Alaska Water Quality Standards were met. Specifically, according to the report:

> "Concentrations of toxic pollutants and pesticides, including metals and cyanide, in influent and effluent were all within the established range or lower than values from a national study of secondary treatment plants."
>
> "Toxic pollutant sludge concentrations were found to be very low compared to the limits established under 40 CFR Part 503 and all were either not-detected or within the established ranges or lower than values from a national study of secondary treatment plants."

I.1.5.5 Enforcement Actions

In the past year, AWWU issued two notices of violation to liquid waste haulers for discharging wastewater with a low pH into the sewer. These violations were found during planned random surveys of waste haulers.

Discharges of fish waste solids over 1 inch in dimension caused sewer obstructions on three separate occasions last year and resulted in three citations, total fines of $1,225, and recovery costs of $30,000 paid to AWWU for cleanup and removing fish waste from the sewer main. This violation was considered Significant Non-Compliance and was published in the *Anchorage Daily News*. A compliance order was issued to the offending industrial user, which required that they install a new fish waste grinder system, submit an Industrial Management Practice Plan to the utility, and install a control manhole where sampling and metering of their discharge can occur. Also, the industrial user had to submit status reports every 2 weeks until all requirements of the Compliance Order were met. All compliance actions were satisfactorily completed.

A third user entered significant non-compliance status by closing their business without advanced warning to AWWU and for submitting biannual monitoring reports late. They have since completed a closure plan, which detailed characterization and disposal of hazardous wastes to the satisfaction of AWWU.

I.1.6 Potential for Parameters of Concern

Recently, EPA has conducted studies (refer to 9-plant study in Appendices A and B) focusing on new POCs. One group of POCs is bioactive chemicals, substances that have an effect on living tissue. Aqueous film-forming-foams (AFFF) have also received a lot of attention lately for contaminating groundwater near fire training areas.

I.1.6.1 Pharmaceuticals

The EPA refers to bioactive chemicals and pharmaceuticals as pharmaceuticals and personal care products as pollutants. They can come from prescription and over-the counter drugs, veterinary drugs, cosmetics, vitamins, and even sunscreen products. Sources of personal care products as pollutants are everyday human activity, pharmaceutical manufacturing, hospitals, illicit drug use, veterinary drug use, and agribusiness.

The EPA has already established a point source category for pharmaceutical manufacturing. Eight priority pollutants and 16 non-conventional pollutants are listed in this point source category. The EPA has identified 304 facilities that use solvents and discharge wastewater from pharmaceutical manufacturing processes.

I.1.6.2 Aqueous Film-forming Foam

AFFF are used to fight highly flammable or combustible liquid fires, such as blazes in gas tankers and oil refineries. For that reason, the biggest users of AFFF are the military and petrochemical and aviation industries. AFFF is an agent that increases the solubility of organic compounds and is resistant to oil/water gravity separation. EPA is not currently evaluating AFFF, but some states have set limits on its disposal.

I.1.6.3 Source Identification

None of the 304 pharmaceutical manufacturers identified by the EPA are located in Anchorage. Therefore, no discharges to AWWU fall under the pharmaceutical point source category. However, AWWU has used that background information to develop a list of constituents to test for to determine if there is any reason for concern about these constituents in the Anchorage area. AWWU is committed to a one-time test of wastewater influent at Asplund WPCF for a variety of emerging POCs. The pretreatment staff have also created a draft guidance document for disposal of pharmaceuticals. They plan to use the testing data to complete a final guidance document in 2010.

AWWU has issued temporary discharge permits for one-time disposal of AFFF approximately three times per year. Restrictions imposed on AFFF disposal include at least 48 hours advance notice of disposal. Concentrated and slug dumping are also prohibited.

I.1.7 Program update following EPA audit and Internal Program Audit

The EPA audited the Anchorage Pretreatment Program in August 2008. AWWU then performed a more in-depth internal audit of its Industrial Pretreatment Program. Improvements were recommended and are being implemented primarily to increase monitoring oversight and incorporate new EPA Streamlining Rule language into the SUO. The EPA created the Streamlining Rule in 2005 to update and clarify provisions in the Pretreatment Regulations. AWWU is now adding EPA streamlining language to the Anchorage Municipal Code.

I.1.7.1 Findings and Response

As a result of the internal audit, AWWU has increased monitoring oversight of Municipal Light and Power, Elmendorf Air Force Base and Fort Richardson Army Post and added biannual monitoring at all sewer outfalls from military bases. Those discharges were analyzed for local limits and found to be in compliance.

AWWU is increasing controls on liquid waste haulers. Automatic sampling and flow measurement, as well as monitoring for lower explosive limit, are now in place. Alarms have also been connected to the remote monitoring system. Improved video surveillance allows pretreatment staff to oversee the locations and record individual hauler activity.

The EPA audit found that several industrial users that had been downgraded from SIU status needed to again be counted as SIUs for monitoring purposes. A formal survey of all commercial users was conducted to ensure complete coverage of the Anchorage area. AWWU pretreatment staff anticipate permitting three more users as a result of this survey (AWWU Pretreatment Staff: personal communication).

I.1.7.2 Other Updates

Over the past year, AWWU has made several other Pretreatment Program improvements. AWWU purchased a new pretreatment software package to help manage industrial users and monitoring data. The Utility also converted its accounts database to North American Industrial Classification System codes, which are more easily cataloged than the previous system of internal codes.

AWWU has modified the discharge permit shell to include new requirements for a business closure plan. They also updated the Sewer Emergency Response Plan. As they continue to educate the public about acceptable sewer discharges, they will also update the Enforcement Response Plan.

I.2 Works Cited

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Appendix J
Letters Related to Consultation

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anchorage Fish and Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

MARCH 3, 1849

in reply refer to AFWFO

May 20, 2009

Lisa Olson
Environmental Protection Agency
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101

Re: Anchorage Water and Wastewater Utility (*Consultation number 2009-0120*)

Dear Ms. Olson,

On May 14, 2009, we received the letter from Michael J. Lidgard, Manager, NPDES Permits Unit, that the Environmental Protection Agency granted "application status" to the Anchorage Water and Wastewater Utility for the purposes of Endangered Species Act consultation on the 301(h) waiver determination and permit reauthorization for the John M. Asplund Water Pollution Control Facility.

Our records indicate that there are no federally listed or proposed species, and/or designated or proposed critical habitat, within the action area of the proposed project. In view of this, requirements of section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq., as amended; ESA) have been satisfied. However, obligations under the ESA must be reconsidered if new information reveals project impacts that may affect listed species or critical habitat in a manner not previously considered, if this action is subsequently modified in a manner which was not considered in this assessment, or if a new species is listed or critical habitat is determined that may be affected by the identified action.

This letter relates only to federally listed or proposed species, and/or designated or proposed critical habitat, under our jurisdiction; namely, the Aleutian shield fern (*Polystichum aleuticum*, listed as endangered in 1988), spectacled eider (*Somateria fischeri,* listed as threatened in 1993), North American breeding Steller's eider (*Polysticta stelleri*, listed as threatened in 1997), the southwest distinct population segment of northern sea otter (*Enhydra lutris kenyoni,* listed as threatened in 2005), short-tailed albatross (*Phoebastria albatrus*, listed as endangered in 2000), polar bear (*Ursus maritimus*, listed as threatened in 2008), Kittlitz's murrelet (*Brachyramphus brevirostris,* listed as a candidate species in 2005), and yellow-billed loon (*Gavia adamsii*, listed as a candidate species in 2009). This letter does not address species under the jurisdiction of the National Marine Fisheries Service, or other legislation or responsibilities under the Fish and Wildlife Coordination Act, Clean Water Act, National Environmental Policy Act, Marine Mammal Protection Act, Migratory Bird Treaty Act, or Bald and Golden Eagle Protection Act.

Thank you for your cooperation in meeting our joint responsibilities under section 7 of the ESA. If you have any questions, please contact me at (907) 271-3063 and refer to consultation number 2009-0120.

Sincerely,

Tim Langer

Tim Langer, Ph.D.
Endangered Species Biologist

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

June 25, 2009

Lisa Olson
NPDES Permits
Environmental Protection Agency
1200 6th Ave, Ste 900
Seattle, WA 98101-3140

Re: Point Woronzof area discharge from John M. Asplund Water Pollution Control Facility; NPDES Permit AK-002255-1

ATTN OF: OWW-130

Dear Ms. Olson:

The National Marine Fisheries Service (NMFS) has received your letter requesting information on threatened or endangered species and Essential Fish Habitat (EFH) associated with the reissuance of a permit for the Point Woronzof area discharge from John M. Asplund Water Pollution Control Facility, NPDES Permit number AK-002255-1. NMFS offers the following information under the Endangered Species Act (ESA) and the EFH provisions of the Magnuson-Stevens Fishery Conservation Management Act (Magnuson-Stevens Act).

Threatened and Endangered Species

Section 7(a)(2) of the ESA directs federal interagency cooperation "to insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species" or result in the destruction or adverse modification of critical habitat. NMFS is responsible for administration of the ESA for cetaceans, sea turtles, anadromous fish, marine fish, seals, sea lions, marine plants and corals. All other species (including polar bears, walrus and sea otters) are administered by the U. S. Fish and Wildlife Service. Further information on NMFS ESA species can be found at http://www.nmfs.noaa.gov/pr/species/esa_species.htm.

Cook Inlet beluga whales are listed as endangered under the ESA and are frequently observed in the waters adjacent to the project and must be considered when evaluating the effects of this project. At this time, critical habitat for Cook Inlet beluga whales has not been designated, however, the project is adjacent to Valuable Habitat Type 1, as defined by the 2008 Conservation Plan for the Cook Inlet Beluga Whale. The western stock of Steller sea lions (west of 144 degrees w. longitude) are also listed as endangered. While their presence in upper Cook Inlet is unusual, earlier this month a Steller sea lion was documented three days in a row near the Port of Anchorage, just north of Point Woronzof. No critical habitat for Steller sea lions is designated near the project area. All marine mammals are protected under the Marine Mammal Protection Act, including harbor seals and harbor porpoises which have also occasionally been documented in the area.

Several ESA-listed stocks of Pacific salmon occur within Alaskan waters. These include the following Evolutionarily Significant Units (ESU): Snake River fall Chinook, Snake River spring/summer Chinook, Puget Sound Chinook, Upper Columbia River spring Chinook, Lower Columbia River spring Chinook, Upper Columbia River steelhead, Upper Willamette River steelhead, Middle Columbia River steelhead, Lower Columbia River steelhead, and Snake River basin steelhead. These stocks range throughout the North Pacific. However, the specific occurrence of listed salmonids within the project area is highly unlikely.

Essential Fish Habitat

Under Section 305(b)(2) of the Magnuson-Stevens Act, federal agencies are required to consult with the Secretary of Commerce on any action that may adversely affect EFH. EFH has been designated in waters used by anadromous salmon and various life stages of marine fish under NMFS' jurisdiction. Five fishery management plans exist for fisheries in Alaska. They cover groundfish in the Gulf of Alaska, groundfish in the Bering Sea and Aleutian Islands, crab in the Bering Sea and Aleutian Islands, and salmon and scallops statewide. Please visit our web site at http://www.fakr.noaa.gov/habitat for additional information on habitat and EFH.

We hope this information is useful to you in fulfilling any requirements under section 7 of the Endangered Species Act and section 305(b)(2) of the Magnuson-Stevens Act. Please direct any marine mammal questions to Mandy Migura at 907-271-1332, and questions regarding EFH to John Olson at 907-271-1508.

Sincerely,

for Robert D. Mecum
Acting Administrator, Alaska Region

cc: John Olson

Point Woronzof NPDES permit T&E ltr mm 6-24-09

Appendix K
Existing NPDES Permit

United States Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

AUTHORIZATION TO DISCHARGE AND DISPOSE BIOSOLIDS UNDER THE NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, 33 U.S.C. §1251 et seq., as amended by the Water Quality Act of 1987, P.L. 100-4, the “Act”, the

Municipality of Anchorage
John M. Asplund Water Pollution Control Facility

is authorized to discharge from a facility located at **Anchorage, Alaska** (latitude: 61° 12′ 22.5”; longitude: 150° 01′ 8.7”)

to receiving waters named **Knik Arm of Cook Inlet**,

in accordance with the discharge point, effluent limitations, monitoring requirements and other conditions set forth herein and

is authorized to dispose biosolids by incineration and to a landfill at the Municipality of Anchorage Regional Landfill,

in accordance with the disposal site, specific limitations, monitoring requirements, management practices, and other conditions set forth herein.

This permit shall become effective August 2nd 2000.

This permit and the authorization to discharge and dispose biosolids shall expire at midnight, August 2nd 2005

Signed this 30th day of June 2000.

Sign by Michael Bussell for
Randall F. Smith, Director
Office of Water, Region 10
U.S. Environmental Protection Agency

TABLE OF CONTENTS

I. SPECIFIC LIMITATIONS AND REQUIREMENTS

A. Effluent Limitations

1. During the effective period of this permit, the permittee is authorized to discharge from outfall 001, subject to the restrictions set forth herein. This permit does not authorize the discharge of any waste streams, including spills and other unintentional or non-routine discharges of pollutants, that are not part of the normal operation of the facility as disclosed in the permit application, or any pollutants that are not ordinarily present in such waste streams.

2. There shall be no discharge of floating solids, visible foam, or oily wastes which produce a sheen on the surface of the receiving water.

3. The pH shall not be less than 6.5 standard units nor greater than 8.5 standard units.

4. The following effluent limits shall apply at all times:

Table 1. EFFLUENT LIMITATIONS

Effluent Parameter	Unit of Measurement	Monthly Average	Weekly Average	Maximum Daily
Biochemical Oxygen Demand (BOD_5)	mg/L	240	250	300
	lbs/day	72,100	75,100	90,100
Total Suspended Solids (TSS)	mg/L	170	180	190
	lbs/day	51,000	54,000	57,000
Fecal Coliform Bacteria[1]	colonies/100 mL	850[2]	---	---
Total Residual Chlorine[1]	mg/L	---	---	1.2

1 Reporting is required within 24-hours if the limitation is violated (see Part II.H.).
2 Geometric mean of at least five samples. Not more than 10% of the samples shall exceed 2600 FC MPN/mL.

B. Monitoring Requirements

1. Overview

The permittee shall implement the plant influent/effluent, water quality, biological, and toxics control monitoring programs as described below. The primary objectives of these programs are as follows:

- Determine compliance with the NPDES Permit
- Determine compliance with State water quality criteria
- Determine effectiveness of industrial pretreatment program
- Aid in assessing water quality at discharge point
- Characterize toxic substances
- Monitor plant performance
- Determine compliance with the regulatory criteria of Section 301(h) of the Clean Water Act
- Determine level of bacteria concentration in nearshore waters
- Monitor for changes in sediment quality (organic enrichment, grain size distribution alteration, and pollutant contamination)
- Determine if pollutants from the discharge are accumulating in exposed biological organisms
- Provide data for evaluating reissuance of this permit

2. Annual Reporting

In addition to the monthly Discharge Monitoring Report required under Part II.C. of this permit, an annual written report, covering the previous calendar year, shall be submitted to EPA by February 15 of each year. The annual report shall contain summaries of the receiving water quality monitoring data, and any sediment analyses or bioaccumulation results if required in the previous year. The report shall also include the toxic and pesticide data required under the influent/effluent monitoring program. In addition to summarizing the data the permittee shall also evaluate and interpret data in relation to the magnitude and ecological significance of observed changes in the parameters measured. Potential changes in water quality, sediment chemistry, and biological parameters over time and with distance from the outfall, shall be addressed. All reports will address compliance with water quality standards by using appropriate descriptive and statistical methods to test for and to describe any impacts of the effluent on water quality.

3. Influent, Effluent, and Sludge Monitoring Requirements

During the effective period of this permit, the following monitoring requirements shall apply:

Table 2. INFLUENT/EFFLUENT/SLUDGE MONITORING REQUIREMENTS

Effluent Parameter	**Sample Location** [1]	**Sample Frequency**	**Sample Type**
Flow	effluent	continuous	continuous
Total Residual Chlorine	effluent	continuous or every 2-4 hours	grab
DO	effluent	4/week	grab
BOD_5	influent & effluent	4/week	24-hour composite
TSS	influent & effluent	4/week	24-hour composite
Temperature	influent & effluent	4/week	grab
pH	influent & effluent	4/week	grab
Fecal Coliform Bacteria	effluent	3/week	grab
Total Ammonia as N	effluent	1/month	24-hour composite
Enterococci Bacteria	effluent	2 per year[2]	grab
Oil and Grease	effluent	2 per year	grab
Toxic Pollutants and Pesticides[3]	influent & effluent sludge	2 per year	24-hour composite
WET[4]	effluent	4 per year	24-hour composite

[1] When influent and effluent sampling is required, samples shall be collected during the same 24-hour period.

[2] Twice per year sampling in this table shall be conducted once during the dry conditions in summer and once during wet conditions.

[3] See I.B.7. for additional pretreatment sampling requirements. Values for each metal shall be reported as “total” and “dissolved” for influent and effluent samples and as ”total” for sludge samples.

[4] See I.C. for additional sampling requirements.

Influent and effluent monitoring results shall be reported monthly as specified in Part II.C. (Reporting of Monitoring Results) with the exception of parameters sampled twice per year which shall be reported annually as specified in Part I.B.2. Heavy metals and cyanide results shall also be included in the Pretreatment reporting requirements as specified in Part II.D.

4. Receiving Water Quality Monitoring Requirements

a. Water Quality Sampling

Water quality must be monitored annually, during dry weather conditions in summer. Nonfixed stations will be sampled during cruises made during a consecutive flood and ebb tide. Each cruise shall be made by following the track of a drogue released above the diffuser. Data from a minimum of three cruises made on a single flood-tide and three cruises made on the ebb-tide shall be analyzed. Stations shall include, but not be limited to: Above the diffuser; as close to the zone of initial dilution (ZID) boundary as practicable (see Definitions for a description of ZID); at least one station in the channel in Knik Arm of Cook Inlet; and the shallow subtidal area (before the drogue grounds).

Three flood-tide control cruises shall be similarly conducted in conjunction with or as soon as practicable following the cruises described above. The control cruises shall begin at a fixed station having the same water depth as the outfall and located due north across Knik Arm from Pt. Woronzof, near Pt. Mackenzie.

The following parameters will be measured at the depths indicated for each station. Profile measurements shall be made at 1 m to 3 m intervals throughout the water column:

Table 3. Receiving Water Quality Monitoring

Surface (above 0.5 m)[1]	**Surface, Mid-depth, and Bottom**	**Profiling**
Fecal coliform bacteria[2]	Dissolved oxygen (DO)	pH
Color	Turbidity	Temperature
Total residual chlorine		Salinity

Table 3. Receiving Water Quality Monitoring		
Surface (above 0.5 m)[1]	**Surface, Mid-depth, and Bottom**	**Profiling**
Total aqueous hydrocarbons[3]		
Total aromatic hydrocarbons[3]		
Metals and cyanide[3,4]		
1. At each station where surface samples are collected, the presence or absence of the following shall be reported: Floating solids, visible foam in other than trace amounts, and oily wastes which produce a sheen on the surface of the receiving water. 2. All water samples for fecal coliform bacteria analyses shall be collected in a standard manner from within the surface (15-30 cm) layer. 3. Samples for these parameters shall be obtained at the first three stations along the first flood tide cruise only, for both the outfall and control location. 4. See I.B.7. for list of metals. Values for each metal shall be reported as "total" and "dissolved"		

b. Intertidal Sampling for Bacteria

Monitoring of fecal coliform bacteria will be conducted at eight intertidal stations listed below during the summer in conjunction with the water quality monitoring program. Two replicate water samples will be gathered from the shallow waters (one to three feet deep at slack high water) at these stations. Sampling stations:

Table 4. Intertidal Sampling Stations

Station No.	**Station Location**[1]	**Latitude**	**Longitude**
1	2000 m east	61° 12' 10"	149° 58' 55"
2	1200 m east	61° 12' 11"	149° 59' 50"
3	750 m east	61° 12' 15"	150° 00' 20"
4	250 m east-southeast	61° 12' 19"	150° 00' 52"
5	250 m south	61° 12' 15"	150° 01' 10"

Table 4. Intertidal Sampling Stations

Station No.	Station Location[1]	Latitude	Longitude
6	750 m southeast	61° 12' 02"	150° 01' 28"
7	2000 m southwest	61° 11' 22"	150° 01' 28"
Control	North, across from diffuser (intertidal)	61° 14' 26"	150° 01' 8.7"

1. Distances and directions of the station locations are from the outfall diffuser and are guidelines. Exact locations used must be recorded and included in all data submissions.

5. Sediment Analyses

Sediment analyses shall be conducted in the summer during the fourth year after the effective date of this permit. The sampling shall be coordinated, to the extent practicable, with the sampling times for the water quality monitoring program and the bioaccumulation study. Samples of the top 2 cm will be collected from the following five stations: Intertidal Stations Number 1 and 2, and the Intertidal Control Station, all specified in Part I.B.4.b. above, a Subtidal Station located at the ZID boundary, and a Subtidal Control station located due north across Knik Arm from Pt. Woronzof, near Pt. Mackenzie, at a similar water depth as the ZID boundary. At each station, two samples will be collected and analyzed for the following: total volatile solids (TVS); toxic pollutants and pesticides; and sediment grain size distribution.

If sediment samples are collected from gravel or cobble substrates, analyses for grain size distributions shall be done on representative samples, but analyses for TVS and for pollutants and pesticides shall be done on the finer size fractions (silt and clay fractions, combined).

Data analyses shall be presented in the written report as mean values and standard deviations by stations, for each parameter measured.

6. Bioaccumulation

A bioaccumulation study shall be conducted in the summer during the fourth year after the effective date of this permit. The sampling shall be coordinated, to the extent practicable, with the sampling times for the water quality monitoring program and the sediment analysis. The intertidal yellow-brown macroalgae *Vaucheria* shall be sampled at two intertidal stations: Station Number 1 and the

Intertidal Control Station from Part I.B.4.b. above. Ten (10) replicate algal samples shall be collected at random distances and bearings within a 10 meter radius of the intertidal station. Each sample shall be analyzed for priority pollutant organics, total hydrocarbons, trace metals and cyanide.

7. Pretreatment Program Sampling Requirements

   a. The permittee shall sample influent, effluent, and sludge from its facility for the following parameters: percent solids (sludge only), arsenic, cadmium, chromium, copper, cyanide, lead, mercury, nickel, silver, and zinc. Metals must be analyzed and reported as total metals and dissolved metals.

   b. Sampling shall be conducted twice per year: once during wet conditions and once during the dry conditions.

   c. The permittee shall sample as described in the following table:

Table 5. Pretreatment Monitoring - Sample Types and Frequency

Wastestream	**Sample Type**	**Frequency**[1]
Influent	24-hour Composite	3 Consecutive days (Mon - Fri)
Effluent	24-hour Composite	3 Consecutive days (Mon - Fri)
Sludge	Composite of 8 grabs/day	Once, during the same time period that influent and effluent samples are being taken

1. The first day of the 3 consecutive days of sampling specified by this table are accomplished by the twice per year sampling for the same constituents specified in Table 2 of Section I.B.3.

   d. Sludge samples shall be taken as the sludge leaves the treatment processes and before mixing with sludge of different age in drying beds or in storage.

   e. Metals concentrations in sludge shall be reported in mg/kg, dry weight.

   f. Daily composite samples shall be analyzed and reported separately. Sample results shall be submitted with the pretreatment annual report required in Section II.D. below.

8. Monitoring Program Plan including Quality Assurance Requirements

   a. Within 90 days of the effective date of this permit, the permittee shall submit to EPA a Monitoring Program Plan that includes a Quality Assurance/Quality Control (QA/QC) program. This plan shall address the details of: 1) all monitoring procedures (e.g., methods to insure adequate preservation of composite samples, methods of station location and relocation, identification of sampling equipment), 2) monitoring objectives, 3) specific QA/QC procedures including the detection limits and precision requirements that will insure that program objectives are met, 4) how data will be used to evaluate the monitoring objectives, 5) name(s), address(es), and telephone number(s) of the laboratories, used by or proposed to be used by the permittee, and 6) other activities designed to achieve data quality goals for the monitoring programs.

   b. The document, *Guidance for Preparation of Quality Assurance Project Plans*, EPA, Region 10, Quality and Data Management Program, QA/G-5, may be used as a reference guide in preparing the QA/QC program. This document is available at http://www.epa.gov/r10earth/offices/oea/qaindex.htm.

   c. The permittee shall amend the Monitoring Program Plan whenever there is a modification in the sample collection, sample analysis, or other conditions or requirements of the plan.

   d. Copies of the Monitoring Program Plan shall be kept on site and shall be made available to EPA and ADEC upon request.

C. Whole Effluent Toxicity (WET) Testing Requirements.

The permittee shall conduct quarterly toxicity tests on 24-hour composite effluent samples.

1. Organisms and Protocols

   a.. The permittee shall conduct tests with a vertebrate and two invertebrate species, as follows for the first three suites of tests. After the screening period, monitoring shall be conducted using the most sensitive species only.

Vertebrate: Topsmelt, *Atherinops affinis* (survival and growth).

Invertebrate: Bivalve species, mussel, *Mytilis spp*. (survival and growth) or Pacific oyster, *Crassostrea gigas* (larval development test), and

Purple urchin, *Strongylocentrotus purpuratus* or sand dollar, *Dendraster excentricus* (fertilization test)

b. The presence of chronic toxicity shall be estimated as specified in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms*, EPA/600/4-87/028, May 1988, and/or *West Coast Marine Methods Manual, First Edition*, Eds. Chapman, G.A., D.L. Denton, and J.M. Lazorchak, EPA/600/R-95-136.

2. Each year the permittee shall re-screen for one quarter with three species and continue to monitor for the rest of the year with the most sensitive species. The screening shall occur in a different quarter than the previous year.

3. Results shall be reported in TUc (chronic toxic units). TUc = 100/NOEC.

4. Toxicity Triggers. For the purposes of determining compliance with Paragraphs 7 and 8 below, chronic toxicity testing requirements are triggered when chronic toxicity is greater than 143TUc.

5. Quality Assurance

   a. A series of five dilutions and a control shall be tested. The series shall include the concentration of the effluent at the edge of the ZID. The concentration of the effluent at the edge of the ZID is 0.70%. The dilution series shall also include two dilutions above 0.70%, and two dilutions below 0.70%.

   b. Concurrent testing with reference toxicants shall also be conducted if organisms are not cultured in-house. Otherwise, monthly testing with reference toxicants is sufficient. Reference toxicants shall be conducted using the same test conditions as the effluent toxicity tests (e.g., same test duration and type).

c. If the effluent tests do not meet all test acceptability criteria as specified in the manual, then the permittee must re-sample and re-test as soon as possible.

d. Control and dilution water shall be natural or synthetic seawater, as described in the manual. If the dilution water used is different from the culture water, a second control, using culture water shall also be used. Receiving water may be used as control and dilution water upon notification of EPA and ADEC. In no case shall water that has not met test acceptability criteria be used as dilution water.

6. Preparation of Initial Investigation Toxicity Reduction Evaluation (TRE) Plan

The permittee shall submit to EPA a copy of the permittee's initial investigation TRE workplan within 90 days of the effective date of this permit. This plan shall describe the steps the permittee intends to follow in the event that chronic toxicity as described in Part I.C.4. above, is detected, and should include at a minimum:

a. a description of the investigation and evaluation techniques that would be used to identify potential causes/sources of toxicity, effluent variability, treatment system efficiency;

b. a description of the facility's method of maximizing in-house treatment efficiency, good housekeeping practices, and a list of all chemicals used in operation of the facility; and

c. if a toxicity identification evaluation (TIE) is necessary, who will conduct it (i.e., in-house or other).

7. Accelerated Testing

a. If chronic toxicity as defined in Part I.C.4. above is detected during the quarterly tests, the permittee shall implement the initial investigation workplan. If implementation of the initial investigation workplan indicates the source of toxicity (for instance, a temporary plant upset), then only one additional test is necessary. If toxicity is detected in this test, then the following Part I.C.7.b. shall apply.

b. If toxicity is detected as defined in Part I.C.4. in the test required in Paragraph a. above, then the permittee shall conduct six more tests, bi-weekly (every two weeks), over a twelve-week period. Testing shall commence within two weeks of receipt of the sample results of the exceedance.

8. TRE and Toxicity Identification Evaluation (TIE)

   a. If chronic toxicity as defined Part I.C.4. is detected in any of the six additional tests required under Part I.C.7.b., then, in accordance with the permittee's initial investigation workplan and EPA manual EPA 833-B-99-002 (*Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants*), the permittee shall initiate a TRE within fifteen (15) days of receipt of the sample results of the exceedance. The permittee will develop as expeditiously as possible a more detailed TRE workplan, which includes:

      i. further actions to investigate and identify the cause of toxicity;

      ii. actions the permittee will take to mitigate the impact of the discharge and to prevent the recurrence of toxicity; and

      iii. a schedule for these actions.

   b. The permittee may initiate a TIE as part of the overall TRE process described in the EPA acute and chronic TIE manuals EPA/600/6-91/005F (Phase I), EPA/600/R-92/080 (Phase II), and EPA-600/R-92/081 (Phase III).

   c. If none of the six tests required under Part I.C.7.b. above indicates toxicity, then the permittee may return to the normal testing frequency.

   d. If a TIE is initiated prior to completion of the accelerated testing, the accelerated testing schedule may be terminated, or used as necessary in performing the TIE.

9. Reporting

   a. The permittee shall submit the results of the toxicity tests, including any accelerated testing conducted during the month, in TUc with the discharge monitoring reports (DMR) for the month following the month in which the test is conducted. If an initial investigation indicates the source of toxicity and accelerated testing is unnecessary, pursuant to Part I.C.7., then those results shall also be submitted with the DMR for the quarter in which the investigation occurred.

b. The full report shall be submitted by the end of the month following the month in which the DMR is submitted.

c. The full report shall consist of: the results; the dates of sample collection and initiation of each toxicity test; the triggers as defined in Part I.C.7. above; the type of activity occurring; the flow rate at the time of sample collection; and the chemical parameter monitoring required for the outfall(s) as defined in the permit.

d. Test results for chronic tests shall also be reported according to the chronic manual chapter on Report Preparation, and shall be attached to the DMR.

D. Sewage Sludge Management Requirements

The permittee is authorized by this permit to dispose of sewage sludge by means of incineration or, alternatively, by disposal at a landfill or by composting. In addition to sludge generated by the Asplund Facility, the facility may accept sludge generated by the following POTW's: Eagle River WWTF, Girdwood WWTF, City of Palmer, City of Wasilla, Talkeetna Service District, and City of Whittier. The following sludge management requirements shall apply:

1. The permittee shall handle and dispose of sewage sludge in such a manner so as to protect public health and the environment from any reasonably anticipated adverse effects due to any toxic pollutants which may be present in the sludge.

2. The permittee shall comply with all existing federal and state laws and regulations that apply to its sewage sludge use and disposal practice(s), and with all future standards promulgated under Section 405 (d) of the Clean Water Act of 1987.

3. The permittee shall ensure pollutants from the sludge do not reach surface waters of the United States.

4. Sludge from the facility may be transferred to the Asplund sewage sludge incinerator, for processing and disposal only in accordance with the requirements of this permit, and any current or future sludge requirements

contained in the operational permit(s) of the incinerator facility, including but not limited to:

   a. The quality of the sludge and the method and delivery of the sludge shall be in compliance with any applicable requirements in the air pollution control permit of the Asplund sewage sludge incinerator.

5. Sludge from the facility may be transferred to the Municipality of Anchorage Regional Landfill, as an alternative use and disposal option only in accordance with the requirements of this permit, and any current or future sludge requirements contained in 40 CFR 258 or the operational permit(s) of the landfill facility, including but not limited to:

   a. The sludge shall be deposited within or directly over the municipal solid waste landfill "unit" and not in a separate unit, pile, lagoon, or trench either exclusively for sludge, or in combination with some waste or material other than municipal solid waste.

   b. The sludge shall have no "free liquids" as defined by EPA test method 9095 in *Test Methods for Evaluating Solid Wastes Physical/Chemical Methods* (EPA Pub.No. SW-846) in accordance with 40 CFR 258.28,

   c. The sludge shall be characterized as non-hazardous in accordance with 40 CFR 258.20, and

   d. The delivery, and any storage, handling, or processing of the sludge shall be conducted in accordance with the requirements of 40 CFR 258 for municipal solid waste landfill unit operations, and in accordance with any sludge requirements established in the operating permit(s), or operating approvals issued or established to implement 40 CFR 258.

6. Sludge from the facility may be transferred to a public or private composting facility. The permittee shall, to the extent practicable, ensure that the composting operation complies with the requirements of 40 CFR 503 Subpart B regarding sludge disposal. AWWU shall take corrective action should the composting facility fall out of compliance with these regulations. The permittee shall maintain a record of its efforts to comply with this paragraph.

7. Sludge delivery shall be suspended or discontinued upon receipt of written instructions from EPA. If any other appropriate authority submits a written request to the sludge generator or recipient facility to suspend or cease any activities associated with sludge management, or if they receive information indicating the recipient facility is not in compliance with the conditions of its operating permit(s), the permittee shall deliver a copy of this request or non-compliance information to EPA within 48 hours of receiving the request. The term "appropriate authority" includes any federal, state, or local agency with regulatory authority over sludge management at either the generator or recipient facility. The permittee may only resume delivery of sludge upon receipt of written authorization from EPA.

8. Any storage of sludge shall be performed in accordance with an NPDES stormwater permit as applicable, and any current or future federal and state standards or permits. Any storage must prevent disease transmission, vector attraction, or nuisance conditions.

9. This permit may be reopened to incorporate additional limits to prevent violations of the current or future operational permit(s) of the recipient facility, or harm to the environment or public health due to mismanagement of the sewage sludge.

10. The permittee shall notify the EPA 180 days prior to changing the sludge management practice.

11. The permittee shall submit a report to EPA on February 19 of each year that includes the following information:

    a. Amount of sludge (tons, dry weight) delivered to each recipient facility.

    b. Results of free liquid tests, and results of any other tests of the sludge such as for hazardous characteristics, total metals, or other parameters used to determine compliance with the requirements of this permit.

E. Pretreatment Program Requirements

1. The permittee shall implement its pretreatment program in accordance with the legal authorities, policies, procedures, staffing levels and financial provisions described in its original approved pretreatment program submission entitled ***Municipality of Anchorage Industrial Pretreatment Program*** **(approved April**

9, 1982), any program amendments submitted thereafter and approved by EPA, and the General Pretreatment Regulations (40 CFR 403) and any amendments thereof. At a minimum, the permittee shall undertake the following pretreatment implementation:

a. Enforce categorical pretreatment standards promulgated pursuant to Section 307(b) and (c) of the Act, prohibitive discharge standards as set forth in 40 CFR 403.5, or local limitations developed by the permittee in accordance with 40 CFR 403.5(c), whichever are more stringent or are applicable to non-domestic users discharging wastewater into the permittee's collection system. Locally derived limitations shall be defined as pretreatment standards under Section 307(d) of the Act.

b. Implement and enforce the requirements of the most recent and effective portions of local law and regulations (e.g. municipal code, sewer use ordinance) addressing the regulation of non-domestic users.

c. Update its inventory of non-domestic users at a frequency and diligence adequate to ensure proper identification of non-domestic users subject to pretreatment standards, but no less than once per year. The permittee shall notify these users of applicable pretreatment standards in accordance with 40 CFR 403.8(f)(2)(iii).

d. Issue, reissue, and modify, in a timely manner, industrial wastewater discharge permits to at least all Significant Industrial Users (SIUs) and categorical industrial users. These documents shall contain, at a minimum, conditions identified in 40 CFR 403.8(f)(1)(iii). The permittee shall follow the methods described in its implementation procedures for issuance of individual permits.

e. Develop and maintain a data management system designed to track the status of the permittee's non-domestic user inventory, non-domestic user discharge characteristics, and their compliance with applicable pretreatment standards and requirements. The permittee shall retain all records relating to its pretreatment program activities for a minimum of three years and shall make such records available to EPA upon request. The permittee shall also provide public access to information considered effluent data under 40 CFR Part 2.

f. Establish, where necessary, contracts or legally binding agreements with contributing jurisdictions to ensure compliance with applicable pretreatment requirements by non-domestic users within these jurisdictions. These contracts or agreements shall identify the agency responsible for the various implementation and enforcement activities in the contributing jurisdiction. In addition, the permittee may be required to develop a Memorandum of Understanding that outlines the specific roles, responsibilities and pretreatment activities of each jurisdiction.

g. Carry out inspections, surveillance, and monitoring of non-domestic users to determine compliance with applicable pretreatment standards and requirements. A thorough inspection of SIUs shall be conducted at least annually.

h. Require SIUs to conduct wastewater sampling as specified in 40 CFR 403.12(e)(1). Frequency of wastewater sampling for the SIUs shall be commensurate with the character and volume of the wastewater, but shall not be less than twice per year. Sample collection and analysis shall be performed in accordance with 40 CFR 403.12 (b)(5)(ii) through (v) and 40 CFR Part 136. If the permittee elects to conduct all the non-domestic user monitoring for any SIU in lieu of requiring self-monitoring the permittee shall conduct sampling in accordance with the requirements of this paragraph.

i. Enforce and obtain remedies for any industrial user in non-compliance with applicable pretreatment standards and requirements. This shall include timely and appropriate reviews of industrial reports to identify all violations of the user's permit or the permittee's local ordinance. Once violations have been uncovered, the permittee shall take timely and appropriate action to address the noncompliance. The permittee's enforcement actions shall track its approved enforcement response procedures.

j. Publish, at least annually in the largest daily newspaper in the permittee's service area, a list of all non-domestic users which, at any time in the previous 12 months, were in Significant Non-Compliance as defined in 40 CFR 403.8 (f)(2)(vii).

k. Maintain adequate staff, funds and equipment to implement its pretreatment program.

l. Conduct an analysis to determine whether influent pollutant loadings are approaching the maximum allowable headworks loading in the permittee's local limits calculations. Any local limits found to be inadequate by this analysis shall be revised. The permittee may be required to revise existing local limits or develop new limits if deemed necessary by EPA.

2. The permittee shall implement an accidental spill prevention program to reduce and prevent spills and slug discharges of pollutants from non-domestic users.

3. Whenever, on the basis of information provided to EPA, it is determined that any source contributes pollutants to the permittee's facility in violation of subsection (b), (c), or (d) of Section 307 of the Act, notification shall be provided to the permittee. Failure by the permittee to commence an appropriate enforcement action within 30 days of this notification may result in appropriate enforcement action by the EPA against the source and permittee.

4. If the permittee elects to modify any components of its pretreatment program, it shall comply with the requirements of 40 CFR 403.18. No substantial program modification, as defined in 40 CFR 403.18(b), may be implemented prior to receiving written authorization from EPA.

5. Under no circumstances shall the permittee allow introduction of the following wastes into the waste treatment system:

    a. Wastes which will create a fire or explosion hazard in the treatment works;

    b. Wastes which will cause corrosive structural damage to the treatment works, but in no case, wastes with a pH lower than 5.0, unless the works is designed to accommodate such wastes;

    c. Solid or viscous substances in amounts which cause obstructions to the flow in sewers, or interference with the proper operation of the treatment works;

    d. Wastewater at a flow rate and/or pollutant discharge rate which is excessive over relatively short time periods so that there is a treatment process upset and subsequent loss of treatment efficiency; and

    e. Any pollutant, including oxygen demanding pollutants (BOD_5, etc.) released in a discharge of such volume or strength as to cause interference in the treatment works.

6. The permittee shall require any industrial user of its treatment works to comply with any applicable requirements of Sections 204(b), 307, and 308 of the Act, including any requirements established under 40 CFR Part 403.

F. Nonindustrial Source Control Program

The permittee shall implement the following nonindustrial source control program:

1. Implement and enforce ordinances to control the introduction of toxic pollutants from nonindustrial sources to the wastewater collection system.

2. Develop and publish disposal guidelines specifying what toxic pollutants can and cannot be discharged to the sewer system and identifying alternative disposal methods for prohibited pollutants.

3. Implement the control program for nonindustrial sources as contained the pretreatment program approved by EPA on April 9, 1982. As part of this program, the following shall be addressed: development of control programs for specific nonindustrial categories of sources, including a program description, method of enforcement, monitoring program, and schedule for implementation.

4. Provide alternative disposal methods for nonindustrial toxic pollutants such as the annual hazardous waste cleanup program.

5. Implement a hazardous waste management plan for small quantity generators.

6. Reporting: A report on the nonindustrial source control program shall be submitted along with each annual pretreatment report. This report shall include, for each of the above activities, its implementation status and its effectiveness in minimizing nonindustrial inputs of toxic pollutants and pesticides.

G. Operation and Maintenance Plan Review

1. Within 180 days after the effective date of this permit, the permittee shall review its operation and maintenance (O&M) plan and ensure that it includes appropriate best management practices (BMPs); the plan must be reviewed annually thereafter. BMPs include measures which prevent or minimize the potential for the release of pollutants to Knik Arm of Cook Inlet. The O&M Plan shall be retained on site and made available to EPA and ADEC upon request.

2. The permittee shall develop a description of pollution prevention measures and controls appropriate for the facility. The appropriateness and priorities of controls in the O&M Plan shall reflect identified potential sources of pollutants at the facility. The description of BMPs shall address, to the extent practicable, the following minimum components:

   - Spill prevention and control;
   - Optimization of chemical usage;
   - Preventive maintenance program;
   - Minimization of pollutant inputs from industrial users;
   - Research, develop and implement a public information and education program to control the introduction of household hazardous materials to the sewer system; and
   - Water conservation.

H. Definitions

1. “Average monthly discharge limitation” means the highest allowable average of “daily discharges” over a calendar month, calculated as the sum of all “daily discharges” measured during a calendar month divided by the number of “daily discharges” measured during that month.

2. “Average weekly discharge limitation” means the highest allowable average of “daily discharges” over a calendar week, calculated as the sum of all “daily discharges” measured during a calendar week divided by the number of “daily discharges” measured during that week.

3. “Biosolids” means any sludge or material derived from sludge that can be beneficially used. Beneficial use includes, but is not limited to, land application to agricultural land, forest land, a reclamation site or sale or give away to the public for home lawn and garden use.

4. “Chronic toxicity” measures a sublethal effect (e.g., reduced growth, reproduction) in an effluent or ambient waters compared to that of the control organisms.

5. “Chronic toxic unit (TU_c)” is a measure of chronic toxicity. The number of chronic toxic units in the effluent is calculated as 100/NOEC, where the NOEC is measured in percent effluent.

6. “Daily discharge” means the discharge of a pollutant measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the “daily discharge” is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the “daily discharge” is calculated as the average measurement of the pollutant over the day.

7. “Dry Weight-basis” means 100 percent solids (i.e., zero percent moisture).

8. A “Grab” sample is a single sample or measurement taken at a specific time or over as short a period of time as is feasible.

9. “Inhibition concentration (IC)” is a point estimate of the toxicant concentration that causes a given percent reduction (p) in a non-quantal biological measurement (e.g., reproduction or growth) calculated from a continuous model (e.g., the EPA Interpolation Model).

10. “IC_{25}" means the estimated toxicant concentration that would cause a 25 percent reduction in a nonlethal biological measurement of the test organisms, such as reproduction or growth.

11. “Maximum daily discharge limitation” means the highest allowable “daily discharge”.

12. “Method detection limit (MDL)” is the minimum concentration of an analyte that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero as determined by a specific laboratory method (40 CFR 136).

13. “No observed effect concentration (NOEC)” is the highest concentration of toxicant to which organisms are exposed in a chronic test, that causes no observable adverse effect on the test organisms (e.g., the highest concentration of toxicant to which the values for the observed responses are not statistically significant different from controls.)

14. “Pathogen” means an organism that is capable of producing an infection or disease in a susceptible host.

15. “Pollutant”, for the purposes of this permit, is an organic substance, an inorganic substance, a combination of organic and inorganic substances, or pathogenic organisms that, after discharge and upon exposure, ingestion, inhalation, or assimilation into an organism either directly from the environment or indirectly by ingestion through the food-chain, could, on the basis of information available to the Administrator of EPA, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunction in reproduction), or physical deformations in either organisms or offspring of the organisms.

16. “Sewage sludge” means solid, semi-solid, or liquid residue generated during the treatment of domestic sewage and/or a combination of domestic sewage and industrial waste of a liquid nature in a Treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the incineration of sewage sludge or grit and screenings generated during preliminary treatment of domestic sewage in a Treatment Works. These must be disposed of in accordance with 40 CFR 258.

17. “Suites of tests” means the two or three species used for testing during the permit term.

18. A “24-hour composite” sample shall mean a flow-proportioned mixture of not less than eight discrete aliquots. Each aliquot shall be a grab sample of not less than 100 mL and shall be collected and stored in accordance with procedures prescribed in the most recent edition of *Standard Methods for the Examination of Water and Wastewater*.

19. A “TRE” is a site-specific study conducted in a stepwise process to narrow the search for effective control measures for effluent toxicity.

20. “Toxic pollutants” are those substances listed in 40 CFR 401.15.

21. “Pesticides” are Demeton, Guthion, Malathion, Mirex, Methoxychlor and Parathion (as listed in 40 CFR 125.58).

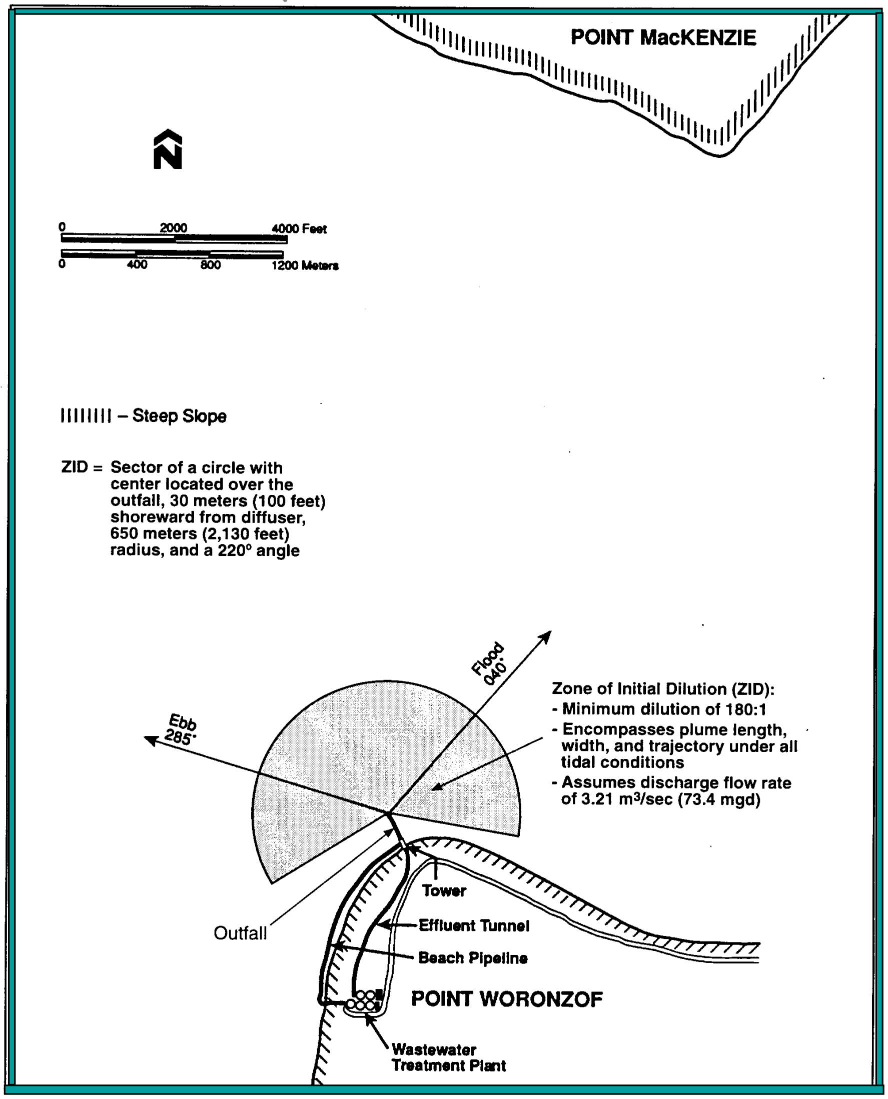
22. “Upset” means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent

limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

23. "Vector attraction" is the characteristic of sewage sludge that attracts rodents, flies, mosquitos or other organisms capable of transporting infectious agents.

24. The "ZID" is the Zone of Initial Dilution. The ZID is defined by (1) a sector of a circle with a center located over the outfall, 30 m (100 ft) shoreward of the diffuser, 650 m (2,130 ft) radius, and a 220° angle, as shown in Figure 1, and (2) the water column above that area.

Figure 1. The Zone of Initial Dilution (ZID) for the Point Woronzof Outfall



II. MONITORING, RECORDING, AND REPORTING REQUIREMENTS

A. Representative Sampling. Samples taken in compliance with the monitoring requirements established under Part I shall be collected from the effluent stream prior to discharge into the receiving waters. Samples and measurements shall be representative of the volume and nature of the monitored discharge.

B. Monitoring Procedures. Monitoring must be conducted according to test procedures approved under 40 CFR 136, unless other test procedures have been specified in this permit.

C. Reporting of Monitoring Results. Monitoring results shall be summarized each month on the Discharge Monitoring Report (DMR) form. The reports shall be submitted monthly and are to be postmarked by the 10th day of the following month. Legible copies of these, and all other reports, shall be signed and certified in accordance with the requirements of Part IV.J. Signatory Requirements, and submitted to the Director, Office of Water and the State agency at the following addresses:

original to: United States Environmental Protection Agency (EPA)
Region 10
NPDES Compliance Unit
1200 Sixth Avenue, OW-133
Seattle, Washington 98101

copy to: Alaska Department of Environmental Conservation
Division of Air and Water Quality
555 Cordova Street
Anchorage, Alaska 99503
(907)269-7523
(907)269-7508 fax

D. Pretreatment Report

1. The permittee shall submit an annual report that describes the permittee's program activities over the previous calendar year. This report shall be submitted to the following address no later than February 15 of each year:

Pretreatment Coordinator
U.S. Environmental Protection Agency Region 10
1200 Sixth Avenue, OW-130
Seattle, WA 98101

2. The pretreatment report shall be compiled following the *Region 10 Annual Report Guidance*. At a minimum, the report shall include:

    a. An updated non-domestic user inventory, including new businesses appropriately categorized and characterized. The permittee shall also list those facilities that have been dropped from the inventory, along with the reason they are no longer discharging.

    b. Results of pretreatment program sampling at the treatment plant as specified in Part I.B.7.

    c. Calculations of removal rates for each pollutant for each day of pretreatment program sampling.

    d. An analysis and discussion of whether the existing local limitations in the permittee's sewer use ordinance continue to be appropriate to prevent treatment plant interference and pass through of pollutants that could affect water quality or sludge quality.

    e. Status of program implementation, including:

        i) Any planned modifications to the pretreatment program originally approved by EPA, including staffing and funding updates.

        ii) Any interference, upset, or NPDES permit violations experienced at the facility directly or indirectly attributable to non-domestic users.

        iii) Listing of non-domestic users inspected and/or monitored during the previous year with a summary of compliance status.

        iv) Listing of non-domestic users planned for inspection and/or monitoring for the next year along with associated frequencies.

        v) Listing of non-domestic users whose permits have been issued, reissued, or modified.

        vi) Listing of non-domestic users notified of promulgated pretreatment standards and/or local standards as required in 40 CFR Part 403.8(f)(2)(iii).

vii) Listing of non-domestic users notified of promulgated pretreatment standards or applicable local standards who are on compliance schedules. The listing must include the final date of compliance for each facility.

f. Status of enforcement activities including:

i) Listing of non-domestic users who failed to comply with applicable pretreatment standards and requirements, including:

a. Summary of the violation(s).

b. Enforcement action taken or planned by the permittee.

c. Present compliance status as of the date of preparation of the pretreatment report.

ii) Listing of those users in Significant Non-Compliance and a copy of the newspaper publication of those users' names.

EPA may require more frequent reporting on those users who attain a level of Significant Non-Compliance.

E. Additional Monitoring by the Permittee. If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR. Such increased frequency shall also be indicated.

F. Records Contents. Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements,

2. The individual(s) who performed the sampling or measurements,

3. The date(s) analyses were performed,

4. The individual(s) who performed the analyses,

5. The analytical techniques or methods used, and

6. The results of such analyses.

G. Retention of Records. The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least three years from the date of the sample, measurement, report, or application. This period may be extended by request of the Director at any time. Data collected on-site, copies of DMRs, and a copy of this NPDES permit must be maintained on-site during the duration of activity at the permitted location.

H. Twenty-four Hour Notice of Noncompliance Reporting

1. The following occurrences of noncompliance shall be reported to EPA and ADEC by telephone within 24 hours from the time the permittee becomes aware of the circumstances:

    a. Any unanticipated bypass which exceeds any effluent limitation in the permit (See Part **III.G. Bypass of Treatment Facilities**),

    b. Any upset which exceeds any effluent limitation in the permit (See Part **III.H. Upset Conditions**), or

    c. Violation of a maximum daily discharge limitation for those toxic or hazardous pollutants identified within Table1 of Section I.A.

2. A written submission shall also be provided to EPA and ADEC within five days of the time that the permittee becomes aware of the circumstances. The written submission shall contain:

    a. A description of the noncompliance and its cause,

    b. The period of noncompliance, including exact dates and times,

    c. The estimated time noncompliance is expected to continue if it has not been corrected, and

    d. Steps taken or planned to reduce, eliminate, and prevent re-occurrence of the noncompliance.

3. The Director may waive the written report on a case-by-case basis if the oral report has been received within 24 hours by the NPDES Compliance Unit in Seattle, Washington, by phone, (206) 553-1846.

4. Reports shall be submitted to the addresses in Part **II.C. Reporting of Monitoring Results**.

I. Other Noncompliance Reporting. Instances of noncompliance not required to be reported within 24 hours shall be reported at the time that monitoring reports for Part II.C. are submitted. The reports shall contain the information listed in Part II.H.2.

J. Inspection and Entry. The permittee shall allow the Director or an authorized representative (including an authorized contractor acting as a representative of the Administrator), upon the presentation of credentials and other documents as may be required by law, to:

1. Enter upon the permittee’s premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit,

2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit,

3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit, and

4. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the Act, any substances or parameters at any location.

III. COMPLIANCE RESPONSIBILITIES

A. Duty to Comply. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for: enforcement action; permit termination, revocation and re-issuance, or modification; or denial of a permit renewal application. The permittee shall give advance notice to the Director and ADEC of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

B. Penalties for Violations of Permit Conditions

1. Civil and Administrative Penalties. Any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act shall be subject to a civil or administrative penalty, not to exceed the maximum amounts authorized by Sections 309(d) and 309(g) of the Act and the Federal Civil Penalties Inflation Adjustment Act (28 U.S.C. § 2461 note) as amended by the Debt Collection Improvement Act (31 U.S.C. § 3701 note).

2. Criminal Penalties

   a. Negligent Violations. Any person who negligently violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act shall, upon conviction, be punished by a fine and/or imprisonment as specified in Section 309(c)(1) of the Act.

   b. Knowing Violations. Any person who knowingly violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act shall, upon conviction, be punished by a fine and/or imprisonment as specified in Section 309(c)(2) of the Act.

   c. Knowing Endangerment. Any person who knowingly violates a permit condition implementing Sections 301, 302, 303, 306, 307, 308, 318, or 405 of the Act, and who knows at that time that he thereby places another person in imminent danger of death or serious bodily injury, shall, upon conviction, be subject to a fine and/or imprisonment as specified in Section 309(c)(3) of the Act .

   d. False Statements. Any person who knowingly makes any false material statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under this Act or who knowingly falsifies, tampers with, or renders inaccurate any monitoring device or method required to be maintained under this Act, shall, upon conviction, be punished by a fine and/or imprisonment as specified in Section 309(c)(4) of the Act.

C. Need to Halt or Reduce Activity not a Defense. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

D. Duty to Mitigate. The permittee shall take all reasonable steps to minimize, or prevent, any discharge, or sludge use or disposal, in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

E. Proper Operation and Maintenance. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed, or used, by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit.

F. Removed Substances. Collected screenings, grit, solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of waste waters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

G. Bypass of Treatment Facilities

1. Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs 2 and 3 of this section.

2. Notice

    a. Anticipated Bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible, at least 10 days before the date of the bypass.

    b. Unanticipated Bypass. The permittee shall submit notice of an unanticipated bypass as required under Part **II.G. Twenty-four Hour Notice of Noncompliance Reporting**.

3. Prohibition of Bypass

    a. Bypass is prohibited and the Director may take enforcement action against a permittee for a bypass, unless:

        (1) The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage,

(2) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgement to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance, and

(3) The permittee submitted notices as required under paragraph 2 of this section.

b. The Director may approve an anticipated bypass, after considering its adverse effects, if the Director determined that it will meet the three conditions listed above in paragraph 3.a. of this section.

H. Upset Conditions

1. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the requirements of paragraph 2 of this section are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

2. Necessary upset demonstration conditions. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

   a. An upset occurred and that the permittee can identify the cause(s) of the upset,

   b. The permitted facility was at the time being properly operated,

   c. The permittee submitted notice of the upset as required under Part **II.H. Twenty-four Hour Notice of Noncompliance Reporting**, and

   d. The permittee complied with any remedial measures required under Part **III.D. Duty to Mitigate**.

3. Burden of proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

IV. GENERAL REQUIREMENTS

A. Notice of New Introduction of Pollutants

1. The permittee shall provide adequate notice to the Director, Office of Water, and ADEC of:

    a. Any new introduction of pollutants into the treatment works from an indirect discharger which would be subject to sections 301 or 306 of the Act if it were directly discharging those pollutants, and

    b. Any substantial change in the volume or character of pollutants being introduced into the treatment works by a source introducing pollutants into the treatment works at the time of issuance of the permit.

2. For the purposes of this section, adequate notice shall include information on:

    a. The quality and quantity of effluent to be introduced into such treatment works, and

    b. Any anticipated impact of the change on the quantity or quality of effluent to be discharged from such publicly owned treatment works.

B. Control of Undesirable Pollutants. Under no circumstances shall the permittee allow introduction of the following wastes into the waste treatment system:

1. Wastes which will create a fire or explosion hazard in the treatment works;

2. Wastes which will cause corrosive structural damage to the treatment works, but in no case, wastes with a pH lower than 5.0, unless the treatment works is designed to accommodate such wastes;

3. Solid or viscous substances in amounts which cause obstructions to the flow in sewers, or interference with the proper operation of the treatment works;

4. Waste waters at a flow rate and/or pollutant discharge rate which is excessive over relatively short time periods so that there is a treatment process upset and subsequent loss of treatment efficiency; and

5. Any pollutant, including oxygen demanding pollutants (e.g., BOD, etc.) released in a discharge of such volume or strength as to cause interference in the treatment works.

C. Requirements for Industrial Users. The permittee shall require any industrial user of these treatment works to comply with any applicable requirements of sections 204(b), 307, and 308 of the Act, including any requirements established under 40 CFR 403.

D. Planned Changes. The permittee shall give notice to the Director and ADEC as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are not subject to effluent limitations in the permit. Notice is also required when the alteration or addition results in a significant change in the permittee's sludge use or disposal practices, including notification of additional use or disposal sites not reported during the permit application process.

E. Anticipated Noncompliance. The permittee shall give advance notice to the Director and ADEC of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

F. Permit Actions. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and re-issuance, termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

G. Duty to Reapply. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. The application should be submitted at least 180 days before the expiration date of this permit.

H. Duty to Provide Information. The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

I. Other Information. When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or any report to the Director or ADEC, it shall promptly submit such facts or information.

J. Signatory Requirements

1. All applications, reports, or information submitted to the Director shall be signed and certified.

2. All permit applications shall be signed by either a principal executive officer or ranking elected official.

3. All reports required by the permit and other information requested by the Director shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

   a. The authorization is made in writing by a person described above and submitted to the Director, and

   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. (A duly authorized representative may thus be either a named individual or any individual occupying a named position).

4. Changes to authorization. If an authorization under paragraph IV.J.3 is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph IV.J.3. must be submitted to the Director prior to, or together with, any reports, information, or applications to be signed by an authorized representative.

5. Certification. Any person signing a document under this section shall make the following certification:

> "*I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the*

> *information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.*"

K. Availability or Reports. Except for data determined to be confidential under 40 CFR 2, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Director. As required by the Act, permit applications, permits, and effluent data shall not be considered confidential.

L. Oil and Hazardous Substance Liability. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under section 311 of the Act.

M. Property Rights. The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private infringement of federal, state, or local laws or regulations.

N. Severability. The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

O. Transfers. This permit may be automatically transferred to a new permittee if:

1. The current permittee notifies the Director at least 30 days in advance of the proposed transfer date,

2. The notice includes a written agreement between the existing and new permittee's containing a specific date for transfer of permit responsibility, coverage, and liability between them, and

3. The Director does not notify the existing permittee and the proposed new permittee of his or her intent to modify, or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in paragraph 2 above.

P. State Laws. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by section 510 of the Act.

Q. Reopener Provision. This permit is subject to modification, revocation and reissuance, or termination at the request of any interested person (including the permittee) or upon EPA initiative. However, permits may only be modified, revoked or reissued, or terminated for the reasons specified in 40 CFR Parts 122.62, 122.63 or 122.64, and 40 CFR Part 124.5. This includes new information which was not available at the time of permit issuance and would have justified the application of different permit conditions at the time of issuance and includes, but is not limited to, future monitoring results. All requests for permit modification must be addressed to EPA in writing and shall contain facts or reasons supporting the request.