Alaska Eskimo Whaling Commission

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Via Electronic Mail to PR1.0648-XU80@noaa.gov

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Re: Taking Marine Mammals Incidental to an Exploration Drilling Program Near Camden Bay, Beaufort Sea, Alaska (75 Fed. Reg. 20482 (April 19, 2010))

Dear Mr. Payne,

Thank you for the opportunity to comment on the application of Shell Offshore Inc. (hereafter "Shell") to the National Marine Fisheries Service ("NMFS") for an Incidental Harassment Authorization ("IHA") pursuant to the Marine Mammal Protection Act ("MMPA") for oil and gas related activities near Camden Bay in the Beaufort Sea. *See* 75 Fed. Reg. 20482 (April 19, 2010). These comments are submitted on behalf of the Alaska Eskimo Whaling Commission ("AEWC"). The AEWC represents the eleven bowhead whale subsistence hunting villages of Barrow, Nuiqsut, Kaktovik, Pt. Hope, Pt. Lay, Wainwright, Kivalina, Wales, Savoonga, Gambell, and Little Diomede.

Our communities depend upon the marine mammals at stake in this application and the environment that supports them, which is undergoing rapid transformation as a result of climate change. Local communities rely on the migration of bowhead whales and other marine mammals through the Chukchi and Beaufort Seas to sustain their people and to preserve their cultural traditions. Improperly managed oil and gas related activities risk a sudden and catastrophic end of these unique cultural traditions. The AEWC sees Camden Bay as the valuable and unique resource that it is, and on behalf of our whaling captains, we are responsible for protecting the Inupiat way of life it supports.

NMFS should be aware up front that the AEWC and Shell were unable to reach an accord on the annual Conflict Avoidance Agreement ("CAA"), which has historically formed the basis for NMFS' statutorily required determination of no unmitigable adverse impacts to subsistence activities. In a meeting to discuss the CAA in Barrow this past February, AEWC's whaling captains attempted to reach a compromise agreement and made several significant concessions, and Shell's company representatives indicated that Shell was likely to agree to the terms offered by the AEWC and the whaling captains at that time. Subsequent to the February negotiations, however, Shell purported to sign a difference version of the CAA, which Shell has unilaterally modified on significant points that were the subject of the February compromise. The unilateral changes made by Shell were not acceptable, and represent changes that the AEWC and whaling captains had not proposed or agreed to.

At this point in time, the AEWC and Shell have been unable to reach agreement on two main provisions. The first relates to provisions for zero discharge. The AEWC and whaling captains' proposed that the oil companies and the AEWC agree to work on joint comments to the Environmental Protection Agency in support of the discharge standards applicable to oil and gas operations in the Norwegian Arctic, standards which have already been implemented in Norway and are applicable to any operations Shell undertakes in the Norwegian Arctic. Shell would not agree to even this reasonable proposal. The second relates to the sound threshold for activities that should be subject to sound source verification procedures. The AEWC and whaling captains proposed a significant reduction in the number of vessels and activities subject to on-site sound source verifications, but Shell is insisting upon even further reductions, which our scientists feel would not provide adequate information on the impact to marine mammals and behavioral changes that would affect the subsistence hunt.

The AEWC is extremely disappointed in Shell's decision not to sign the 2010 CAA. Our whaling captains made very significant concessions on key mitigations measures they feel are essential in an effort to find common ground with Shell and other offshore operators. In particular, despite their strong objections to ocean discharge, especially in Camden Bay, the whaling captains' agreed to remove the "zero volume discharge" measure that was in the 2009 CAA in return for agreement from the oil companies to join the AEWC in joint comments to the EPA as described above. Because Shell has failed to sign the agreement, the AEWC is now looking to NMFS to fulfill its Congressional mandate and ensure that Shell's activities do not have more than a negligible impact on marine mammal stocks or an unmitigable adverse impact on the subsistence activities of our whaling captains and their crews.

The AEWC also emphasizes up front the importance of the unique habitat surrounding the proposed well sites locations. The traditional knowledge of our whaling captains, and NMFS' own research, tells us that Camden Bay is one of the most important and unique locations during the fall westward bowhead whale migration.

In fact, based on the observations of our whaling captains, as well as scientific research results, we know that virtually the entire bowhead whale population makes use of this habitat for biologically significant activities that include feeding, resting, sheltering, and caring for young.[1] Two points are critical when considering development impacts in this area. First, even before raising concerns about oil spill, we know from direct observations that bowhead whales do not use areas where waste is present in the water column or where the water is muddy. Shell's proposal to discharge its drilling muds and cuttings as well as operational waste into our Camden Bay waters will result in a significant adverse impact to migrating whales' use of this habitat. It goes without saying that an oil spill in this area could be devastating to habitat and whales alike.

The second critical point that NMFS must consider here is the fact that your agency is responsible for representing our subsistence hunting interests and protecting our quota at the International Whaling Commission (IWC), which next meets in two weeks. Given the tragedy our government is confronting in the Gulf of Mexico, NMFS must seriously consider whether it wishes to go to the upcoming IWC meeting and report that it has just authorized additional oil exploration drilling in the frontier waters of the Arctic Ocean and the habitat of the endangered bowhead whale. In this context, we must remind NMFS that the IWC has become a determined conservation organization that can act to protect whales only through the setting of quotas. And the U.S. Commissioner to the IWC has told us that this year must be treated as a bowhead whale quota year at the IWC.

Of course, the AEWC's comments are also informed by the recent catastrophic blowout in the Gulf of Mexico, which demonstrates the extreme risk that accompanies offshore oil and gas activities in the frontier conditions of the Arctic Ocean. Drifting pack ice, heavy seas, harsh and unpredictable weather, extended darkness and frigid temperatures all present unique challenges and threats to the operation of a mobile drill rig and the associated fleet of support vessels. We have been reminded once again that offshore activities simply are not failsafe. Accidents always have happened and they will continue to happen until companies are forced to develop environmentally sound and context-appropriate technologies that allow oil to be developed without the risk of it entering the water. Furthermore, the Gulf of Mexico blowout illustrates that a significant amount of time is needed to respond to catastrophic events, time that is simply not available in the very limited operating window in the Beaufort Sea. In the event of an end-of-season blowout, there may be only days to respond before the area is frozen over for the next seven or eight months. It would be impossible to respond to the spill during the winter months, and oil would be trapped under the ice and foul the openings in the ice that whales, seals, and other marine mammals depend upon to breathe during the winter season, causing countless casualties.

The use of current containment and cleanup technologies also must be seriously questioned. Even assuming they could function, an assumption that is yet to be proven, the environmental consequences of in situ burning in arctic sea ice -- on the air, the water, and the animals that live in and on the ice -- have yet to be considered. And the use of dispersants to send oil into the water column presents unknown consequences for the many animals living there. Although,

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[1] We understand that NMFS has been provided by a declaration from Dr. Robert Suydam in which he discusses the results of monitoring activities in Camden Bay. We encourage to review his declaration in this regard at paragraphs 13-15 as well as the underlying data in the LGL 2008 report.

we know that for the Bering-Chukchi-Beaufort Seas stock of bowhead whales, virtually all of who use the Camden Bay habitat, oil in the water column carries a significant threat of fouling baleen, with potentially lethal consequences.

NMFS is charged with the responsibility for regulating offshore activities to protect marine mammals, and we now find ourselves at an historic moment following the Gulf incident in which the entire nation and the indeed the world will be watching to see what lessons have been learned.

While much remains to be learned, certain points are clear. First and foremost, decision-making at the Minerals Management Service ("MMS") has been subject to undo influence by the oil industry for many years, compromising both the safety and environmental functions of the agency. MMS' track record in Alaska is no better then the situation in the Gulf, as demonstrated by the recent Government Accountability Office's report on MMS' environmental review of offshore projects in this region. In fact, the system our nation uses to regulate offshore oil and gas activities is fundamentally broken, and at this time, NMFS cannot rely on environmental findings and risk assessments reached by its sister agency, including the present application by Shell. Rather, since MMS has had lead responsibility, NMFS now must conduct its own environmental review and risk assessment, or NMFS must make an affirmative decision that it will rely on conclusions about environmental impacts and risk that are known to be biased in favor of development, essentially at any cost.

Further, neither NMFS nor MMS has undertaken the analysis necessary to determine what impact a major oil spill and resulting response activities would have on marine mammals and the subsistence activities of Alaskan Natives. MMS, at the recommendation of the oil industry, consistently downplays the risk of a blowout and a major spill resulting from exploratory drilling activities. As the Gulf incident demonstrates, however, we can no longer ignore this very real possibility, and we must struggle with the fact that drilling could cause a major catastrophe. We call on NMFS to assert leadership and undertake its own independent assessment, in the context of regulating industrial activities pursuant to the Marine Mammal Protection Act, of the consequences of a major spill in Arctic waters.

In fact, NMFS can only issue an IHA if it determines, based on its independent review, that the harassment permitted by the IHA will have no more than a "negligible impact" on marine mammal stocks and "will not have an unmitigable adverse impact on the availability" of marine mammals for taking for subsistence purposes. Based on the evidence before the agency, these findings cannot now be made, not only because of abuses of public trust at MMS, but also because of the blind eye NMFS's other sister agency, the Environmental Protection Agency, has turned to arctic habitat and subsistence impacts where ocean discharges are concerned.

NMFS currently is in the process of preparing an Environmental Impact Statement, in partnership with MMS, assessing the potentially significant impacts of oil and gas exploration activities in the Arctic.[2] In choosing this course, NMFS has recognized that these activities can

[2] National Marine Fisheries Service, Notice of Intent to Prepare an Environmental Impact Statement on Effects of Oil and Gas Activities in the Arctic Ocean, 75 Fed. Reg. 6175 (Feb. 8, 2010).

have significant impacts on marine mammals and that a longer term, more comprehensive view needs to be taken of these activities. A prudent course for NMFS at this time is to forego authorizing any activities carrying the risk of putting oil into the water, pending a more thorough environmental analysis that looks objectively at risks and explores environmentally sound development alternatives. As a policy matter, neither NMFS nor this Administration, generally, should seek to facilitate activities based on an Exploration Plan approved through a process that the Administration and now the public know has been strongly biased against environmentally responsible analysis and safeguards. At this time, the emphasis within NMFS should be the development, on behalf of the American public, of a robust long-term plan for balancing the needs of industry with Congress' mandate in the Marine Mammal Protection Act to prioritize the protection of our subsistence resources and our subsistence uses.

As our record with the Open Water Season Conflict Avoidance Agreement shows, the AEWC and its whaling captains are not opposed to properly mitigated oil and gas activities, undertaken in an environmentally responsible manner, but we know now more than ever before that our regulatory system is broken in numerous respects. Now is the time for NMFS to demonstrate real leadership under its Congressional mandate to protect marine mammals and our subsistence practices. NMFS's response to these events as they relate to future activities in the Arctic will forever cement in the minds of our whaling captains and the local communities of the Arctic whether this agency takes its Congressional mandate seriously and truly intends to protect our way of life and the public's interest in the Arctic.

We stand ready, Mr. Payne, to help NMFS and the federal government reassess offshore activities in the Arctic and determine how those activities can safely co-exist with our subsistence practices. We would welcome the opportunity to engage with you, Mr. Lecky, Assistant Administrator Schwaab, Administrator Lubchenko, and the Obama Administration over the coming months as we all look for answers to those questions. At this time, we cannot emphasize enough the importance of the decisions now facing your agency, and the harm that will be caused to the public's trust not only of the agency but of the Administration should NMFS fail to act with utter objectivity, integrity, and prudence. With that larger context and our overall requests in mind, please consider as well the more specific comments set forth below.

I. The Marine Mammal Protection Act

The findings required of the Secretary pursuant to Section 101(a)(5)(D) of the MMPA are mandatory. Congress directs that the Secretary *shall find* that there will be *no more than a negligible impact* to marine mammals and *no* unmitigable adverse impact to the availability of marine mammals for subsistence taking. Thus, Congress does not give the Secretary discretion in making the mandatory findings.

This nondiscretionary congressional directive is consistent with the MMPA's overall treatment of both marine mammal and subsistence protections. Congress has set a "moratorium on the taking ... of marine mammals," 16 U.S.C. § 1371(a), with the sole exemption provided for the central role of subsistence hunting by Alaska Natives. Thus, Congress has given priority to subsistence takes of marine mammals over all other exceptions to the moratorium, which may be applied for and obtained only if certain statutory and regulatory requirements are met. One such exception is an IHA. However, incidental harassment authorizations are available only for specified activities for which the Secretary makes the mandated findings. Thus, the pursuit of those activities is subordinated, by law, to the critical subsistence uses that sustain Alaska's coastal communities.

Furthermore, an IHA can only be granted if the activity has *no* potential to result in serious injury or mortality. 16 U.S.C. § 1371(a)(5)(D). If such injury or mortality is possible, take can only be authorized pursuant to a Letter of Authorization ("LOA") that complies with 16 U.S.C. § 1371(a)(5)(A) and 50 C.F.R. § 216.105.

II. NMFS's And Shell's Failure To Consider the Potential Impacts of a Blowout and/or Major Oil Spill

At the outset, we request that NMFS return Shell's application as incomplete because of Shell's failure to provide information on the possible impacts to marine mammals resulting from an oil spill of *any size* in its application materials. *See* 50 C.F.R. § 216.104(b)(3) ("Applications that are determined to be incomplete or in appropriate for the type of taking requested will be returned to the applicant"). Because both Shell's application materials and NMFS's public notice ignore entirely the threat of an oil spill and the resulting serious and/or lethal takes of marine mammals and interference with subsistence activities, the application should be rejected and returned to the applicant.

Indeed, NMFS has previously explained that:

> [I[n order for NMFS to accept an incidental harassment application, such application must be complete, accurate (to the extent possible), and address in some detail the information items requested as part of the application. If an application does not provide documentary evidence sufficient for NMFS to make a preliminary determination that the activity is likely to result in only a small take (by harassment) of marine mammals and have no more than a negligible impact on the species or stocks impacted or their habitat, *NMFS will return the application as incomplete.*

60 Fed. Reg. 28,379, 28,381 (May 31, 1995) (emphasis added).

In this case, Shell has failed to provide any information whatsoever in its IHA application regarding the possible release of oil into the waters of the Arctic Ocean and what impact such a release may have an marine mammals and subsistence activities. Shell, as it must, has developed plans to respond to a spill, and notes in its application material that its fleet of support vessels will include an "oil spill response (OSR)" ship as well as an OSR tanker "for its storage capability of recovered liquids."[3] Although this response capability is woefully inadequate, it documents

[3] Shell Offshore Inc., Application of Harassment Authorization for the Non-Lethal Take of Whales and Seals in Conjunction with Planned 2010 Exploration Drilling Program near Camden Bay in the Beaufort Sea, Alaska (Second Revised Submission March 2010) (hereinafter "IHA Application") at 3-4.

that even Shell recognizes its exploratory activities are accompanied by a reasonable possibility of a petroleum release. That release could occur in the form of a major blowout, as happened in the Gulf, or a lesser incident on the drilling ship, or even a refueling accident.

It is thus incomprehensible that the Federal Register notice fails to include any mention whatsoever of a possible release of oil and the resulting harm to marine mammals and subsistence activities. Nowhere does NMFS even acknowledge the risk of an oil spill, regardless of whether that spill would be catastrophic as in the Gulf or less severe. NMFS never discloses its justification for ignoring these potential impacts in releasing its supposed draft authorization for public comment. Instead, NMFS is simply silent on this issue despite the well-known fact that marine mammals are vulnerable to the effects of exposure to oil.

Finally, in this regard, we note a recent conclusion from MMS from a Draft Environmental Impact Statement prepared in 2008.[4] In that recent analysis, MMS concluded that the potential adverse effects of a large spill are heightened when industrial activities occur near areas with large aggregations of bowhead whales. Camden Bay, and the vicinity of the proposed drilling sites, is an area where thousands of bowhead whales congregate to feed and rest during their fall migration. This area is also near or adjacent to the subsistence hunting grounds for the villages of Nuiqsut and Kakotvik. A large oil spill in this habitat during the fall migration could expose thousands of whales to oil, with potentially lethal impacts, while also causing long-term contamination of this relatively pristine Arctic environment and long-term interference with the subsistence activities of AEWC's whaling captains and their crews. The timing and location of the proposed drilling activities increase the potential consequences of a spill, regardless of the size, and should cause NMFS to provide special scrutiny to these issues in conducting its analysis.

In sum, NMFS can no longer maintain silence on this issue through the MMPA permitting process. For years, the AEWC and its whaling captains have noted the unique risks that accompany exploratory drilling and have opposed the permitting of activities with the grave threats posed by the risk of catastrophic spills and smaller, chronic releases of oil. Notiwthstanding Shell's claims to the contrary, there are no proven technologies for responding to a spill in a broken ice environment, and any response activities implemented are also likely to result in the death or injury of marine mammals, both directly and through damage to the ocean food chain. Twenty years after the *Exxon Valdez* illustrated the difficulties of oil spill cleanup, the difficulties now being experienced by industry in spill cleanup in the Deepwater Horizon incident are a wake-up call for the Arctic, as we can no longer pretend that past problems have been addressed and industrial activities are now safe and without risk to the environment.

For these reasons, AEWC strongly recommends that NMFS return the application to Shell because it lacks any information whatsoever about potential take resulting from a release of oil of any size. AEWC further requests specific clarification from NMFS on whether and how the agency considers the risk of an oil spill when authorizing exploratory drilling activities pur-

[4] Minerals Management Service, Beaufort Sea and Chukchi Sea Planning Areas, Oil and Gas Lease Sales 209, 212, 217, and 221 – Draft Environmental Impact Statement, MMS 2008-0055 (November 2008) at 4-115.

suant to the Marine Mammal Protection Act, including both the legal and factual bases for the agency's position.

III. NMFS's and Shell's Failure to Consider the Potential Impacts of Discharge Associated with Exploratory Drilling Activities

Shell and NMFS have similarly disregarded entirely the potential threats to marine mammals and subsistence activities resulting from the discharge of millions of gallons of cooling water, drilling fluids, muds, cuttings and other contaminants into Camden Bay and the Beaufort Sea. Because Shell's application does not contain any information regarding the possible discharge of pollution and its impacts on marine mammals or subsistence activities, it should be returned to the applicant as incomplete, and the IHA should not be issued.

AEWC and its whaling captains have pushed on this issue for years, because our traditional knowledge teaches us that bowhead whales and other marine mammals are very sensitive to water pollution. Whales have an acute sense of smell and will react strongly to foreign substances in the water. Exploration-related discharge has the potential to deflect whales just as sound would do, causing adverse effects on the subsistence hunts of Nuiqsut and Kaktovik. As opposed to sound, however, water pollution lasts longer and may continue to deflect whales long after the original discharge takes place. Whereas Shell could "turn off" the source of underwater noise, Shell loses control of the water pollution once it enters the water column. After discharge, the rate of dilution and/or dissipation is controlled not by Shell but by the conditions found in the vicinity of the site, including water column structure and conditions, weather conditions, currents, seas and ice. The impacts of discharge may therefore last much longer than the impacts of underwater noise, which historically has been the main focus of NMFS's review of exploratory drilling proposals.

The discharge of pollution could result in the harassment, injury or death to individual marine mammals. Exposure to contaminants could interfere in the whales' acute sense of smell or possibly other important life functions. Acute or chronic exposure to contaminants could lead to other negative health effects over time, and contaminants could bioaccumulate in the food web, leading to additional impacts and stressors on the whales.

On August 31, 2009, the North Slope Borough provided to MMS extensive comments on Shell's exploration plan for Camden Bay, including detailed information on the associated water quality impacts resulting from the discharge of toxic and bioaccumulative contaminants. We understand that the Borough has provided those comments to NMFS, and AEWC incorporates those comments by reference and strongly encourages NMFS to review that information. Based on information from Shell's Exploration Plan, the proposed activities involve the discharge of literally millions of gallons of cooling water, drill cuttings, spent drilling fluids, excess cement, sanitary wastewater, ballast water, bilge water and other sources of pollution. As discussed by the Borough, Shell's planned operations include the discharge of biocides, chlorine, ammonia, polynuclear aromatic hydrocarbons (PAHs), heavy metals (i.e. chromium, mercury and cadmium), benzene, ethylbenzene, temperature and other pollutants. The Borough also highlighted the concern about stratified and estuarine conditions that restrict the mixing and dilution of discharged contaminants.

Shell ignores this issue entirely in its IHA application. Nowhere does Shell disclose what contaminants will be discharged, the volume and concentration of discharged contaminants, the fate and transport of the contaminants, and the potential impacts to marine mammals. Again, without having any of this information available in the IHA application, NMFS cannot make an informed decision, and the application should be returned to Shell as incomplete. Moreover, NMFS cannot correct this deficiency without republishing a notice of the proposed IHA in order to disclose to the public and then accept comment on the agency's assessment of takes from exploration-related discharge. NMFS must engage the public in a thorough, up-front review of this issue with public notice and comment prior to granting an IHA to Shell.

As a reasonable and fully practicable mitigation measure, the AEWC's whaling captains have proposed adoption by the offshore operators, through the CAA, and the AEWC proposes adoption by the U.S. Government of the arctic discharge standards articulated by Norway, standards which are practiced in other areas and which already apply to Shell's operations in the Norwegian Arctic.[5] The MMPA specifically requires NMFS to prescribe, in the IHA, the "means of effecting the least practicable impact on" marine mammal species and stocks. 16 U.S.C. § 1371(a)(5)(D)(ii)(I). As the Norwegian report documents, "during normal operations, *no discharges of any substances with a negative impact on the environment are permitted from petroleum installations*."[6] Shell has and will argue that observance of this standard in the Beaufort Sea would result in increased vessel traffic to transport waste ashore. However, drilling vessels can be retrofitted with waste storage facilities, an option Shell has ignored for the five years it has been preparing its drilling plans for the Arctic.

NMFS, for its part, has ignored entirely the potential impacts of pollutants on marine mammals and subsistence uses and has not considered at all potential mitigation measures in the form of zero discharge technologies. Reliance upon the Environmental Protection Agency in this context is not possible, since that agency also has not considered these issues. Instead of conducting an assessment of how marine discharge could result in the take of marine mammals, a much simpler and more responsible approach would be for the agency to require Shell to adopt, as a reasonable mitigation measure for the protection of marine mammals and the subsistence hunt, the requirements that have been applied to Shell's operations by other developed countries for the protection of the Arctic marine environment.

The AEWC again requests specific clarification from NMFS as to whether and how it considers the potential impacts of discharge in reviewing Shell's application for an IHA and the legal and factual bases for the agency's position. In particular, AEWC seeks specific clarification from NMFS as to whether and/or how it determined that potential discharges do or do not have the potential to take marine mammals or result in unmitigable adverse impacts to subsistence activities. AEWC also seeks clarification from NMFS as to whether and how it determined

[5] The Royal Norwegian Ministry of the Environment, *Report No. 8 to the Storting (2005-06) – Intergrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands* (Attached).
[6] *Id.* at 50 (emphasis added).

that zero discharge technologies are or are not the means of effecting the least practicable impact on marine mammals.

IV. Shell's Operations Have the Potential to Cause Adverse Impacts to the Fall Subsistence Hunt of Bowhead Whales in Barrow.

The MMPA requires that any incidental take authorized will not have "an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses" by Alaska Natives. 16 U.S.C. § 1371(a)(5)(D)(i)(II). The operations proposed by Shell may very well interfere with the fall subsistence hunt of bowhead whales by deflecting them from the traditional subsistence hunting grounds and/or rendering the whales skittish as a result of exposure to industrial activity and therefore more difficult to strike and land.

In addition to the adverse impacts to subsistence hunts that could occur from a spill or operational discharges discussed above, NMFS's analysis of "unmitigable adverse impacts" to the Barrow fall hunt consists of a single sentence. "Additionally, Barrow lies 298 mi. (479.6 km) west of Shell's Camden Bay drill sites, so whalers in that area would not be displaced by any of Shell's activities."[7] This is the only justification set forth by NMFS in assessing potential adverse impacts to Barrow's fall hunt.

In reaching this conclusion, NMFS has ignored the potential impact of Shell transiting the western Beaufort Sea with the 514 ft. drillship Discoverer and the associated fleet of support vessels during Barrow's fall migration. As NMFS is well aware, Shell is planning on conducting drilling operations in the Chukchi Sea in the 2010 open water season with the same drill ship and the same fleet of support vessels. This creates the very real possibility that Shell will transit the Western Beaufort Sea during the fall bowhead hunt in Barrow either en route to or from the Camden Bay well sites. If Shell transits the Western Beaufort during this time, there is a strong possibility that vessel traffic could interfere with the fall subsistence hunt for our Barrow whaling captains. As NMFS has acknowledged many times in the past, bowhead whales exhibit flight response from oncoming vessels, and the movement of the Discoverer and the numerous support vessels could therefore alter bowhead whale behavior and movement and thereby interfere with the traditional subsistence hunt.

To address this issue, Shell should be required to sign the 2010 Open Water Season Conflict Avoidance Agreement, which provides for the means of avoiding conflicts between industrial operations and subsistence activities. To date, Shell has not signed the CAA for 2010, and this fact should weigh heavily against NMFS issuing the IHA, particularly where there has been no analysis or discussion of vessel traffic and potential impacts to the fall hunt at Barrow.

V. NMFS Failed to Consider Potential Impacts to Feeding and Resting Behavior in Camden Bay

As NMFS concedes in the Federal Register notice, aerial surveys in recent years have identified heavy bowhead whale use of Camden Bay, in particular for feeding during the west-

[7] 75 Fed. Reg. at 20509.

ward fall migration.[8] This recent data supports the traditional knowledge of our whaling captains, who for years have discussed the critical importance of Camden Bay as habitat for bowhead whales and the unique risks posed by industrial operations in this area. In reaching its finding of "negligible impacts" to the stock and harassment of a "small number" of whales, NMFS fails to assess the impact of excluding bowhead whales from this area, and the conclusions set forth in the Federal Register notice are not supported by the best available science as required by 50 C.F.R. § 216.104(c).

To start with, we note that NMFS itself highlighted this issue as a concern in 2008, when it issued the Biological Opinion to MMS regarding oil and gas activities in the Arctic. At that time, NMFS noted the "potential for noise disturbance to displace whales from important feeding areas" and concluded that "special scrutiny should be given to * * * drilling operations which may impact these areas."[9] NMFS went so far as to issue a specific conservation recommendation to MMS that the agency "continue to investigate the use of the Chukchi and Beaufort Seas by feeding bowhead whales and assess the importance of this feeding to the health and wellbeing of these animals."[10]

The question here is whether NMFS has followed its own advice and considered the impacts to bowhead whales resulting from their potential exclusion from the feeding grounds present in Camden Bay. In the Federal Register notice, NMFS provides an internally inconsistent and cryptic two-sentence analysis that fails to provide either clear direction from the agency or a scientific basis for its conclusions.[11] NMFS acknowledges that "Camden Bay is one of a few feeding locations for bowhead whales in the Beaufort Sea" but then concludes that drilling is not expected to "preclude bowhead whales from obtaining sufficient food resources along their traditional path."[12]

NMFS fails to articulate how it reached the conclusion that drilling in Camden Bay will not prevent bowhead whales from obtaining sufficient food during the fall migration. The AEWC specifically disagrees with NMFS's so-called analysis on this point. As our whaling captains have said many times, Camden Bay is a critical feeding area during the bowhead whale migration, and Shell's own monitoring data supports this fact. We view NMFS's discussion of this issue as highly controversial and contrary to the best available science.

As NMFS recognized in the Biological Opinion, we know that feeding in the Beaufort Sea is important to bowhead whales, because the "[l]ipid content of blubber, at least in subadults, is higher when they leave the Beaufort in the fall than when they return in spring."[13] The exist-

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[8] 75 Fed. Reg. at 20494.

[9] National Marine Fisheries Service, *Endangered Species Act – Section 7 Consultation Biological Opinion – Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska; and Authorization of Small Takes Under the Marine Mammal Protection Act* (July 17, 2008) at 99.

[10] *Id.* at 117.

[11] 75 Fed. Reg. at 20494.

[12] *Id.*

[13] 2008 Biological Opinion at 18.

ing data, however, do not clearly establish "the relative significant of feeding in various regions."[14] What we do know is that bowheads feed during their fall migration and the evidence suggests that this feeding activity is important to the survival of whale, in particular subadults.

NMFS's alleged analysis of this issue in the Federal Register notice is not based on the best available science as required by 50 C.F.R. § 216.104(c). We certainly know that Camden Bay provides feeding opportunities, as documented by our whaling captains, by research sampling stomach contents of whales taken at Cross Island (Lowry et al., 2004), by Shell's monitoring reports, and by NMFS's own statements in the IHA.[15] We also know that industrial activities, including underwater noise associated with drilling and icebreaking activities, have the potential to deflect whales from their normal migration route and therefore away from feeding opportunities near proposed well sites.

In order to determine that operations at the proposed well sites will not prevent whales from obtaining enough food, NMFS must have concluded either: 1) that whales do not require the food that they obtain in and near Camden Bay; or 2) that whales can obtain a replacement food source if they miss feeding opportunities in and near Camden Bay.

On the first point, as discussed above, the best available science, as included in the 2008 Biological Opinion, clearly establishes that feeding in the Beaufort is important to subadults during the fall migration. On the second point, both our traditional knowledge and western science tell us that bowhead whales are opportunistic feeders. Bowhead whale food is aggregated and not uniformly distributed across the ocean. NMFS has not provided any scientific basis for concluding that whales can find sufficient alternative feeding opportunities if they are deflected from Camden Bay.

NMFS has failed to provide an adequate scientific basis for its conclusions on this issue and the AEWC therefore asks for specific clarification from NMFS. How did NMFS determine the minimum food requirements for bowhead whales during the fall migration? Did NMFS determine that Shell's operations could interfere with bowhead whales obtaining food in and near Camden Bay? How did NMFS determine that bowhead whales could "obtain sufficient food sources" if feeding behavior is disturbed in and near Camden Bay? Did NMFS determine what impact could result to bowhead whales if they were unable to obtain a replacement food source?

Finally, we note as well that NMFS and Shell have failed to provide information on the "age, sex and reproductive condition" of the marine mammals that will be impacted. 50 C.F.R. § 216.104(a)(6). Interference with feeding behavior can impact different members of the population in different ways, and therefore it is critical for Shell to supply and NMFS to assess informa-

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[14] *Id.*

[15] We note in this regard that counsel for MMS and the Department of the Interior stated in a recent court filing that MMS did not consider Camden Bay to be important feeding habitat. *Native Village of Point Hope et al. v. Salazar*, Ninth Circuit Case Nos. 09-73942, 09-73944, 10-70166, 10-70368 (attached). AEWC seeks clarification from NMFS on whether it concurs with MMS's assertion in its response brief on this issue. Does NMFS consider the proposed well site locations to be near or adjacent to important feeding habitat?

tion on the number of mothers and calves impacted by the proposed activities. As we discussed in the past, the best available science suggests that for baleen whales cow-calf pairs should be used as the "defining limit."[16] NMFS must require Shell to provide information that complies with the requirements of 50 C.F.R. § 216.104(a)(6).

VI. NMFS's Flawed Analysis of Icebreaker Noise

As is well documented in the scientific literature (Richardson, et al., 1995), icebreaker noise is second only to seismic noise in terms of amplitude and occurs at frequencies that compete with bowhead whale calls. The sound source, however, is propeller cavitation and not actual ice breaking. In its application, Shell has developed a novel theory as to how it intends to operate its icebreakers, alleging that propeller cavitations during its proposed ice management activities will be 15-20 percent of the vessel's propeller rotation capacity.[17] Shell attempts to distinguish between ice management and icebreaking activities, asserting that ice management activities involve significantly lower propeller cavitation speed. NMFS asserts that Shell "does not have any intention of breaking ice" and that Shell also stated that it "would stop operations and move off site instead of breaking ice."[18]

This simply makes no sense and is not supported by any scientific or technical information we have reviewed. In fact, in its Clean Air Act permit application, Shell estimates that it will conduct icebreaking operations for more than one-third of the time it is operating in the Beaufort Sea.[19] NMFS must review its own analysis and provide both the AEWC and the public with an explanation of this contradiction. Furthermore, if NMFS based its analysis on Shell's representation that it would stop operations instead of breaking ice, then NMFS should include that provision as a required mitigation measure in the IHA itself.

Moreover, NMFS states that sound levels produced by ice management "would not be as intense as during icebreaking."[20] AEWC seeks clarification on whether NMFS has any data documenting underwater noise produced by so-called ice management as opposed to icebreaking. In the absence of any data, the potential impacts from ice management as discussed by Shell must be considered highly uncertain and controversial, as the existing science indicates that icebreaking operations can deflect bowhead whales by 20-50 km from the sound source.

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[16] McCauley, R.D. et al. 2000. Marine seismic surveys-a study of environmental implications. APPEA Journal: 692-708 (attached).
[17] 75 Fed. Reg. at 20484.
[18] *Id.*
[19] United States Environmental Protection Agency Region 10, Seattle, Washington, Statement of Basis for Proposed Outer Continental Shelf Prevention of Significant Determination Permit No R10OCS/PSD-AK-2010-01 (February 17, 2010). AEWC has also attached its brief from the *Native Village of Point Hope* case. We encourage NMFS to review the arguments made in that document, which sets forth additional comments on information related to the likely extent of sea ice and prior agency statements on the likely need for icebreaking activities.
[20] 75 Fed. Reg. at 20486

NMFS and Shell also fail to provide any actual evidence or estimate of the amount of underwater noise conducted by the operation of the ice management vessels as described by Shell. Even assuming Shell's operation scenarios are correct, how much noise would be produced by the icebreakers? In the IHA Application, Shell states that the area ensonified to 120dB or greater would extend only to 7.4 km from the drillship. How did Shell arrive at this data? Did NMFS independently verify the accuracy of this modeling? What methods were used and how did JASCO estimate the noise output of the icebreakers given Shell's representation on operational restrictions? None of this information is available to the public, and it is critical that AEWC and other stakeholders have access to this information to provide informed input into NMFS's ultimate conclusions.

VII. NMFS's Failure to Implement Adequate Mitigation Measures

The MMPA authorizes NMFS to issue a take authorization only if it first finds that there will be adequate monitoring of such taking, and that all methods and means of ensuring the least practicable impact have been adopted. 16 U.S.C. § 1371(a)(5)(D)(ii)(I). As detailed below, Shell's proposed monitoring and mitigation measures are insufficient, and NMFS should not issue an IHA for the proposed activities until adequate monitoring and mitigation techniques for avoiding adverse impacts to the marine mammals and subsistence hunting are developed.

To begin with, AEWC is extremely concerned that NMFS did not implement the mitigation measures required in 2007 when Shell previously applied for an IHA for exploratory drilling in the Beaufort Sea. At that time, NMFS required an exclusion zone of 160-dB rms for aggregations of 12 or more feeding, non-migratory, balaenopterid whales. If such an aggregation was identified by aerial surveys or other monitoring protocols then Shell was required to lower its activity and noise levels in the drilling area until such time as the aggregation had moved outside the 160-dB zone. NMFS also imposed an exclusion zone for aggregations of 12 or more bowhead whales or 4 or more bowhead whale cow/calf pairs within an acoustically verified 120-dB monitoring zone. NMFS prohibited Shell from resuming normal activity levels until two consecutive aerial surveys confirmed that there were fewer than 12 migrating bowheads or 4 cow/calf pairs in the 120-dB zone.[21]

NMFS implemented these mitigation measures in 2007 to ensure that "the bowhead whale migration is not significantly affected." AEWC believes that these mitigation measures are based on the best available science, which demonstrates that bowhead whales react to low levels of industrial noise and begin to deflect from the migration at 120 dB received sound levels and that deflection from the migration route can cause potentially biologically significant impacts by interfering in feeding and other important behavior.

The AEWC seeks clarification from NMFS on why it did not impose similar mitigation measures this year. The AEWC is unaware of any data or scientific information since 2007 that

[21] National Marine Fisheries Service, Environmental Assessment for the Shell Offshore, Inc. Incidental Harassment Authorization to Take Marine Mammals Incidental to Conducting an Offshore Drilling Project in the U.S. Beaufort Sea Under the Marine Mammal Protection Act (October 2007).

would call into question NMFS' previous conclusions on mitigation and the need for exclusions zones at received sound levels of 120 dB and 160 dB. These issues have been discussed for many years through the open water meetings and peer review process, and the AEWC is extremely concerned that NMFS would simply eliminate these mitigation measures without providing any rationale whatsoever for its change of position. Given the many years of effort that have gone into discussing and evaluating appropriate mitigation and monitoring, this sudden, unexplained reduction in its mitigation requirements, again calls NMFS' objectivity in the matter of this application into question.

Moreover, the AEWC again calls NMFS's attention to the inherent problems in the Marine Mammal Observer ("MMO") program relied upon as mitigation by Shell. The 2010 open water peer review panel highlighted potential shortcomings in the MMO program, which warrant a thorough review by NMFS as part of the IHA/NEPA into the appropriate level of reliance to be placed on MMOs as part of a mitigation package.[22] In particular, the peer review panel recommended that MMOs should be managed by an independent organization and that NMFS should provide greater instruction in estimating the number of takes. The peer review panel also noted the availability and perception biases inherent in visual observations.

VIII. The IHA Cannot Be Approved Because NFMS Has Failed To Provide Public Comment On The Draft Authorization

The plain language of both the MMPA and NMFS' implementing regulations require that NMFS provide the opportunity for public comment on the "proposed incidental harassment *authorization*," 50 C.F.R. § 216.104(b)(1)(i) (emphasis added); 16 U.S.C. § 1371(a)(5)(D)(iii), and not just on the application itself as NMFS has done here. The authorization itself must prescribe certain requirements such as "permissible methods for taking by harassment," "means of effecting the least practicable impact on such species," measures to "ensure no unmitigable adverse impact on the availability of the species or stock for taking for subsistence use," requirements pertaining to "monitoring and reporting" and for "independent peer review" of such monitoring and reporting if the taking may affect subsistence use. 16 U.S.C. § 1371(a)(50(D)(ii). Indeed, NMFS's regulations further provide that "[a]ny preliminary finding of 'negligible impact' and 'no unmitigable adverse impact' shall be proposed for public comment along with [] the proposed incidental harassment authorization . . .." 50 C.F.R. § 216.104(c).

Given Shell's refusal to sign the CAA, without a complete draft authorization and accompanying findings, AEWC cannot provide meaningful comments on Shell's proposed activities, ways to mitigate the impacts of those activities on marine mammals, and measures that are necessary to protect subsistence uses and sensitive resources. We are aware that NMFS takes the position that the Federal Register notice provides information equivalent to a draft of the IHA itself, however that position is both contrary to the plain language of the law and common sense. In particular, the language of the IHA governs the specific mitigation, monitoring and reporting requirements, and Shell's ultimate legal obligations will be interpreted based not on what is in

[22] Expert Panel Review of Monitoring and Mitigation Protocols in Applications for Incidental Take Authorizations Related to Oil and Gas Exploration, Including Seismic Surveys, in the Chukchi and Beaufort Seas, Anchorage, AK (March 22-26, 2010).

the Federal Register notice but what is in the authorization itself. Only by reviewing the specific language governing Shell's activities can the AEWC provide meaningful input into the IHA process.

IX. NMFS Must Prepare an EIS to Consider the Potentially Significant Impacts, Including the Cumulative Impacts of Shell's Proposed Activities

With respect to the National Environmental Policy Act ("NEPA"), NMFS simply states that it is "currently preparing an Environmental Assessment" to determine whether Shell's activities may have a significant impact on the environment. 75 Fed. Reg. at 20509. For a number of reasons, it is clear that NMFS should not issue an EA but must instead prepare an Environmental Impact Statement ("EIS") given the potential for significant impacts to the environment. See 40 C.F.R. § 1508.27.

In particular, the AEWC calls special attention to the potentially significant cumulative impacts of Shell's proposed drilling activities when combined with all other past, present and reasonably foreseeable future activities. 40 C.F.R. § 1508.7. In this regard, NMFS must specifically consider the cumulative impacts of Shell's Camden Bay proposal in combination with the following present proposals, all of which may be planned during the 2010 open water season:

1) Shell's Chukchi Sea Exploration Plan
2) Shell's Beaufort and Chukchi Sea Geophysical Work
3) GXT's Beaufort Sea seismic surveys
4) Statoil's Chukchi Sea seismic surveys
5) Seismic surveys planned in the Canadian Arctic
6) USGS seismic surveys
7) Production operations at Northstar

We understand that NMFS has received applications for IHAs and/or has in its possession information on the extent of all of these activities. We specifically request that NMFS include in the record for this decision all the available information in its possession relating to these projects. NMFS must use that information in conducting a thorough, objective analysis of cumulative impacts.

Moreover, NMFS must also consider the reasonably foreseeable drilling activities in future years. Future drilling is foreseeable for a number of reasons. First, Shell has sought authorization to drill five total wells – three in the Chukchi and two in the Beaufort. Shell, however, informed the Minerals Management Service that it has time to drill only three wells in a single season, because it plans to use the Discoverer and its support vessels to drill all the wells.[23] Shell, therefore, would need at least a second year to drill all the wells included in the two exploration plans. Moreover, Shell has applied for a multi-year Clean Air Act permit from EPA, and has therefore already sought coverage for drilling operations in future years.

[23] Letter from Marvin Odum, President, Shell Oil Company, to Kenneth Salazar, U.S. Department of the Interior, Re: Shell Offshore Inc. 2010 Exploration Plans for Alaska OCS (June 24, 2009).

In conducting the legally required cumulative impact analysis, NMFS must endeavor to determine whether the full suite of industrial activity planned for the Arctic may have a significant impact on bowhead whales, other marine mammals, and the health of the Inupiat people. 40 C.F.R. § 1508.27. NMFS must consider whether multiple exposures to underwater noise, pollution, and vessel traffic could impact bowhead whales and decrease survival rates or reproductive success. NMFS should also consider how many bowhead whales in the population would be exposed to underwater noise, where those exposures would take place, what impact that would have on bowhead whale behavior and whether those impacts could result in biologically significant impacts. NMFS should also consider the cumulative impact of discharge and whether bioaccumulation of contaminants could have lethal or sublethal effects on bowhead whales and other marine mammals. NMFS must also consider the cumulative impacts to air quality resulting from the discharges associated with all of the vessels that will be involved in the numerous industrial operations. NMFS must then synthesize that information into a health impact assessment looking at the overall combined effect to the health of the Inupiat people.

Several other significance criteria should also weigh heavily in NMFS's decision to prepare an EIS for Shell's project. 40 C.F.R. § 1508.27. In particular, this issue involves several areas of controversy and uncertainty, including: 1) NMFS' estimates of noise produced by ice management as opposed to ice breaking; 2) NMFS' failure to consider underwater noise produced by the fleet of support vessels; 3) NMFS' failure to impose mitigation measures developed in 2007; 4) NMFS' conclusions about impacts to feeding behavior; 5) NMFS' failure to consider the impacts of discharge; 5) the combined cumulative impacts of Shell's operations in combination with all other industrial activities planned for the Arctic in 2010 and beyond; and 6) the impacts of a catastrophic spill, which can no longer b considered too remote a possibility for environmental analysis, as demonstrated by recent events in the Gulf of Mexico. These are not simple or straightforward issues that can be easily resolved in a concise Environmental Assessment, rather they should be and legally must be addressed through a complete EIS process that will entail an analysis of issues that push the boundaries of our existing scientific knowledge.

Finally, as we noted at the outset, NMFS appears to recognize the need for an EIS to address the numerous complex issues involved in permitting oil and gas activities in the Arctic. Given the fact that NMFS has already started the process of preparing an EIS for this purposes, and given the dramatically increased level of activity planned for 2010, we fail to see how NMFS could possibly reach a defensible finding of no significant impacts when Shell's operations are placed in the proper context. We are unaware of any analysis of what the combined impacts could be to bowhead whales if they encounter seismic testing in Canadian waters, drilling in Camden Bay, seismic in the Beaufort Sea, operations at Northstar, vessel traffic between the Beaufort and Chukchi Seas, drilling in the Chukchi, seismic and geophysical work in the Chukchi and vessel traffic through the Bering Strait. This level of industrial activity in the Arctic is unprecedented, and NMFS has no prior studies or analyses upon which to conclude that all of these activities will not have a significant impact on bowhead whales and other marine mammals.

X. Conclusion

The AEWC, its whaling captains, their families and their communities – indeed the Inupiat people – rely on the Arctic Ocean for their existence. It feeds us, it sustains us, and it inspires us every day. This is why we work tirelessly to protect these resources. We have a positive vision of how our traditions and our people can co-exist with the oil industry's efforts to access the resources of the OCS. The current system, however, is fundamentally broken, as the Deepwater Horizon incident highlights in stark clarity.

What is needed now is for our federal government to demonstrate leadership. All the pieces are in place if our government leaders are willing to make difficult decisions during these historic times. The Deepwater Horizon incident will lead to a reorganization of MMS and a reassessment of its regulatory functions. NMFS is embarking on a long-term planning process for the Arctic in preparing a Draft EIS for oil and gas activities. Meanwhile, the scientific community is beginning to gather key baseline data on the Arctic ecosystem.

Mr. Payne, we would much rather be spending our time working with you to implement our positive vision for the Arctic, which does include the oil industry, as opposed to fighting each of these site-specific proposals. Until now, however, NMFS, MMS and the federal government have left us no choice. Make no mistake – exploratory drilling carries with it the risk of a catastrophic spill that would have dire consequences for our people for years and generations to come. We cannot sit idly by and allow that to happen. But, if you and the Obama Administration can simply create meaningful time for a collaborative discussion between the federal government, local communities and the oil industry, we believe we can find common ground and resolve these issues. We implore you to assist in that process by returning Shell's application for the IHA for the reasons set forth above. We all need to take advantage of this moment to step back and reflect and learn from the lessons of the last several years. If we don't, our children and grandchildren will one day ask us why we made these mistakes.

Please give serious considerations to our request, and know that I and everyone else at the AEWC stand by to assist and work with you in whatever way we can in finding common ground as we move forward.

Sincerely,

Harry Brower
Chairman

cc: Mayor Edward Itta, North Slope Borough
Eugene Brower, President of the North Slope Borough Assembly
Senator Murkowski
Senator Begich
Representative Young
Eric C. Schwaab, Assistant Administrator for Fisheries

AEWC Comments on Shell 2010 Camden Bay IHA
May 19, 2010

ATTACHMENTS

1. Alaska Eskimo Whaling Commission and Inupiat Community of the Arctic Slope, Brief of Petitions, *Alaska Eskimo Whaling Commission et al. v. Salazar*, Ninth Circuit Case No. 09-73944, 10-70368.

2. Letter from Marvin Odum, President, Shell Oil Company, to Kenneth Salazar, U.S. Department of the Interior, Re: Shell Offshore Inc. 2010 Exploration Plans for Alaska OCS (June 24, 2009) (excerpts)

3. McCauley, R.D. et al. 2000. Marine seismic surveys – a study of environmental implications. APPEA Journal 692-708.

4. National Marine Fisheries Service, Environmental Assessment for the Shell Offshore, Inc. Incidental Harassment Authorization to Take Marine Mammals Incidental to Conducting an Offshore Drilling Project in the U.S. Beaufort Sea Under the Marine Mammal Protection Act (October 2007) (excerpts).

5. The Royal Norwegian Ministry of the Environment, *Report no. 8 of the Storting (2005-06) – Intergrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands*

6. United States Environmental Protection Agency Region 10, Seattle, Washington, Statement of Basis for Proposed Outer Continental Shelf Prevention of Significant Determination Permit No R10OCS/PSD-AK-2010-01 (February 17, 2010) (excerpts).

7. U.S. Department of the Interior and Minerals Management Service, Brief of Respondents, *Native Village of Point Hope et al. v. Salazar*, Ninth Circuit Case Nos. 09-73942, 09-73944, 10-70166, 10-70368 (excerpts)

Nos. 09-73942, 09-73944, 10-70166, 10-70368

IN THE UNITED STATES COURT OF APPEALS
FOR THE NINTH CIRCUIT

ALASKA ESKIMO WHALING COMMISSION
AND INUPIAT COMMUNITY OF THE ARCTIC SLOPE,

NATIVE VILLAGE OF POINT HOPE, *et al.*,

Petitioners,

v.

KEN SALAZAR, Secretary of the Interior, and
MINERALS MANAGEMENT SERVICE,

Respondents,

and

SHELL OFFSHORE INC., and the STATE OF ALASKA,

Intervenor-Respondents.

Petitions for Review of Minerals Management Service Decisions

Petitioners Alaska Eskimo Whaling Commission and Inupiat Community of the Arctic Slope's Opening Brief On The Merits

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CORPORATE DISCLOSURE STATEMENT

Pursuant to Federal Rule of Appellate Procedure Rule 26.1, the Petitioners hereby state that none of them has any parent companies, subsidiaries, or affiliates that have issued shares to the public.

TABLE OF CONTENTS

Table of Authorities

Cases

Statutes

Administrative Procedure Act

National Environmental Policy Act

Outer Continental Shelf Lands Act

Regulations

OCSLA Regulations

NEPA Regulations

Federal Register Notices

INTRODUCTION

In these consolidated petitions for review, local Inupiat communities on the north coast of Alaska challenge two decisions of the Minerals Management Service ("MMS") to allow offshore drilling in the middle of the bowhead whale migration. The Inupiat have relied on the subsistence resources of the Arctic Ocean since time immemorial to carry on their indigenous traditions, and the bowhead whale is their most important subsistence resource. The proposed drilling operations in the Beaufort and Chukchi Seas threaten to undermine decades of work by the Alaska Eskimo Whaling Commission ("AEWC") to document the health of the stock and ensure a well managed and sustainable subsistence hunt.

MMS determined that underwater noise associated with a 514-foot drillship, icebreakers and numerous support vessels would not have a significant impact on bowhead whales. MMS's analysis and conclusions fly in the face of the traditional knowledge of the Inupiat as well as the current state of western science regarding the migration and impacts from underwater noise. MMS ignored impacts to feeding habitat and mothers and calves – the most vulnerable members of the population – and MMS seriously underestimated the impacts of icebreakers in both the Beaufort and the Chukchi Seas. MMS even went so far as to ignore data from recent studies it has funded, which document bowhead whale use of the Chukchi Sea project area. Finally, MMS analyzed each individual project in a vacuum without considering the cumulative impacts of the two projects in combination with numerous other industry proposals for 2010 and subsequent years.

The projects also threaten the relatively pristine air quality of the Arctic and therefore the health and well being of local communities, as the operations from July to October would emit pollution equivalent to several million cars driving 12,000 miles in a year. MMS took only the most cursory look at these impacts, instead simply assuming, without adequate public disclosure and analysis, that the impacts would not be significant.

STATEMENT OF JURISDICTION

Respondents Ken Salazar, Secretary of the Interior, and MMS (collectively, "MMS") authorized the 2010 Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska ("Camden Bay Exploration Plan") and the 2010 Exploration Drilling Program OCS Lease Sale 193 Chukchi Sea ("Chukchi Sea Exploration Plan") pursuant to Section 11 of the Outer Continental Shelf Lands Act ("OCSLA"), 43 U.S.C. § 1340.

The Court of Appeals has original jurisdiction pursuant to 43 U.S.C. § 1349(c)(2). *See also Edwardsen v. Dep't of the Interior*, 268 F.3d 781, 784 (9th Cir. 2001) (citing *Nat'l Parks & Conservation Ass'n v. FAA*, 998 F.2d 1523, 1527-28 (10th Cir. 1993)).

A petition for review of the "Secretary's action" must be filed "within sixty days after the date of such action * * *." 43 U.S.C. § 1349(c)(3)(C). MMS issued the conditional letter of approval of the Camden Bay Exploration Plan on October 16, 2009. Excerpt of Record ("ER") 156. Petitioners AEWC and Inupiat Community of the Arctic Slope (collectively, "AEWC") filed the Petition for Review, No. 09-73944, on December 15, 2009, within 60 days of the Secretary's decision.

MMS issued the conditional letter approval of the Chukchi Sea Exploration Plan on December 7, 2009. ER1. AEWC filed the Petition for Review, No. 10-70368, on February 4, 2010, within 60 days of the Secretary's decision.

STATEMENTS OF THE ISSUES PRESENTED FOR REVIEW

1. Whether MMS's failure to consider adequately the direct and potentially biologically significant impacts to bowhead whales caused by the Camden Bay and Chukchi Sea Exploration Plans violates NEPA's "hard look" requirement.

2. Whether MMS's failure to consider adequately the cumulative and potentially biologically significant impacts to bowhead whales violates NEPA's "hard look" requirement.

4. Whether MMS's failure to consider direct impacts to the subsistence hunt of beluga whales in Point Lay violates NEPA's "hard look" requirement.

5. Whether MMS's failure to consider adequately direct and cumulative impacts to air quality violates NEPA's "hard look" requirement.

6. Whether MMS's failure to regulate adequately air pollution from exploration activities violates OCSLA.

STATEMENT OF THE CASE

These consolidated petitions challenge MMS's decisions to conditionally approve two offshore exploratory drilling plans submitted by Shell Offshore, Inc. ("Shell"). Petition No. 09-73944 challenges MMS's conditional approval of the Camden Bay Exploration Plan. Petition No. 10-70368 challenges MMS's conditional approval of the Chukchi Sea Exploration Plan.

MMS deemed Shell's Camden Bay Exploration Plan complete on August 11, 2009, ER846, and amended on September 18, 2009. ER2622. AEWC provided comments on Shell's application materials on August 31, 2009. ER665. On October 15, MMS published the Environmental Assessment ("EA"), ER2174, and Finding of No Significant Impact ("FONSI"), ER163, and issued the conditional approval letter, ER156. MMS did not publish a draft EA, accept public comment on its NEPA analysis, or provide notice of any other administrative appeal rights.

MMS deemed Shell's Chukchi Sea exploration plan complete on October 20, 2009. ER556. AEWC provided comments on Shell's application materials on

November 10, 2009. ER306. On December 7, MMS published the EA, ER24, the FONSI, ER11, and the conditional approval letter, ER1. MMS did not publish a draft EA, accept public comment on its NEPA analysis, or provide notice of any other administrative appeal rights.

AEWC filed petition No. 09-73944 on December 15, 2009. On December 30, 2009, Intervenor Shell Offshore, Inc. ("Shell") filed an urgent motion for relief asking for a premature determination that Petitioners were not entitled to a stay. AEWC filed a motion to expedite on January 13, 2010. The Court denied Shell's motion for urgent relief and granted the motion to expedite on January 15, 2010.

On February 4, 2010, AEWC filed petition No. 10-70368. AEWC filed a motion to consolidate and motion to expedite on February 8, 2010. The Court granted the motions on March 2, 2010.

STATEMENT OF FACTS

I. Petitioners' Interests

Eight separate villages lie along the north coast of Alaska, and the populations of those villages are predominantly Inupiat Eskimos who have relied upon the subsistence harvest of wildlife such as the bowhead whale for thousands of years. ER1636. Inupiats rely upon the resources of the Beaufort and Chukchi Seas, including the bowhead whale, to feed their families and sustain their culture and traditions. ER1637. The Beaufort Sea stretches from the Canadian border in northeastern Alaska to Point Barrow. The Chukchi Sea extends from Point Barrow in the east to the Bering Strait in the west.

Subsistence practices define the cultural, social and spiritual values that lie at the heart of the Inupiat heritage. As MMS has stated:

> This close relationship between the spirit of a people, their social organization, and the cultural value of subsistence hunting may be unparalleled when compared with other areas in America where energy development is taking place. The Inupiat's continuing strong dependence on subsistence foods, particularly marine mammals and caribou, creates a unique set of potential effects from onshore and offshore oil exploration and development on the social and cultural system.

ER1637. "Subsistence practices are assigned the highest cultural values by the Inupiat and provide a sense of identity in addition to being an important economic pursuit." ER1633.

The bowhead whale is the single most important subsistence resource as it forms the foundation of the Inupiat's cultural system. ER1633. "Bowhead whale hunting strengthens family and community ties and the sense of a common Inupiaq heritage, culture, and way of life. In this way, whale-hunting activities provide strength, purpose, and unity in the face of rapid change." ER1634. The bowhead whale subsistence hunt also provides an important and irreplaceable source of healthy subsistence foods for the community. ER1673-1674.

AEWC is a non-profit organization representing subsistence whaling captains and co-manages the bowhead whale with the National Oceanic and

Atmospheric Administration ("NOAA") pursuant to a formal cooperative agreement. ER2077. The purposes of the agreement are "to protect the bowhead whale and Eskimo culture [and] to promote the scientific investigation of the bowhead whale." ER2089.

The subsistence hunt of the bowhead whale is regulated by the International Whaling Commission ("IWC"), which sets strict quotas on the number of whales that can be taken for subsistence purposes. ER1634. AEWC has for many years participated in the development of scientific data regarding the status of the bowhead whale population and its habitat, and that information is used to support AEWC quotas before the IWC. ER2078. Decades of efforts by AEWC, in partnership with NOAA, have resulted in a "steady recovery of the [bowhead whale] population" due in large part to a "well-managed subsistence hunt." ER1306-1307. Any activity that threatens the bowhead whale, its habitat or the existing scientific consensus related to the health of the bowhead whale stock, threatens AEWC's ability to advocate for and obtain its quota from the IWC. ER2078. Threats to the bowhead whale therefore directly threaten the subsistence practices of AEWC's whaling captains, their families, and their communities.

The Inupiat Community of the Arctic Slope ("ICAS") is a federally recognized sovereign tribal government organized pursuant to the Indian Reorganization Act of 1934. ER2063. As the regional Native government, ICAS represents the interests of Inupiat communities that depend on the resources of the Beaufort and Chukchi Seas. *Id.* ICAS communicates with MMS and other agencies on a government-to-government basis on behalf of the Inupiat people regarding activities on the Outer Continental Shelf ("OCS"). *Id.*

II. The Proposed Exploration Activities

In the Beaufort Sea, Shell proposes to drill two exploratory wells near Camden Bay and north of Point Thompson. ER163-164; 261-262. Shell proposes one well on the Sivulliq prospect and another on the Torpedo prospect. ER177. Each well would take approximately 35-40 days to drill. ER178. The drilling operations would be conducted during the 2010 open water season, starting on or about July 10 and finishing by October 31.[1]

In the Chukchi Sea, Shell proposes to drill three wells on five proposed well locations in three separate prospects. ER28. The three prospects – Burger, Crackerjack and SW Shoebill – are west of Point Barrow and north of Wainright and Point Lay and about 60 miles off the coast. ER37. Each well would take approximately 37 days to drill. ER40. The drilling operations would be conducted during the 2010 open water season, starting on July 4 and finishing by October 31.

Shell proposes to use the same fleet of vessels for both projects. The drillship *Discoverer* is 514 feet in length with a top speed of 8 knots. ER872-874;

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[1] Shell would move off-site during the Kaktovik and Nuiqsut subsistence hunts. ER1045.

1049-1050. The *Discoverer* would be supported by a minimum of six additional vessels used for ice management, anchor handling, oil spill response, refueling, resupply, and servicing. ER45-46; 190. The air emissions from the fleet of vessels are substantial, ER2125, and met MMS's significance test for air quality impacts in Camden Bay. ER577.

Because Shell plans to use the same fleet of vessels, it states it can only drill three wells during the 2010 season despite the fact it has requested authorization to drill a total of five wells. ER1155. Shell has not stated how the two plans will be coordinated – which three wells it will drill, which seas they are in, or in which sequence they will be drilled.

The proposed exploration activities in both seas would be located directly in the middle of the fall migration route for the bowhead whale, and the activities would be timed during the fall migration. Camden Bay and the area around the proposed well sites provide important feeding and resting habitat for bowhead whales, particularly mothers and calves, during their fall migration. *See infra* at 12. The planned well sites in the Chukchi Sea are also in the middle of the migration corridor. *See infra* at 13-14.

III. Shell's Proposed 2007 Exploration Plan for Camden Bay

In 2007, Shell submitted an exploration plan for the Beaufort Sea that included drilling twelve exploration wells over three years. *Alaska Wilderness*

League v. Kempthorne, 548 F.3d 815, 819 (9th Cir. 2008), *withdrawn* 559 F.3d 916, *dismissed as moot* 571 F.3d 859. Shell proposed to drill four wells at the Sivulliq prospect in the first year and then additional wells in future years. *Id.*

MMS's approval of the 2007 exploration plan was challenged by AEWC and other petitioners in three consolidated petitions for review. *Id.* at 819-820. After issuing two stays, the Court vacated MMS's approval of the 2007 exploration plan because the agency failed to adequately consider impacts to bowhead whales and subsistence activities pursuant to NEPA. *Id.* at 835. After Shell filed a petition for rehearing, the Court withdrew the opinion and stated that it would replace it with a new opinion. *Id.* at 916-917. Shell subsequently withdrew its exploration plan, and the Court dismissed the petitions for review as moot. *Id.* at 859.

IV. The Bowhead Whale

Bowhead whales (*Balaena mysticetus*) are "slow-moving, late-maturing, long-lived animals." ER1307. As baleen whales, they filter prey through fibers in their mouths. ER1314. The may live well over 100 years and reach sexual maturity around 15-20 years old. ER1308. The population is estimated to be approximately 12,600 with an annual growth of 3.4 percent. ER2337-2338.

The Western Arctic stock of bowhead whales migrates through the Chukchi and Beaufort seas twice per year between the Bering Sea and the Canadian

Beaufort. ER1308-1311. Mating starts in January or February and likely takes place primarily in the Bering Sea. Gestation lasts for an estimated 13-14 months, and females give birth to a single calf every three to four years. ER2334.

Most calving occurs during the spring eastward migration in the Chukchi Sea, which takes place during the ice breakup and usually lasts from late March through mid-June. ER1307. The National Marine Fisheries Service ("NMFS") has noted the potential "high biological cost of reproduction, a fact noteworthy in considering the potential impacts of excluding females from feeding areas." *Id.* In the spring, whales tend to migrate through leads in the ice that form between shorefast ice and the receding offshore pack ice. *Id.*

Most whales continue to travel eastward into Canadian waters, but in recent years more whales have been identified summering in the eastern Chukchi and Western Beaufort. ER1310; 2335. "Incidental sightings suggest that bowhead whales may occupy the Chukchi Sea in the summer more regularly than commonly believed." ER1310.

The westward fall migration begins in August and September, although the timing varies somewhat from year to year. ER1310. Mothers and calves tend to arrive in Alaskan waters towards the end of the migration, usually around the middle to end of September and into October. ER1311.

During the fall migration, bowhead whales feed on a regular basis in nearshore waters of the Alaskan Beaufort. ER1314. "[S]ome bowheads apparently take their time returning westward during the fall migration, sometimes barely moving at all, with some localities being used as staging areas due to abundant food resources or social reasons." *Id.* "Lipid content of blubber, at least in subadults, is higher when they leave the Beaufort in the fall than when they return in spring. This evidence suggests the importance of feeding in the Beaufort Sea during summer and early autumn." ER1315. A 2004 study found that 78 percent of subadults and 73 percent of adults had been feeding during the fall migration. *Id.*

The area in and around the proposed drilling locations near Camden Bay are particularly important feeding and resting grounds for bowhead whales, including mothers and calves, during the fall migration. AEWC whaling captains have for years reported significant feeding activity in Camden Bay, and they also report that mothers and calves routinely rest in the Bay before their westward migration. ER2064; 2067-68; 2070; 2075; *see also* ER1685 (1989 report documenting concerns of AEWC).

Observations of scientists confirm the traditional knowledge of the Inupiat whaling captains. In 2007 and 2008, Shell conducted seismic surveys at Sivulliq, and its monitoring program documented extensive bowhead whale feeding activity in the immediate area. Many thousands of whales were estimated to be in the prospect area at any one time. ER1402 (Table 5.3). Moreover, the report concludes that "a high proportion of sighted whales appeared to be feeding * * * near and west of Sivulliq" and that "[f]eeding was the most commonly reported activity." ER1411.

After passing Point Barrow, bowheads migrate west through the Chukchi Sea. ER 1313. Historically, information has been sparse on bowhead distribution and abundance in the Chukchi during the fall migration. According to NMFS, bowheads "commonly are seen from the coast to about 150 km (93 miles) offshore between Point Barrow and Icy Cape, suggesting that most bowhead disperse southwest after passing Point Barrow * * *." *Id.* The last systemic surveys in the Chukchi Sea were more than 15 years ago. ER1310.

More recently, AEWC, the Alaska Department of Fish & Game ("ADF&G"), and the North Slope Borough's Department of Wildlife Management have been cooperating in a study funded in part by MMS to collect more data on bowhead whale use of the Chukchi Sea during the fall migration. ER1271-1276. AEWC whaling captains have worked with ADF&G to place satellite tags on 32 bowhead whales, which were then tracked as they moved across the Chukchi Sea. ER2339-2341. Every single tagged whale migrated through the lease sale area, with some whales actually reversing course, swimming back east through the sale area, and then reversing course again and passing through the area for a third time in the same migratory season. ER2341. The authors noted when discussing the preliminary data that this was the "best information available on the fall distribution of whales in the Chukchi Sea." ER1273.

Bowhead whales are dependent on hearing for important life functions, including communication, finding mates, navigation, detecting predators, and gaining other information about their environment. ER1320; 1640. "Increased noise levels could interfere with communication among whales, mask important natural sound, cause physiological damage, or alter normal behavior, such as causing avoidance behavior that keeps animals from an important area or displace a migration route farther from shore." ER1320. Sounds that are loud enough can cause temporary and permanent damage to whales' ability to hear, ER1322, and lower levels of sound can cause behavioral changes such as deflection from migration routes. ER1320.

Marine vessels and especially drillships and icebreakers are sources of underwater noise that have the potential to harass and harm bowhead whales, excluding them from important habitat or changing their behavior during the fall migration. "If drillships are attended by icebreakers, as typically is the case during the fall in the U.S. Beaufort Sea, and we expect to be the case in the Chukchi Sea, the drillship noise frequently may be masked by icebreaker noise, which is often louder." ER1350.

Studies have been conducted on prior drilling operations near Camden Bay. In 1986, studies of drilling at Hammerhead (which has been renamed Sivulliq) showed that no whales were closer than 9.5 km (6 miles) from the drillship and the zone of influence appeared to extend out to 15-25 km. In 1992, during drilling at the Kuvlum site bowhead whales began to move north at a distance of 32 km (19 miles) east of a drillship accompanied by an icebreaker. ER1351; 1343-1344. In 1993, whales avoided an area within 20 km (12 miles) of the drilling platform near the same location. Bowhead whales begin to react to sounds as low as 80-100 dB. ER1338.

Concerns over the impacts of deflection are heightened when the activities are located adjacent to feeding and resting habitat. ER1360. "Because of the potential for noise disturbance to displace whales from important feeding areas, special scrutiny should be given to seismic and drilling operations which may impacts these areas." *Id.* NMFS recommended to MMS that it should "continue research to describe the impact of exploration activities on migrational movements and *feeding behavior* of bowhead whales." ER1363 (emphasis added).

V. Air Quality in The Arctic

Air quality of the Beaufort and Chukchi Sea Planning Areas is considered to be relatively pristine. ER113; 240. The nearest communities to Shell's operations are the North Slope communities of Kaktovik and Nuiqsut along the Beaufort Sea. ER2125. Emissions associated with Shell's drilling fleet include thousands of tons of pollutants per year, including nitrogen dioxide ("NO_2"), sulfur dioxide ("SO_2"), particulate matter ("PM"), carbon monoxide ("CO") and volatile organic compounds ("VOC"). ER609.

The projected emissions are equivalent to millions of cars driving 12,000 miles per year in the fragile arctic environment. ER630. For example, the contribution from Shell's Beaufort Sea operations of fine particulate matter ("$PM_{2.5}$") alone would consume almost a quarter of the short-term National Ambient Air Quality Standard ("NAAQS") – standards designed to protect human health – at the location. ER2125. Fine particulate matter contributes to both lung and heart health issues and is particularly a concern on the North Slope where chronic lung disease rates are higher than in most U.S. populations. ER2126-2128.

STANDARD OF REVIEW

The Ninth Circuit reviews MMS's compliance with NEPA when preparing OCSLA exploration plans pursuant to the arbitrary and capricious standard of the Administrative Procedure Act ("APA"), 5 U.S.C. § 706(2)(A). *Village of False*

Pass v. Clark, 733 F.2d 605, 613 (9th Cir. 1984). Courts provide a "thorough, probing, in-depth review" of agency actions. *Citizens to Preserve Overton Park v. Volpe*, 401 U.S. 402, 415 (1971), *overruled on other grounds* 430 U.S. 99, 105 (1977). MMS must articulate a rational connection between the facts found and the conclusions reached. *Baltimore Gas and Elec. Co. v. Natural Resources Defense Council*, 462 U.S. 87, 105 (1983); *Midwater Trawlers Co-op v. Dep't of Commerce*, 282 F.3d 710, 716 (9th Cir. 2002). The Court must determine whether the "the agency relied on factors Congress did not intend it to consider, entirely failed to consider an important aspect of the problem, or offered an explanation that runs counter to the evidence before the agency or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise." *Lands Council v. McNair*, 537 F.3d 981, 987 (9th Cir. 2008) (internal quotations omitted).

SUMMARY OF ARGUMENT

MMS failed to take a "hard look" at the direct and cumulative impacts of the Camden Bay and Chukchi Sea Exploration Plans on bowhead whales. In the Beaufort Sea, MMS ignored potential impacts to feeding habitat and mothers and calves, which MMS and NMFS have previously concluded may result in biologically significant impacts. MMS also assumed icebreaking activities, which generate loud noise over very large areas, would be infrequent and anomalous in the Arctic Ocean during the fall, which contradicts the record evidence.

In the Chukchi Sea, MMS failed to acknowledge studies it has funded documenting that bowhead whales use the project area. Moreover, MMS incorporated flawed data from Shell on the impacts of icebreakers.

MMS also failed to conduct an adequate cumulative impacts analysis, arbitrarily dismissing any potential for the two exploration projects to have a combined impact on bowhead whales, despite the fact that Shell may be driving its fleet of vessels directly through the fall migration to get one from project area to the other. Furthermore, MMS ignored numerous other industry proposals for drilling, seismic, and other geophysical work in both the Beaufort and Chukchi Seas in 2010 and beyond.

MMS also failed to consider and regulate adequately the impacts of Shell's air emissions and the threats posed to the health of local Inupiat communities. MMS disregarded the formation of secondary fine particulate matter and ozone, and arbitrarily exempted Shell's activities from further regulation pursuant to OCSLA.

ARGUMENT

I. The National Environmental Policy Act ("NEPA")

NEPA declares "a broad national commitment to protecting and promoting environmental quality." *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 348 (1989); *see also* 42 U.S.C. § 4331. NEPA's disclosure goals are two-fold: (1) to insure that the agency has carefully and fully contemplated the environmental effects of its action, and (2) to insure that the public has sufficient information to challenge the agency. *See Robertson*, 490 U.S. at 349; 40 C.F.R. § 1500.1(b). By focusing the agency on the environmental consequences of its proposed action, NEPA "ensures that important effects will not be overlooked or underestimated only to be discovered after resources have been committed or the die otherwise cast." *Robertson,* 490 U.S. at 349.

In other words, NEPA requires that an agency take a "hard look at the environmental impacts of a proposed action." *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1211 (9th Cir. 1998) (internal citation omitted). This environmental review must be supported by detailed data and analysis. *Idaho Sporting Congress v. Thomas*, 137 F.3d 1146, 1150 (9th Cir. 1998), *overruled on other grounds by McNair*, 537 F.3d at 997. Vague, conclusory and unsupported statements do not constitute a "hard look." *Great Basin Mine Watch v. Hankins*, 456 F.3d 955, 973 (9th Cir. 2006); *Ocean Advocates v. Army Corps of Engineers*, 361 F.3d 1108, 1124 (9th Cir. 2004).

"A threshold question in a NEPA case is whether a proposed project will 'significantly affect' the environment, thereby triggering the requirement for an

EIS." *Blue Mountains Biodiversity Project*, 161 F.3d at 1212 (citing 42 U.S.C. § 4332(2)(C)). An "agency may prepare an EA to decide whether the environmental impact of a proposed action is significant enough to warrant preparation of an EIS." *Id.* (citing 40 C.F.R. § 1508.9). The agency may not divide the project "into multiple actions, each of which individually has an insignificant environmental impact, but which collectively have a substantial impact." *Kern v. BLM*, 284 F.3d 1062, 1078 (9th Cir. 2002) (internal citations omitted).

"The purpose of an EA is to provide the agency with sufficient evidence and analysis for determining whether to prepare an EIS or to issue a FONSI." *Metcalf v. Daley*, 214 F.3d 1135, 1143 (9th Cir. 2000) (citing 40 C.F.R. § 1508.9). "Because the very important decision whether to prepare an EIS is based solely on the EA, the EA is fundamental to the decision-making process." *Id.*

II. MMS Failed to take a "Hard Look" at the Direct Impacts of the Camden Bay Exploration Plan on Bowhead Whales.

Shell's planned operations involve the operation of a drillship, icebreakers, and multiple support vessels in unique feeding habitat during the fall migration. MMS concluded that the impacts would not be significant but failed to consider the potential impacts to important feeding and resting habitat and mother and calves, the most vulnerable members of the population. Both MMS and NMFS have concluded in the past that these types of activities may result in biologically significant impacts, but MMS ignored these important aspects of the problem in its analysis. Moreover, icebreakers are often the greatest source of noise, and MMS arbitrarily assumed that icebreaking during the migration would be "infrequent" and "anomalous" in the Beaufort Sea during the fall when Shell's own application materials document just the opposite. ER229. MMS failed to consider important aspects of the problem, and its conclusions run counter to the evidence in the record. *McNair*, 537 F.3d at 987.

A. MMS Failed to Consider the Potential Impacts to Feeding Habitat and Mother and Calves.

Underwater noise can potentially deflect whales from important feeding and resting grounds, causing whales to miss feeding opportunities and/or expend greater energy during the fall migration. These impacts can potentially cause "biologically significant impacts," ER1650, jeopardizing survival of mothers and calves and reproductive success. ER1354.[2]

In its 2008 Biological Opinion, NMFS concluded that "[b]ecause [of] the potential for noise disturbance to displace whales from important feeding areas, *special scrutiny should* be given to * * * drilling operations which may impact these areas." ER1360 (emphasis added). NMFS found that:

> [d]epending on their timing, location, and number, these activities potentially could produce sufficient noise and disturbance that whales might

[2] Feeding whales may also expose themselves to higher noise levels than they would otherwise withstand, which increases the risk of hearing damage or physiological stressors caused by exposure to noise. ER1359.

> avoid an area of high value to them and *suffer consequences of biological significance*. These consequences would be of particular concern if such areas include[] those used for feeding and resting by large numbers of individuals or by females and calves.

ER1354 (emphasis added). Moreover, the effects of icebreakers on "migrating bowheads, especially mothers and calves, could be biologically significant if [they] caused aggregations to leave resting and feeding areas." ER1335. In light of these concerns, NMFS included a conservation recommendation that MMS should "continue to investigate the use of the Chukchi and Beaufort Seas by feeding bowhead whales and assess the importance of this feeding to the health and wellbeing of these animals." ER1364.[3]

MMS also has recognized that any potential impacts on mothers and calves merit "special consideration." ER1554-1555. With low reproductive rates, whales demonstrate an "extremely high maternal investment in young." ER1554. "The ability of the female to provide adequate care * * * to her offspring during its period of dependency is critical to the continued recovery and the long-term viability of the population." *Id.* Mothers and calves are also uniquely vulnerable to the impacts of underwater noise like that produced by offshore activities. "Females with young are more responsive to noise and human disturbance than

[3] NFMS also stated that MMS "should continue research to describe the impact of exploration activities on the migrational movements and feeding behavior of the bowhead whale." ER1363.

other segments of the population." ER1354. In 2005, the National Research Council concluded that "[v]ery low thresholds should be considered for any disturbance that might separate a dependent infant from its caregiver." ER1555.

The Beaufort Sea, and particularly the project area, is an important feeding area for bowhead whales. In 2007 and 2008, Shell monitored for marine mammals at the Sivulliq site in conjunction with seismic testing. In 2007, "a high proportion of sighted whales appeared to be feeding * * * near and west of Sivulliq * * *." ER1390. "Feeding was the most commonly recorded activity" among sighted whales in the project area, and the study estimated that several thousands of whales (out of a total population of approximately 12,600) were in the area at one time. ER1411. The next year, in 2008, feeding was again the most commonly recorded activity at Sivulliq. ER1286. These results confirm the findings of a 2004 study, which concluded that bowhead whales "feed regularly in the nearshore waters of the eastern, central and western Alaskan Beaufort Sea" during September and October. ER1315.

Despite this record information, MMS failed to consider the impacts of deflecting whales from feeding opportunities and included in the EA only the most cursory discussion of Camden Bay as a feeding area. The EA says only that bowhead whales "[m]ay be found feeding near drill site locations." ER213. In the discussion of potential effects from drilling and icebreaking noise, ER224-227, MMS never mentions impacts to feeding habitat or even acknowledges Shell's own monitoring data. In its conclusion section, MMS again fails to mention any potential impacts to feeding behavior. ER229. MMS also failed to consider or disclose the potential impacts to mothers and calves. In fact, the only time the word "calf" shows up in the EA is when MMS *rejects* a mitigation measure designed to protect cow/calf pairs. ER230.

In its exploration plan, Shell provided inaccurate and contradictory information on feeding habitat. Shell's Environmental Impact Assessment ("EIA") mentions only briefly that bowhead whales feed near the project area. ER1144. In discussing the potential impacts of underwater noise, Shell entirely disregards impacts to feeding habitat. ER1152.

Shell's materials also include an application for an incidental harassment authorization ("IHA") to be submitted to NMFS.[4] Without discussing any of its own monitoring studies, Shell states that:

> feeding does not appear to be an important activity by bowheads migrating through the eastern and central part of the Alaskan Beaufort in most years. In the absence of important feeding areas, the potential diversion of a small number of bowheads is not expected to have any significant or long-term consequences for individual bowheads or their population.

ER1124.

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[4] NMFS regulates harassment of marine mammals pursuant to the Marine Mammal Protection Act, 16 U.S.C. § 1371(a).

This statement conflicts with Shell's own monitoring reports, and it also concedes that deflection of whales from feeding areas *could* have long-term population-level impacts, which is consistent with NMFS's conclusions on biological significance. ER1354. NMFS's statements, in particular, are important because the Ninth Circuit has held that an EIS is required if the plaintiff raises "'substantial questions whether a project *may* have a significant effect * * *.'" *Idaho Sporting Congress*, 137 F.3d at 1150 (quoting *Greenpeace Action v. Franklin*, 14 F.3d 1324, 1332 (9th Cir. 1992)) (emphasis added).

This is precisely the type of site-specific data that should have been considered by MMS. At the lease sale stage, the agency stated it would review subsequent exploration projects and conduct "further NEPA environmental evaluations using *site-specific data*, which is not available or needed in the current lease sale EIS." ER1609 (emphasis added); *see also Village of False Pass v. Watt*, 565 F.Supp. 1123, 1135 (D. Alaska 1983) (stating that the exploration stage is when "threats to the environment are readily visualized and evaluated") (internal citation omitted), *aff'd* 733 F.2d 605 (9th Cir. 1984). Here, Shell collected site-specific data showing the project area provides important feeding habitat for bowhead whales. *See supra* at 22-23. Shell then ignored its own data in its application materials, and MMS subsequently failed to consider impacts to feeding habitat. In doing so, MMS ignored an important aspect of the problem, and its conclusions are arbitrary. *League of Wilderness Defenders v. Forest Serv.*, 549 F.3d 1211, 1215 (9th Cir. 2008) (quotations omitted).

B. MMS's Conclusions on the Impacts of Noise from Icebreakers Conflict with the Record.

Noise from icebreakers can be very loud, up to 185 decibels ("dB") or more, and can drown out drillship noise. ER1649. Migrating whales may react to icebreakers "out to radii of 10-30 kilometers (6.2-18.6 miles) and sometimes to 50+ kilometers (31.1 miles)." ER1650. Because of the large area impacted and the potential for deflection, MMS concluded in the lease sale EIS that "[e]ffects of an actual icebreaker on migrating bowheads, especially mothers and calves, could be biologically significant." *Id.*

Instead of analyzing the impacts of an icebreaker operating during the migration, MMS simply assumed that there would be little ice in the Beaufort Sea in September.

> During July, August, and September, the project locations are expected to be mostly ice-free; thus *the need for icebreaking or ice management should be infrequent once the vessels reach the project site*. The presence of an icebreaker is a safety precaution in the event of an *anomalous ice-related occurrence*, and few belugas, gray, and bowhead whales may experience short-term effects up to a moderate level of effect from ice-management activities and any necessary icebreaking activities.

ER229 (emphasis added). MMS does not estimate how many whales would be exposed to icebreaker noise and also excludes October although the migration continues during this time and Shell plans on drilling until October 31st.

MMS's conclusions are premised upon the flawed assumption that active icebreaking would be an anomalous event in the Arctic during the fall. MMS does not provide any analysis of ice conditions or cite to any factual support for this critical assumption.

Shell itself admits it is likely to conduct frequent icebreaking operations. In the EIA, Shell predicts the likely extent of ice management activities for purposes of estimating its air emissions, ER1147, concluding it will conduct ice management activities 38 percent of the time. ER1148.[5] Shell acknowledges that "sea ice generally begins forming in September or early October and covers most of the nearshore area by mid-November." ER1141. Further, Shell recognizes that ice floes and pack ice "usually can be found anywhere offshore in the Beaufort," and ice can be blown in "during any part of the drilling season." ER1142.

At the same time, Shell contradicts itself in other places in its exploration plan. In the IHA application, used to assess impacts to bowhead whales, Shell states that "[l]ittle to no ice management is expected to occur during the migration, so additional estimates [of impacts to whales] for ice-management activities were not calculated." ER1119.

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[5] Those estimates were based on ice data from 2003-2005, while in 2006, the project area was "ice covered the majority of the period between July and October." ER709.

This assumption was critical to Shell's predictions of impacts to whales, because it estimated the number of whales exposed to sound levels of 120 dB and 160 dB or more by multiplying:

- the anticipated area to be ensonified to the specified level in the time period and habitat zone to which a density applied, by
- the expected species density.

ER1118.[6] Ice management activities are known to create louder sounds than drilling operations and therefore, those sounds propagate over much larger areas, which Shell estimates to be at least "10-15 km from the drillship and 8 km on either side." ER1119. By excluding icebreaker noise, Shell minimized the size of the ensonified area and thereby minimized the number of whales predicted to be exposed to underwater noise. ER2349-2350. Even excluding the impacts of icebreakers during the migration, Shell predicted that almost 2,000 whales, out of a population of approximately 12,600, would be exposed to 120 dB or greater. ER1120.

MMS appears to have carried forward Shell's flawed analysis on icebreaking operations, although MMS does not cite to anything in the record for its assumptions. ER227; 229. In the past, however, MMS and NMFS recognized that icebreaking is expected during the fall and not "anomalous." In 2003, MMS

[6] For migrating bowhead whales, Shell used a different method, because "it is not accurate to assume that the same individuals would be present in the area from one day to the next." ER1117. Shell, therefore, included a variable relating to how long the operations would take place. *Id.*

stated that "[i]f drillships are attended by icebreakers, as typically is the case during the fall in the U.S. Beaufort Sea * * * drillship noise frequently may be masked by icebreaker noise, which is often louder." ER1649. In 2006, MMS again reached the same conclusion, stating icebreakers tending to drillships "typically is the case during the fall in the U.S. Beaufort Sea." ER1558; *see also* ER1350 (similar NMFS conclusions from 2008). These statements are consistent with Shell's EIA, acknowledging ice can be found at any time during the operating period and predicting that it would break ice 38 percent of the time. ER1142. MMS's conclusions to the contrary are unsupported and conflict with the record. *Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (1983).

III. MMS Failed to Consider Adequately the Direct Impacts of the Chukchi Sea Exploration Plan on Bowhead Whales.

MMS's analysis of impacts to bowhead whales from the Chukchi Exploration Plan is flawed in similar but distinct ways. MMS's conclusions similarly rely on Shell's estimates of the number of whales exposed to underwater noise of a certain sound level (120 db or 160 db). MMS, however, again ignored key evidence in the record regarding bowhead whale use of the project area and relied on inaccurate and unreliable data from Shell on bowhead whale density and noise propagation.

First, MMS failed to consider the most up-to-date information on bowhead whale use of the project area. MMS mistakenly assumes that few bowheads will use the area from July-October and does so without citing to or discussing studies conducted with MMS funding that have looked at this issue and reached contrary conclusions. Second, in analyzing how many whales would be exposed to industrial noise, MMS and Shell ignored the fact that whales are migrating though the area over time. The exposure estimates do not account for the number of whales that would swim past Shell's operations during the migration and instead look simply at a snapshot in time. Third, MMS's and Shell's estimates of the area of ocean exposed to industrial sounds appear to be flawed and contradict the work of Shell's own noise modeling contractor.

Because of these errors, MMS's conclusion that impacts to bowhead whales would be minor and temporary are arbitrary and not supported by the record. MMS, in relying on Shell's materials, ignored important aspects of the problem, and offered an explanation that runs counter to the evidence. *McNair*, 537 F.3d at 987 (internal citations and quotations omitted). Moreover, MMS violated NEPA's regulations, which require the agency to independently verify information provided by an applicant, 40 C.F.R. § 1506.5, disclose the underlying data and methodologies, 40 C.F.R. § 1502.24, and ensure the scientific integrity of its NEPA analysis, 40 C.F.R. § 1500.1.

In the Chukchi Sea EA, MMS first discusses the presence of bowhead whales and concludes that an "unknown portion of the population migrates in the vicinity of drill sites * * *." ER75. Despite the data gaps, MMS concludes that impacts would be minor because the "area of disturbance would be limited temporally and spatially." ER77. To this point in the EA, however, MMS does not describe how it reaches this conclusion or even what time and space limitations were assumed to exist. MMS then contradicts itself and assumes later in the EA that "[f]ew bowheads are expected to be encountered during drilling operations, minimizing any effects." ER89. MMS does not provide any support for this statement, which contradicts its earlier finding that bowhead use of the area is unknown.

Next is the discussion focused specifically on underwater noise. ER90. Here, MMS begins to disclose the critical assumptions it uses as a foundation for its conclusion of minor impacts. MMS states that sounds from ice management activities are expected to diminish to "less than 160 dB within a distance of less than 110 yd (100 m) of the drillship and to 120 dB within 2.9-4.7 m (4.6-7.5 km)." ER90. These critical assumptions are error and are unsupported by the record.

Moreover, MMS specifically relies on Shell's estimates to support its conclusions, stating that "Shell has estimated the number of marine mammals that might be exposed to sound levels of greater than 120 dB and 160 dB." ER90.

MMS concludes that:

> [t]he estimated number of threatened or endangered whales that might be exposed to levels of greater than 120 dB and 160 dB are presented in Table 4.1.8-1 of the Shell EIA. Very few bowheads would be exposed * * *. *Based on these numbers* and the above analysis of impacts, the effects of sound energy generated by drilling and ice management * * * would be minor and temporary, affecting few if any whales, and consisting of temporary behavioral response.

ER94 (emphasis added).

A. MMS Ignored Recent Data on Bowhead Whale Use of the Chukchi Sea and the Project Area.

MMS ignored and failed to disclose data from two key studies that were both funded by MMS and are widely considered to be the best available information on bowhead use of the Chukchi Sea during the fall migration. While the last comprehensive surveys in the Chukchi Sea were more than fifteen years ago, ER (BIOP at 13), MMS recently funded both a satellite-tagging study led by ADF&G, as well as a new round of aerial surveys.

As part of the satellite tagging study, AEWC whaling captains have coordinated with scientists to tag thirty-two bowhead whales. ER1271. The results are telling, as every single tagged whale passed directly through the Lease Sale 193 area, and many passed close to Shell's proposed well sites. ER2341 (map showing whale movement and Shell drilling location). The authors noted that the track lines are "appropriate for identifying migration corridors," ER1272, and described this data, which was available in early 2009, as the "best information available on fall distribution of whales in the Chukchi Sea." ER1273.

MMS has also been funding the Chukchi Offshore Monitoring in Drilling Area ("COMIDA") program, which involves an updated round of aerial surveys. ER2342. In 2009, these surveys documented bowheads "every month in the Chukchi Sea" and bowheads "in offshore survey blocks in September and October, indicating migration across active oil and gas lease areas." ER2398. The authors noted that this information supports "data collected from 1982-91 during MMS-sponsored aerial surveys." ER2398.

MMS's critical conclusions on bowhead abundance in the Chukchi do not reflect a reasoned assessment of this MMS-funded data. The agency first concluded that an "unknown portion of the population migrates in the vicinity of the drill sites * * *." ER75. MMS failed to discuss or even cite to its earlier surveys, the recent tagging study, or the aerial surveys, which all document that bowhead whales migrate close to the proposed well site locations. MMS then stated that "[f]ew bowheads are expected to be encountered during drilling operations, minimizing any effects." ER89. Here again, MMS failed to discuss the findings of the studies it funded for the specific purpose of assessing the overlap between oil and gas activities and the bowhead migration. In fact, MMS provides no record support whatsoever for this key finding. *Id.* Shell also repeats this same error in its application materials, concluding that "whales would not be likely to occur near the planned drilling activities * * *." ER951.

MMS was required to "examine the relevant data" and then articulate a "rational connection between the facts found and the choice made." *Motor Vehicles Mfrs Ass'n.*, 463 U.S. at 43 (internal citation omitted). Here, MMS did just the opposite. It ignored relevant data, failed to disclose this information to the public, and offered no record support for its critical assumption that migrating bowhead whales are unlikely to use the project area. MMS's failure to disclose this information violates NEPA's purpose, which is to ensure that the agency has fully contemplated the effects of its action, *Robertson*, 490 U.S. at 349. MMS would first have to admit that bowhead whales use this area before conducting a reasoned analysis of impacts to the species.

B. MMS's Estimates of Impacts to Bowhead Whales Ignore the Fact That Whales Will Migrate Past the Project Area.

The Native Village of Point Petitioners discuss MMS's failure to disclose flaws in Shell's model for estimating impact to bowhead whales. Br. at 26-28. AEWC joins in that argument and provides the following additional detail.

MMS states that it relied upon Shell's estimates located at Table 4.1.8-1 of the Shell EIA. ER94; 1005. This data is taken from Shell's IHA application, which purports to describe how Shell arrived at these figures. ER963 (Table 6-4).

Shell first calculated density estimates for bowhead whales during the summer season (July-August) and the fall season (September-October). ER960-961 (Tables 6-1 and 6-2). Shell also calculated the area of ocean to be exposed to sounds in excess of 120 dB and 160 dB. ER963 (Table 6-3). Finally, the number of whales exposed to industrial noise "was estimated by multiplying the anticipated area to be ensonified in the time period (i.e. summer and fall) and habitat zone to which a density applies, by the expected species density." *Id.* In essence, the calculation was based on the animal density multiplied by the area of noise. ER2354-2355. Shell plans to drill in the Chukchi for more than 100 days, and the bowhead whale is a migratory species, yet Shell did not estimate how many whales would move through the area during its four months of operations.

The Court must look no further than Shell's own analysis for the Beaufort to see why the Chukchi analysis is fundamentally flawed. ER1119-1120. There, Shell stated that during "the fall most bowheads will be migrating west past the exploration drilling program, so it is not accurate to assume that the same individuals would be present in the area from one day to the next." ER1112. Shell therefore calculated the "number of whales expected to pass the drilling program each day." *Id.* In other words, Shell factored in the duration of the drilling activities and estimated how many migrating whales would pass by during that time – something it did not do for the Chukchi.

MMS will likely ask for deference from the Court in reviewing its methods, and Shell will likely make the same argument. *See, e.g., McNair*, 537 F.3d at 993 (stating that courts will defer to the "agency's determination in an area involving a 'high level of technical expertise'") (quoting *Selkirk Conservation Alliance v. Forsgren*, 336 F.3d 944, 954 (9th Cir. 2003)). The concept of deference, however, applies only to the *agency's* expertise and only when the issue falls within the expertise of that agency. *Bennett v. Spear*, 520 U.S. 154, 169 (1997) (finding that the "species and habitat investigations [under the ESA] are not within the action agency's expertise"). The Court certainly owes no deference to the application materials submitted by Shell.

Moreover, NEPA places an obligation on MMS to independently verify information provided by an applicant, 40 C.F.R. § 1506.5(a)-(b), and ensure the scientific integrity of its NEPA analysis, 40 C.F.R. § 1500.1 Here, MMS simply adopted Shell's material by reference, ER94, but there is no information in the record as to whether or how MMS independently verified Shell's estimates. *See Utahans for Better Transp. v. U.S. Dept. of Transp.*, 305 F.3d 1152, 1165 (10th Cir. 2002). The Court, therefore, is left with nothing more than Shell's own self-serving application materials, which are not entitled to deference. In *McNair*, the Court held that the agency must explain the "reasons it considers the underlying evidence to be reliable," 537 F.3d at 994, but here MMS simply adopted Shell's conclusions without any independent analysis or discussion of whether Shell's information was reliable and accurate.

C. MMS's Analysis of Icebreaker Noise Contradicts the Record, and MMS Failed to Disclose the Underlying Methodology Used to Reach its Conclusions.

The final flaw in MMS's and Shell's analysis relates to estimates of how much sound will be produced by the icebreakers. A close review of the record reveals that Shell's assumptions contradict its own modeling study, and therefore the information is inaccurate and unreliable. Moreover, even the estimates produced by Shell's contractor are suspect, because MMS failed to provide the underlying data and an explanation of the method used to reach its conclusions, which violates the public disclosure requirements of NEPA. *See, e.g.*, *Idaho Sporting Congress*, 37 F.3d at 1150 (holding that the public must receive underlying data and an explanation of the agency's methodology or else the court is "second guessing an agency's scientific conclusions" and the public loses the "ability to challenge an agency action") (citing 40 C.F.R. § 1502.24). Without this information, the Court cannot verify whether the agency made a "reasoned decision based on its evaluation of the evidence." *Earth Island Institute v. Forest Serv.*, 351 F.3d 1291, 1301 (9th Cir. 2003).

Shell had a contractor conduct a modeling study of the noise to be produced by its icebreaker. ER52-53. MMS notes the results of the modeling study, ER68, which are also repeated in Shell's EIA, ER1002, and IHA Application, ER963. MMS also includes the modeling study, which was performed by JASCO Applied Sciences ("JASCO"), in the Administrative Record. ER1229.

The first fatal error is that Shell appears to have misrepresented JASCO's conclusions in its application. The results of JASCO's work are contained in Table 7 of its report. ER1243. The table lists predicted sound radii for three separate well sites. A comparison of JASCO's work with Shell's application materials reveals that Shell consistently under-reported the modeled sound radii.

At the Crackerjack C well site, for instance, JASCO predicted that the radius for 120 dB would be 18.6 km during the fall (October). ER1243. In the EIA, however, Shell predicted that the radius for 120 dB would be only 4.64 km. ER100. Shell under-reported the predicted radius by approximately 75 percent. At Burger C during October, JASCO predicted a 120 dB radius of 15.5 km, whereas Shell reported 7.5 km. *Compare* ER1243 with ER1002. Shell consistently under-reports each of JASCO's predictions for the 120 dB zone.

MMS then incorporated the incorrect data provided by Shell into its own NEPA analysis, ER68; 90, and again failed to provide any independent review of Shell's application materials. 40 C.F.R. § 1506.5(a)-(b). Instead, MMS simply adopted Shell's estimates, which conflict with the modeling results prepared by JASCO. This is similar to other situations in which the Court has rejected the use of plainly inaccurate or unreliable data. *See, e.g.*, *Idaho Sporting Congress*, 137 F.3d at 1151 (holding that the agency decision was arbitrary and capricious absent an explanation for why data in an underlying report conflicts with data relied upon in the EA); *McNair*, 537 F.3d at 998 (stating that an agency's conclusions are arbitrary and capricious if they are based on "outdated or inaccurate information") (internal citation omitted).

Moreover, MMS failed to disclose the underlying methodology and data used in the modeling. *Idaho Sporting Congress*, 137 F.3d at 1150 (holding that in preparing an EA the agency must "identify any methodologies used and [] make explicit reference by footnote to the scientific and other sources relied upon for conclusions") (citing 40 C.F.R. § 1502.24); *see also Earth Island Institute*, 351 F.3d at 1300-01 (holding that NEPA requires that the "public receive the underlying environmental data from which [an expert] derived her opinion") (quotations omitted). MMS simply restates the results without informing the public of how those estimates were calculated. ER68; 90. Without knowing how this information was prepared, the public has no way of confirming or validating whether those calculations are accurate.

JASCO also failed to provide an adequate explanation of the method it used to calculate icebreaker noise. JASCO claims only that it calculated these figures based on data from 1993 and 1994 "through back propagation * * * using a numerical modeling method which fully accounts for both sea bottom and sea floor reflection." ER1240. JASCO does not describe the modeling method, cite to any published papers that discuss the method, or even provide a name for the method. This is little more than the proverbial "black box," from which numbers emerge without any explanation or justification. Neither the Court nor Petitioners or even MMS has any way of verifying that this information is accurate.

The lack of public disclosure is critical, because the sound radii reported by Shell are suspect and conflict with other evidence in the record. In the Lease Sale 193 EIS, MMS predicted much greater ranges of disturbance. MMS concluded that "detectable effects on movement and behavior are predicted to extend commonly out to radii of 10-30 km (6.2-18.6 mi) and sometimes to 50+ km (31.1 mi). ER1469. MMS noted studies finding that the icebreaker noise was detectable more than 50 km away and that migrating bowheads avoided an icebreaker with a drillship by more than 25 km. *Id.* These figures conflict with Shell's estimates that the zone of influence to 120 dB would extend at most to 7.5 km and in most cases would be approximately 5 km. ER1002. Neither Shell nor MMS explains the difference between the modeling conducted by Shell's contractor and the results of prior studies.

IV. MMS Failed to Take a "Hard Look" at the Potential Cumulative Impacts to Bowhead Whales.

To properly assess the potential impacts to bowhead whales, MMS must consider the cumulative impact of the drilling plans when combined with other present and reasonably foreseeable future actions. 40 C.F.R. § 1508.7. Shell plans to drill multiple wells in the Beaufort and Chukchi Seas in the same season, using the same equipment, all within the migratory corridor of the bowhead whale. Moreover, additional foreseeable industrial operations by Shell and others are likely to occur in 2010 and subsequent years. The cumulative impacts from exposure to multiple activities is a critical issue because, as NMFS has concluded, "[c]oncern is warranted over the distribution in time and space of several noise-producing activities." ER1360.

As the Supreme Court stated, "[o]nly through comprehensive consideration of pending proposals can the agency evaluate different courses of action." *Kleppe v. Sierra Club*, 427 U.S. 390, 410 (1976). The D.C. Circuit relied on this language when it struck down the Department of Interior's five-year OCSLA plan based on its failure to consider the cumulative noise impacts on migratory marine mammals. *NRDC v. Hodel*, 865 F.2d 288, 293 (D.C. Cir. 1988). These mistakes are now repeating themselves, as MMS has similarly failed to take a "hard look" at the cumulative impacts of the two exploration plans on migratory bowhead whales.

MMS's purported analysis of cumulative impacts is virtually identical in the two EAs. MMS assumes that drilling commences in the Beaufort, the fleet of vessels transits to the Chukchi, and then drilling commences in the Chukchi. ER119; 245. Neither Shell nor MMS has in fact clarified when drilling will take place at each location or how Shell will coordinate the operation of its fleet between the two seas.

Using these assumptions, MMS estimates that "there would be at least 11 days between the end of drilling operations in one project area and the commencement of drilling operations in the other project area." ER119; 245. MMS concludes that because of the:

> time required for transition of the drillship from one project area to the other, which is longer than the travel time for migrating species, the same animals would not be expected to be exposed to sound from both drilling operations and individual animals would not be expected to be exposed to long period of sound from the vessels in transit.

Id. At its core, MMS assumes "migrating animals are not expected to sequentially encounter operations in both seas," *id.*, because the whales swim fast enough to avoid multiple exposures.

MMS fails to provide any factual support for its key assumption that whales swim faster than offshore drilling boats. "[V]ague and conclusory statements, without any supporting data, do not constitute a 'hard look' at the environmental consequences of the action as required by NEPA." *Great Basin Mine Watch*, 456

F.3d at 973. MMS's conclusion is belied by evidence in the record establishing that whales migrate neither in a linear fashion, nor at consistent speeds. Both NFMS and MMS have noted that movement and speed of migrating whales "vary widely." ER 1311; 1624. "Some bowheads apparently take their time returning westward during the fall migration, sometimes barely moving at all, with some localities being used as staging areas due to abundant food resources or social reasons." ER1314; *see also* ER1624. NMFS noted a 1989 study in which whales migrated at average speeds of 1.5-2.5 km/h, ER1311, which is far less than the 14.8 km/h (9.2 mph) speed of Shell's vessels, ER 1118. Maps depicting migration patterns of tagged bowhead whales over eleven days in September 2009 show that most whales stayed in the same general geographic area for that period of time, at times doubling back again and again on their previous migration path. ER624-627; *see also* ER2360.

MMS also failed to address the potential cumulative impacts of additional seismic and geophysical work planned for the Beaufort and Chukchi Seas in 2010. ER2358-2359. In the Beaufort, GXT is planning 5,178 km^2 of seismic surveys. ER2513-2562. GXT commissioned a preliminary Environmental Assessment, which was dated July 27, 2009, several months before MMS released the EAs for Shell. ER2513 The report includes proposed seismic survey lines, which overlap with the proposed drill sites at Camden Bay, and mentions both a survey vessel and "large class" icebreaker. ER2522 (Figure 1).[7] Many other industry operations are also planned for 2010, including additional geologic surveys planned by Shell, ER2399, 3D seismic surveys by Statoil in the Chukchi, ER2563[8], and 2D seismic surveys by TGS-NOPEC in the Chukchi, ER2725.

Finally, MMS completely ignores the possibility of future exploratory drilling operations in both the Beaufort and Chukchi Seas. Those operations are more than reasonably foreseeable. Here, Shell has asked for permission to drill a total of five wells but admits it can only drill three wells in 2010. ER118. That leaves at least two wells left over for future years. Moreover, in 2007, Shell submitted an exploration plan for 12 wells in the Beaufort Sea over three years. *Alaska Wilderness League*, 548 F.3d at 818-19, *dismissed as moot* 571 F.3d 859. In the first years alone, Shell proposed to drill four wells at Sivulliq, whereas in 2010 Shell proposes only a single well. ER185. At bare minimum, MMS should have considered the potential combined cumulative impacts of drilling and the associated disturbance in feeding and migratory habitat for at least three years in a row.

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[7] The Court should also note that LGL, GXT's contractor, characterizes the Beaufort as "ice-covered [] from October to June," ER2521, which conflicts markedly with Shell's assumption that no icebreaking would need to occur during the migration, which often lasts into October. *See supra* at 26-27.

[8] MMS noted Statoil's seismic surveys but did not analyze the impacts from this project together with Shell's proposals. ER120-121.

In fact, Shell applied for a multi-year air permit from EPA. EPA explains that the "proposed permit will allow Shell to operate * * * for a multi-year exploration drilling program." ER285. Nevertheless, MMS completely ignored the possibility that Shell would drill for more than one season. MMS concludes that impacts are "temporary," ER226, and "short-term," ER229, but MMS ignores the obvious fact that Shell is planning to drill in these locations for multiple, sequential years.

MMS is likely to rely on earlier NEPA documents to bolster its analysis, but those cannot support a finding of no significance with respect to *these* site-specific drilling proposals. In the Lease Sale 193 EIS, for instance, MMS noted that data on past offshore activities "are inadequate to fully evaluate potential impacts on whales during this period, including the duration of habitat use effects or numbers and types of individuals that do not use high-use areas because of the activities." ER1499. MMS also noted that "the effectiveness of mitigation is not entirely clear, nor is it clear when, or if, the level of activity might become large enough to cause effects that are biologically significant to a large number of individuals." ER1500. MMS acknowledged that "cumulative noise and disturbance associated with oil and gas activities * * * could potentially have an additive or even synergistic effect on bowhead whale habitat use." ER1499. In the end, however, MMS concluded that it "is not clear what the potential range of outcomes might be if multiple disturbance activities occur within focused areas of high importance to the whales." *Id.*

NMFS's 2008 Biological Opinion reached similar conclusions. ER1354. NMFS also emphasized the importance of conducting a site-specific analysis.

> Depending on their timing, location, and number, these activities potentially could produce sufficient noise and disturbance that whales might avoid an area of high value to them and suffer consequences of biological significance. These consequences would be of particular concern if such areas included those used for feeding or resting by large numbers of individuals or by females and calves.

Id.; *see also* ER1357 (NMFS concluding it is not "certain about effects of multiple seismic surveys and disturbance sources of *many years* within areas which may be frequently used for feeding or resting by large numbers of whales") (emphasis added).

Bowhead whales are migratory species that range over large areas with a low reproductive rate. MMS impermissibly narrowed its analysis to the individual exploration plans without taking a comprehensive look at the cumulative impact of those plans in combination with present and reasonably foreseeable future activities. The exploration stage is when "threats to the environment are readily visualized and evaluated." *Village of False Pass*, 565 F.Supp. at 1135. MMS must conduct an appropriate site-specific cumulative impacts analysis *before* the activities commence so it can serve as a "practical contribution to the decision-making process." *Pit River Tribe v. Forest Serv.*, 469 F.3d 768, 785 (9th Cir.

2006) (citing 40 C.F.R. § 1502.2(g)). By waiting until some later time to consider the cumulative impacts of the increasing industrial operations in the Arctic, MMS may foreclose management options or take action only after the impacts have occurred.

V. MMS Failed to Take a "Hard Look" at the Potential Impacts to the Beluga Whale Subsistence Hunt of Point Lay.

The community of Point Lay is located on the Chukchi Sea coast and relies primarily on the subsistence hunt of beluga whales, which is the "pivotal marine mammal resource for the community." ER103; 1460.[9] The beluga hunt makes up more than 60 percent of the community's annual subsistence harvest, and takes place during a narrow window of time within a confined geographic area each year. ER103. Point Lay residents hunt belugas from the middle of June until the middle of July, ER103; 1483; 2074, typically directing beluga whales into Kasegaluk Lagoon during the whales' migration through the Chukchi Sea. *Id.*

Vessel traffic through the Chukchi Sea has long been considered a potential threat to the Point Lay subsistence hunt. Beluga whales "are sensitive to noise and may be displaced from traditional harvest areas by heavy boat traffic or seismic survey noise." ER1483. In 2006, MMS concluded that vessel movement and icebreaking activity in the area "could compromise the Point Lay subsistence

[9] In recent years, Point Lay has also reinitiated a bowhead whale hunt, and the community landed one whale in the spring of 2009. ER2075.

effort," because the belugas' flight response to vessel traffic could "affect their availability to subsistence hunters." *Id.* MMS noted that repeated vessel traffic over several years could lead to long-term interference with the hunt if "belugas acclimated to the noise." *Id.*

Moreover, Shell's planned vessel traffic potentially overlaps the location and timing of Point Lay's subsistence hunt. Shell plans on moving its vessels into the Chukchi Sea on or around July 1st, which is when Point Lay is typically engaged in the annual beluga hunt. ER999. Despite previously acknowledging the risks to Point Lay, MMS failed to consider the potential impacts to the beluga hunt. MMS focused solely on the drilling activity, concluding that "the hunt takes place nearshore, over 60 mi from the drilling activity and the supply/flight corridor." ER110.

At no point in either EA did MMS consider or disclose the fact that vessel transit, ER927, including a drillship, icebreakers and support vessels, through the Chukchi in late June and early July would correspond with and potentially interfere with the beluga hunt at Point Lay. MMS did not disclose whether Shell would have to break ice during this time or if the fleet may have to travel near shore to take advantage of the spring lead system to complete its transit. MMS was simply silent on the issue without conducting any analysis.

VI. MMS Failed to Adequately Analyze the Impacts of Shell's Air Emissions Under NEPA.

The air quality of both the Beaufort and Chukchi Sea drill sites "is considered to be relatively pristine." ER113; 240. Emissions associated with Shell's fleet include thousands of tons of pollutants per year. ER609. The projected emissions are equivalent to millions of cars driving 12,000 miles in a year in the fragile arctic environment. ER630.

It "could easily be said" that even "a marginal degradation of the quality of the air we breathe" is "environmentally significant for purposes" of NEPA. *Public Citizen v. Dept. of Transp.*, 316 F.3d 1002, 1024 (9th Cir. 2003), *overturned on other grounds,* 541 U.S. 752 (2004). The exploration plans here include emissions that will take up large portions of the standards developed to protect air quality by the EPA (called the NAAQS). Nevertheless, with almost no analysis, MMS concluded that impacts to air quality "are expected to be negligible to minor and short term." ER115; 241. MMS's conclusions violate NEPA because the agency failed to consider critical information regarding Shell's emissions and are again based on inadequate and inaccurate data.

A. MMS Cannot Satisfy Its NEPA Obligations by Relying on Future Clean Air Act Permits.

MMS's conclusions on the impacts from thousands of tons of emissions is based largely on the fact that Shell must obtain a Clean Air Act permit from EPA.

ER113-115; 240-241. Whether such a permit is issued or not is irrelevant here because MMS "cannot satisfy [its] obligations under NEPA" by relying on a Clean Air Act permit – "a non-NEPA document" – issued by another agency. *S. Fork Band Council of W. Shoshone of Nev. v. Dept. of Interior*, 588 F.3d 718, 726 (9th Cir. 2009); *League of Wilderness Defenders.*, 549 F.3d at 1219 (rejecting attempts to tier to a non-NEPA document). Rather, MMS must fully analyze the impacts of the permitted activity, and its failure to do so here violates NEPA. *Id.*

MMS does not disclose in the Camden Bay EA that emissions from the operations are above the designated "significance levels" under the OCSLA regulations. 30 C.F.R. § 250.303(f). For example, the "predicted annual average concentration" for NO_2 was "*five times* the significant impact area concentration" in a 50-km radius around the drilling operations, ER1195 (emphasis added), and the air emissions will exceed significance levels for 24-hour PM_{10} and 24-hour SO_2 at a distance of 50 km from the drillship. ER296; 577 ("Highest concentrations from the proposed project exceed MMS significance levels"). While these emissions are "significant" under MMS's own regulations, the agency does not analyze the impacts of these exceedances on air quality and human health deferring instead to the future air permit. ER113-115; 240-241. By failing to consider the impacts of these emissions, MMS "entirely failed to consider an important aspect of the problem" and offered conclusions that "run[] counter to the evidence before the agency." *League of Wilderness Defenders*, 549 F.3d at 1215.

Additionally, MMS's reliance upon Best Available Control Technology ("BACT") to mitigate the impacts is misplaced. For example, modeling results from the Beaufort that *already took into account the application of BACT*, ER578, show large exceedances of the significance levels near the drill ship. MMS' failure to provide or consider this information in the EA also violates NEPA. *Dep't of Transportation v. Public Citizen*, 541 U.S. 752, 768 (2004) (NEPA "guarantees that the relevant information will be made available to the larger audience").

B. MMS Relied on Flawed Data in Its NEPA Analysis.

MMS's "negligible to minor" air quality impacts determinations are based on data and modeling results that EPA determined were flawed. At the beginning of September, EPA required Shell to collect additional background particulate matter data and provide new modeling results to support its Beaufort air permit. ER583-586.[10] While Shell provided updated air emission information in response to requests from MMS for each exploration plan, ER557; 606, that information is based upon the flawed particulate matter data and modeling results rejected by EPA, neither of which were updated until mid-December.

The particulate matter background data is critical to the analysis of impacts,

10 MMS was aware of EPA's concerns about the inadequacies with the modeling and background data before it issued its NEPA decisions. ER582.

especially since the most recent data collected in July, 2009 showed a concentration of $PM_{2.5}$ that was 75 percent higher than the "background concentration used in the permit analysis." ER845. Using the July data would result in modeled *violations of the 24-hour $PM_{2.5}$ NAAQS*. *Id.* Thus, MMS knew that Shell's data was inaccurate and that background pollutant concentrations were much higher than Shell represented. MMS failed to disclose this fact in the EA, and instead concluded that "[b]y demonstrating compliance with the applicable NAAQS * * * [the] permit application shows that Shell would not have a significant adverse impact at the nearest villages along the Beaufort Sea coast, Nuiqsut and Kaktovik." ER240; *see also* ER115 (reaching similar conclusion for Chukchi coastal communities).

In short, the data and modeling results rejected by EPA are the same results relied upon by MMS in its EAs. "To take the required 'hard look' at a proposed project's effects, an agency may not rely on incorrect assumptions or data" in its NEPA document. *Native Ecosystems Council*, 418 F.3d at 964 (citing 40 C.F.R. § 1500.1(b)). By relying on incorrect data, MMS violated NEPA.

C. MMS Failed to Consider Emissions From all Project Operations.

Emissions from many sources of air pollution involved in Shell's exploration activities were not considered by MMS. Emissions from these sources were neither disclosed nor quantified by Shell in its exploration plans or air permit applications. ER289 (discussing the "other vessels that will be associated with Shell's exploratory drilling program"). Whatever limits may exist under the Clean Air Act for regulating air pollutants associated with Shell's operations, those limitations are irrelevant for purposes of analyzing the impacts of the exploration plans under NEPA. *See S. Fork Shoshone*, 588 F.3d at 725.

However, MMS never analyzed the impacts from *all* of Shell's vessels including the oil tanker, barge, shallow water landing craft, monitoring vessel, and the drillship propulsion engine. ER580 ("Shell only did a BACT analysis for the drill rig" and not "all the OCS sources"); ER289. Additionally, the EAs largely ignore emissions from: Shell's fleet traveling hundreds of miles from Dutch Harbor to the drill sites and back again, ER927; movement of the fleet from the Beaufort for the whale hunt in August, ER1045; helicopter travel between the drill sites and shore; and fixed-wing aircraft trips, ER927; 1045. *See* ER114-115; 240-241.

Even the emissions that MMS did consider will, for example, double annual fine particulate matter emissions and more than double 24-hour concentrations of PM_{10} compared to background levels. ER618. Similarly, emissions of NO_2 will also more than double annual concentrations compared to background levels. *Id.* The emissions that were disclosed are substantial, which makes it all the more critical that MMS actually disclose the sum total of Shell's air emissions and analyze them under NEPA before approving the exploration plans. *See Baltimore Gas & Electric Co.*, 462 U.S. at 97 (the NEPA document must give "the public the assurance that the agency 'has indeed considered environmental concerns in its decisionmaking process'") (internal citations omitted); *Kern*, 284 F.3d at 1073 (setting aside NEPA document where the agency failed "to articulate, publicly and in detail, the reasons for and likely effects of [its] management decisions").

D. MMS Failed to Consider the Formation of Secondary Air Pollutants in Its NEPA Analysis.

1. MMS Ignored the Formation of Secondary Particulate Matter.

An important component of air quality and human health impacts associated with the exploration plans is the formation of secondary $PM_{2.5}$, a very harmful Criteria Air Pollutant under the federal Clean Air Act. *See* 72 Fed. Reg. 20,586 (April 25, 2007); ER2128-2129. Emissions of NOx, VOCs, SO_2 and ammonia can form $PM_{2.5}$, which can threaten human health. *Id.* at 20,589; ER2129; *see also* 72 Fed. Reg. at 20,586 ("Health effects * * * include premature death, aggravation of heart and lung disease, and asthma attacks.").

Despite the health risks posed by secondary $PM_{2.5}$, neither the EA, nor Shell's exploration plans analyzes the potential for its formation and the resulting impacts to local Inupiat communities. This is critical because the project emissions include the pollutants (NOx, VOCs, SO_2 and ammonia) that can lead to secondary formation of $PM_{2.5}$, ER2129, and temperature inversions that limit dispersion and create high relative humidity along the North Slope of Alaska that also contribute to the formation of secondary $PM_{2.5}$. ER2129-2130. When Shell's emissions are added to the baseline, the ambient air concentrations of $PM_{2.5}$ will constitute almost 90 percent of the NAAQS. ER618. Therefore, the formation of secondary $PM_{2.5}$ could lead to exceedances of the NAAQS. Nevertheless, MMS failed to consider this "important aspect of the [air quality] problem" in the EA. *League of Wilderness Defenders*, 549 F.3d at 1215.

2. MMS Ignored the Formation of Ozone.

Ozone exposure can lead to adverse health effects in humans ranging from decreased lung function to possible cardiovascular-related mortality and respiratory morbidity. 73 Fed. Reg. 16,436 (Mar. 27, 2008); ER2132. Ground-level ozone is formed from precursor emissions of VOCs and NOx, which originate from a wide variety of sources, both mobile and stationary, and its concentrations are affected by temperature, sunlight, wind, and other weather factors. 73 Fed. Reg. at 16,437; ER1660. MMS failed to explain whether project emissions, either alone or in combination with other emission sources, are likely to result in ozone formation and what impact this could have on human health.[11]

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[11] The only reference to potential ozone formation appears in Shell's EIA, which states, "[t]he proposed project should not have a significant impact on the

The Project includes emissions of NOx and VOCs, ER1003, and when combined with existing industrial emissions, which already total more than 80,000 tons per year of NOx and more than 2,500 tons per year of VOCs, result in substantial emissions of precursor pollutants. ER2134. Additionally, temperature inversions and significant snow cover exist at the drill sites much of the year, ER2134-2135, creating conditions that "trap[] the chemicals close to the ground" and the heat from the "reflected sunlight" starts the "chemical reactions" to create Ozone. ER2133-2136. By failing to conduct *any* analysis of ozone formation from the NOx and VOC emissions combined with other existing sources in the region, MMS "failed to address certain crucial factors" associated with the Project. *Found. for N. Amer. Wild Sheep v. Dep't of Agri.*, 681 F.2d 1172, 1178 (9th Cir. 1982).

VII. MMS Failed to Regulate Shell's Air Emissions in Compliance with OCSLA.

OCSLA requires MMS to ensure that "exploration will not * * * result in pollution, create hazardous or unsafe conditions, [or] unreasonably interfere with other uses of the area * * *." 43 U.S.C. § 1340(g)(3). More specifically, MMS is required to establish regulations "for compliance with the national ambient air quality standards pursuant to the Clean Air Act (42 U.S.C. 7401 *et seq.*), to the

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contribution to ozone formation." ER1149. Shell provides no support for this conclusion.

extent that activities authorized under this subchapter significantly affect the air quality of any State." 43 U.S.C. § 1334(a)(8). Thus, MMS's regulations require specific information and analyses to be submitted along with exploration plans.

With respect to air emissions, if emissions from a facility will "result in an onshore ambient air concentration above the significance level" set by MMS, then those emissions "shall be deemed to significantly affect the air quality of the onshore area * * *." 30 C.F.R. § 250.303(f)(1). Such significant emissions "shall be reduced through the application of BACT." 30 C.F.R. § 250.303(g)(1). In addition, the facility "shall use an approved air quality model to determine whether the emissions of [total suspended particulate] TSP or SO_2 that remain after the application of BACT cause [] maximum allowable increases over the baseline concentrations" set by the EPA. 30 C.F.R. § 250.303(g)(2)(i). If they do, the facility "shall apply whatever additional emission controls are necessary to reduce or off-set the remaining emissions of TSP or SO_2 so that concentrations in the on-shore ambient air * * * do not exceed the maximum allowable increases." 30 C.F.R. § 250.303(g)(2)(ii). These analyses were never performed for Shell's exploration plans, because MMS invoked the only two exemptions available in its regulations to avoid this analysis of Shell's air emissions.

First, while MMS determined that the Beaufort air emissions "exceed the MMS significance levels," ER575-577; ER1149, MMS deemed Shell's operations "temporary," ER193, thus, negating the need for any further review or analysis of the emissions under OCSLA. *See* 30 C.F.R. §§ 250.303(g)(2)(i); 250.302 (stating that "temporary facility" means activities conducted at a location "for less than 3 years").

MMS's conclusion on this point is arbitrary, because MMS failed to consider and reconcile evidence in the record to the contrary. Shell is seeking an air permit for exploration activities that will last for at least three years. *See supra* at 44-45. The exploration plans submitted to MMS indicate Shell intends to engage in exploratory activities during the many years it will take to drill up to four wells on two sites in the Beaufort Sea and at least three or more wells at five drill sites in the Chukchi Sea. ER575-577; 565. In 2007 Shell proposed to drill twelve wells over three years in the Beaufort Sea alone, *Alaska Wilderness League*, 548 F.3d at 818, and these are not the only lease blocks for which Shell holds leases. ER1138. MMS's decision that Shell's operations are "temporary" does not reflect a reasoned consideration of this record evidence.

By arbitrarily delineating Shell's operations as "temporary," MMS never determined "whether the emissions of [total suspended particulate] TSP or SO_2 that remain after the application of BACT cause [] maximum allowable increases over the baseline concentrations" and require the application of "additional emission controls [that] are necessary to reduce or off-set the remaining emissions of TSP or

SO_2" below the "maximum allowable increases." 30 C.F.R. § 250.303(g)(2)(ii). Indeed, MMS never even required Shell to provide the requisite modeling of its emissions at the shoreline. *See* ER576-577 ("We do not know if concentrations at the shoreline exceed the significance levels"); ER618 (Shell's modeling results "near the drillship"). Especially given the proximity of Shell's particulate matter emissions to the 24-hour NAAQS for $PM_{2.5}$, ER618, MMS's decision to classify Shell's operations as temporary and foreclose any further air quality analysis was arbitrary.

Second, MMS's decision that the Chukchi operations are "exempt from further air quality review," because the emissions are *at* or below the "exemption" amounts, ER51, is based on calculations that fail to comply with MMS's rules. The regulations require emissions calculations to be based on "the maximum rated capacity of the equipment * * * under its physical and operational design." 30 C.F.R. § 250.218(a)(3). However, Shell provided emissions calculations "assuming continuous operation at capacity for the entire drilling season per year, *unless limited by owner-requested restriction.*" ER901 (emphasis added). For example, among the owner requested restrictions are limitations on NOx emissions from the ice management fleet and the anchor handler. ER905-906. Shell's failure to include the potential NOx emissions from these vessels (instead of the emissions with the owner requested limits in place) may very well have changed MMS's determination that Shell's operations were "exempt" from further air quality review pursuant to 30 C.F.R. § 250.303(d), because MMS's calculations put the exemption level for NOx at 1,998 tons per year compared to Shell's reported emissions of 1,965 tons per year. ER51.[12]

Additionally, MMS's regulations require emissions calculations "[f]or each source on or associated with the drilling unit * * *." 30 C.F.R. § 250.218(a)(1). Shell failed to include the emissions from the drillship's propulsion engine in its emissions calculations. *See* ER901 ("*Discoverer* emissions are estimated without the propulsion engines operating"). The propulsion engine on the drillship has one of the highest horsepower rating out of the engines Shell is proposing to use, *see e.g.*, ER 611 (propulsion engine rated at 7,200 horsepower compared to next highest rated engine the generator engines at 1,325), and thus, has the greatest potential to emit air pollutants. As these examples illustrate, had MMS' required Shell to provide the information required by MMS regulations, the agency may have reached a different conclusion.

[12] Similarly, Shell proposes using low or ultra-low sulfur fuel to power certain engines. ER905. This owner limitation altered the SO_2 and particulate matter calculations for these engines thereby, also calling into question MMS's exemption determinations.

VIII. The Court Should Vacate MMS's Approval of the Plans and Remand Them to the Agency.

The Native Village of Point Hope discusses the appropriate legal standard regarding relief in this case. Br. at 56-58. The declarations submitted by AEWC provide additional factual support demonstrating harm to AEWC's members and whaling captains, AEWC's scientific and organizational interests, and the local communities of the North Slope. ER2062-2064; 2066-2068; 2069-2072; 2073-2075; 2076-2089; 2122-2139; 2331-2374.

CONCLUSION

Petitioners respectfully request that the Court vacate MMS's approval of the Camden Bay and Chukchi Sea Exploration Plans and remand the decisions back to the agency.

Respectfully submitted,

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March 8, 2010

CERTIFICATE OF COMPLIANCE PURSUANT TO FEDERAL RULE OF APPELLATE PROCEDURE 32(A)(7)(B) AND (C) AND NINTH CIRCUIT RULE RULE 32-1

I, Christopher Winter, certify that:

1. This brief complies with the type-volume limitation of Federal Rule of Appellate Procedure 32(a)(7)(B) because:

This brief contains 13,976 words excluding the parts of the brief exempted by Federal Rule of Appellate Procedure 32(a)(7)(B)(iii).

2. This brief complies with the typeface requirements of Federal Rule of Appellate Procedure 32(a)(5)and the type style requirements of Federal Rule of Appellate Procedure 32(a)(6) because:

This brief has been prepared in a proportionally spaced typeface using Microsoft Office Word for Mac version 11.5.6, font size 14, and Times New Roman type style.

DATED this 8th day of March, 2010.

/s/ Christopher Winter
Christopher Winter
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STATEMENT OF RELATED CASES

Pursuant to Circuit Rule 28-2.6, Petitioners state that other than the consolidated Petitions for Review, they are aware of no other related cases pending in this Court.

PROOF OF SERVICE

I hereby certify that I electronically filed the foregoing with the Clerk of the Court for the United States Court of Appeals for the Ninth Circuit by using the appellate CM/ECF system on March 8 2010. I certify that all participants in the case are registered CM/ECF users and that service will be accomplished by the appellate CM/ECF system.

I further certify that on March, 8, 2010, four copies of the Joint Excerpts of Record compiled on behalf of all Petitioners in consolidated case number 09-73942, 09-73944, 10-70166, and 10-79368 were sent by Federal Express ground to the Clerk of the Court, U.S. Court of Appeals for the Ninth Circuit, James R. Browning Courthouse, 95 Seventh Street, San Francisco, CA 94103-1526. One copy was sent by Federal Express ground to:

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ADDENDUM OF AUTHORITIES

and functions of the Secretary of Transportation relating thereto, to the Department of Homeland Security, and for treatment of related references, see sections 468(b), 551(d), 552(d), and 557 of Title 6, Domestic Security, and the Department of Homeland Security Reorganization Plan of November 25, 2002, as modified, set out as a note under section 542 of Title 6.

§ 1334. Administration of leasing

(a) Rules and regulations; amendment; cooperation with State agencies; subject matter and scope of regulations

The Secretary shall administer the provisions of this subchapter relating to the leasing of the outer Continental Shelf, and shall prescribe such rules and regulations as may be necessary to carry out such provisions. The Secretary may at any time prescribe and amend such rules and regulations as he determines to be necessary and proper in order to provide for the prevention of waste and conservation of the natural resources of the outer Continental Shelf, and the protection of correlative rights therein, and, notwithstanding any other provisions herein, such rules and regulations shall, as of their effective date, apply to all operations conducted under a lease issued or maintained under the provisions of this subchapter. In the enforcement of safety, environmental, and conservation laws and regulations, the Secretary shall cooperate with the relevant departments and agencies of the Federal Government and of the affected States. In the formulation and promulgation of regulations, the Secretary shall request and give due consideration to the views of the Attorney General with respect to matters which may affect competition. In considering any regulations and in preparing any such views, the Attorney General shall consult with the Federal Trade Commission. The regulations prescribed by the Secretary under this subsection shall include, but not be limited to, provisions—

(1) for the suspension or temporary prohibition of any operation or activity, including production, pursuant to any lease or permit (A) at the request of a lessee, in the national interest, to facilitate proper development of a lease or to allow for the construction or negotiation for use of transportation facilities, or (B) if there is a threat of serious, irreparable, or immediate harm or damage to life (including fish and other aquatic life), to property, to any mineral deposits (in areas leased or not leased), or to the marine, coastal, or human environment, and for the extension of any permit or lease affected by suspension or prohibition under clause (A) or (B) by a period equivalent to the period of such suspension or prohibition, except that no permit or lease shall be so extended when such suspension or prohibition is the result of gross negligence or willful violation of such lease or permit, or of regulations issued with respect to such lease or permit;

(2) with respect to cancellation of any lease or permit—

(A) that such cancellation may occur at any time, if the Secretary determines, after a hearing, that—

(i) continued activity pursuant to such lease or permit would probably cause serious harm or damage to life (including fish and other aquatic life), to property, to any mineral (in areas leased or not leased), to the national security or defense, or to the marine, coastal, or human environment;

(ii) the threat of harm or damage will not disappear or decrease to an acceptable extent within a reasonable period of time; and

(iii) the advantages of cancellation outweigh the advantages of continuing such lease or permit force;

(B) that such cancellation shall not occur unless and until operations under such lease or permit shall have been under suspension, or temporary prohibition, by the Secretary, with due extension of any lease or permit term continuously for a period of five years, or for a lesser period upon request of the lessee;

(C) that such cancellation shall entitle the lessee to receive such compensation as he shows to the Secretary as being equal to the lesser of (i) the fair value of the canceled rights as of the date of cancellation, taking account of both anticipated revenues from the lease and anticipated costs, including costs of compliance with all applicable regulations and operating orders, liability for cleanup costs or damages, or both, in the case of an oilspill, and all other costs reasonably anticipated on the lease, or (ii) the excess, if any, over the lessee's revenues, from the lease (plus interest thereon from the date of receipt to date of reimbursement) of all consideration paid for the lease and all direct expenditures made by the lessee after the date of issuance of such lease and in connection with exploration or development, or both, pursuant to the lease (plus interest on such consideration and such expenditures from date of payment to date of reimbursement), except that (I) with respect to leases issued before September 18, 1978, such compensation shall be equal to the amount specified in clause (i) of this subparagraph; and (II) in the case of joint leases which are canceled due to the failure of one or more partners to exercise due diligence, the innocent parties shall have the right to seek damages for such loss from the responsible party or parties and the right to acquire the interests of the negligent party or parties and be issued the lease in question;

(3) for the assignment or relinquishment of a lease;

(4) for unitization, pooling, and drilling agreements;

(5) for the subsurface storage of oil and gas from any source other than by the Federal Government;

(6) for drilling or easements necessary for exploration, development, and production;

(7) for the prompt and efficient exploration and development of a lease area; and

(8) for compliance with the national ambient air quality standards pursuant to the Clean Air Act (42 U.S.C. 7401 et seq.), to the extent that activities authorized under this subchapter significantly affect the air quality of any State.

(b) Compliance with regulations as condition for issuance, continuation, assignment, or other transfer of leases

The issuance and continuance in effect of any lease, or of any assignment or other transfer of any lease, under the provisions of this subchapter shall be conditioned upon compliance with regulations issued under this subchapter.

(c) Cancellation of nonproducing lease

Whenever the owner of a nonproducing lease fails to comply with any of the provisions of this subchapter, or of the lease, or of the regulations issued under this subchapter, such lease may be canceled by the Secretary, subject to the right of judicial review as provided in this subchapter, if such default continues for the period of thirty days after mailing of notice by registered letter to the lease owner at his record post office address.

(d) Cancellation of producing lease

Whenever the owner of any producing lease fails to comply with any of the provisions of this subchapter, of the lease, or of the regulations issued under this subchapter, such lease may be forfeited and canceled by an appropriate proceeding in any United States district court having jurisdiction under the provisions of this subchapter.

(e) Pipeline rights-of-way; forfeiture of grant

Rights-of-way through the submerged lands of the outer Continental Shelf, whether or not such lands are included in a lease maintained or issued pursuant to this subchapter, may be granted by the Secretary for pipeline purposes for the transportation of oil, natural gas, sulphur, or other minerals, or under such regulations and upon such conditions as may be prescribed by the Secretary, or where appropriate the Secretary of Transportation, including (as provided in section 1347(b) of this title) assuring maximum environmental protection by utilization of the best available and safest technologies, including the safest practices for pipeline burial and upon the express condition that oil or gas pipelines shall transport or purchase without discrimination, oil or natural gas produced from submerged lands or outer Continental Shelf lands in the vicinity of the pipelines in such proportionate amounts as the Federal Energy Regulatory Commission, in consultation with the Secretary of Energy, may, after a full hearing with due notice thereof to the interested parties, determine to be reasonable, taking into account, among other things, conservation and the prevention of waste. Failure to comply with the provisions of this section or the regulations and conditions prescribed under this section shall be grounds for forfeiture of the grant in an appropriate judicial proceeding instituted by the United States in any United States district court having jurisdiction under the provisions of this subchapter.

(f) Competitive principles governing pipeline operation

(1) Except as provided in paragraph (2), every permit, license, easement, right-of-way, or other grant of authority for the transportation by pipeline on or across the outer Continental Shelf of oil or gas shall require that the pipeline be operated in accordance with the following competitive principles:

(A) The pipeline must provide open and nondiscriminatory access to both owner and nonowner shippers.

(B) Upon the specific request of one or more owner or nonowner shippers able to provide a guaranteed level of throughput, and on the condition that the shipper or shippers requesting such expansion shall be responsible for bearing their proportionate share of the costs and risks related thereto, the Federal Energy Regulatory Commission may, upon finding, after a full hearing with due notice thereof to the interested parties, that such expansion is within technological limits and economic feasibility, order a subsequent expansion of throughput capacity of any pipeline for which the permit, license, easement, right-of-way, or other grant of authority is approved or issued after September 18, 1978. This subparapraph[1] shall not apply to any such grant of authority approved or issued for the Gulf of Mexico or the Santa Barbara Channel.

(2) The Federal Energy Regulatory Commission may, by order or regulation, exempt from any or all of the requirements of paragraph (1) of this subsection any pipeline or class of pipelines which feeds into a facility where oil and gas are first collected or a facility where oil and gas are first separated, dehydrated, or otherwise processed.

(3) The Secretary of Energy and the Federal Energy Regulatory Commission shall consult with and give due consideration to the views of the Attorney General on specific conditions to be included in any permit, license, easement, right-of-way, or grant of authority in order to ensure that pipelines are operated in accordance with the competitive principles set forth in paragraph (1) of this subsection. In preparing any such views, the Attorney General shall consult with the Federal Trade Commission.

(4) Nothing in this subsection shall be deemed to limit, abridge, or modify any authority of the United States under any other provision of law with respect to pipelines on or across the outer Continental Shelf.

(g) Rates of production

(1) The leasee[2] shall produce any oil or gas, or both, obtained pursuant to an approved development and production plan, at rates consistent with any rule or order issued by the President in accordance with any provision of law.

(2) If no rule or order referred to in paragraph (1) has been issued, the lessee shall produce such oil or gas, or both, at rates consistent with any regulation promulgated by the Secretary of Energy which is to assure the maximum rate of production which may be sustained without loss of ultimate recovery of oil or gas, or both, under sound engineering and economic principles, and which is safe for the duration of the activity covered by the approved plan. The Secretary may permit the lessee to vary such rates if he finds that such variance is necessary.

[1] So in original. Probably should be ''subparagraph''.

[2] So in original. Probably should be ''lessee''.

(h) Federal action affecting outer Continental Shelf; notification; recommended changes

The head of any Federal department or agency who takes any action which has a direct and significant effect on the outer Continental Shelf or its development shall promptly notify the Secretary of such action and the Secretary shall thereafter notify the Governor of any affected State and the Secretary may thereafter recommend such changes in such action as are considered appropriate.

(i) Flaring of natural gas

After September 18, 1978, no holder of any oil and gas lease issued or maintained pursuant to this subchapter shall be permitted to flare natural gas from any well unless the Secretary finds that there is no practicable way to complete production of such gas, or that such flaring is necessary to alleviate a temporary emergency situation or to conduct testing or work-over operations.

(j) Cooperative development of common hydrocarbon-bearing areas

(1) Findings

(A)[3] The Congress of the United States finds that the unrestrained competitive production of hydrocarbons from a common hydrocarbon-bearing geological area underlying the Federal and State boundary may result in a number of harmful national effects, including—

(i) the drilling of unnecessary wells, the installation of unnecessary facilities and other imprudent operating practices that result in economic waste, environmental damage, and damage to life and property;

(ii) the physical waste of hydrocarbons and an unnecessary reduction in the amounts of hydrocarbons that can be produced from certain hydrocarbon-bearing areas; and

(iii) the loss of correlative rights which can result in the reduced value of national hydrocarbon resources and disorders in the leasing of Federal and State resources.

(2) Prevention of harmful effects

The Secretary shall prevent, through the cooperative development of an area, the harmful effects of unrestrained competitive production of hydrocarbons from a common hydrocarbon-bearing area underlying the Federal and State boundary.

(Aug. 7, 1953, ch. 345, § 5, 67 Stat. 464; Pub. L. 95–372, title II, § 204, Sept. 18, 1978, 92 Stat. 636; Pub. L. 101–380, title VI, § 6004(a), Aug. 18, 1990, 104 Stat. 558; Pub. L. 109–58, title III, § 321(a), Aug. 8, 2005, 119 Stat. 694.)

REFERENCES IN TEXT

The Clean Air Act, referred to in subsec. (a)(8), is act July 14, 1955, ch. 360, 69 Stat. 322, as amended, which is classified generally to chapter 85 (§ 7401 et seq.) of Title 42, The Public Health and Welfare. For complete classification of this Act to the Code, see Short Title note set out under section 7401 of Title 42 and Tables.

AMENDMENTS

2005—Subsec. (a)(5). Pub. L. 109–58 inserted "from any source" after "oil and gas".

[3] So in original. No subpar. (B) has been enacted.

1990—Subsec. (j). Pub. L. 101–380 added subsec. (j).

1978—Subsec. (a). Pub. L. 95–372 expanded provisions formerly contained in subsec. (a)(1) so as to include the enforcement of safety and environmental laws and regulations, consultation with the Attorney General and the Federal Trade Commission, and regulations for the suspension or temporary prohibition of any operation or activity including production, the cancellation of leases or permits, the prompt and efficient exploration and development of a lease area, and compliance with the national ambient air quality standards to the extent that activities authorized significantly affect the air quality of any State.

Subsec. (b). Pub. L. 95–372 redesignated as subsec. (b) provisions formerly contained in subsec. (a)(2) conditioning the issuance and continuation of leases or of assignments or other transfers of leases upon compliance with regulations, and struck out provisions that had set a penalty of a fine of not more than $2,000 or imprisonment for not more than six months or both for the knowing and willful violation of rules or regulations promulgated by the Secretary. See section 1350 of this title.

Subsec. (c). Pub. L. 95–372 redesignated as subsec. (c) provisions formerly contained in subsec. (b)(1) covering the cancellation of nonproducing leases for failure of the owner to comply with any of the provisions of this subchapter, or of the lease, or of the regulations issued under this subchapter.

Subsec. (d). Pub. L. 95–372 redesignated as subsec. (d) provisions formerly contained in subsec. (b)(2) covering the cancellation and forfeiture of producing leases for failure of the owner to comply with any of the provisions of this subchapter, the lease, or regulations promulgated under this subchapter.

Subsec. (e). Pub. L. 95–372 redesignated as subsec. (e) provisions formerly contained in subsec. (c) relating to pipeline rights-of-way and inserted provisions relating to regulations prescribed by the Secretary of Transportation and assurances of maximum environmental protection through the use of the best available and safest technologies including the safest practices for pipeline burial, and substituted references to the Federal Energy Regulatory Commission and the Secretary of Energy for existing references to the Federal Power Commission and the Interstate Commerce Commission.

Subsecs. (f) to (i). Pub. L. 95–372 added subsecs. (f) to (i).

EFFECTIVE DATE OF 1990 AMENDMENT

Amendment by Pub. L. 101–380 applicable to incidents occurring after Aug. 18, 1990, see section 1020 of Pub. L. 101–380, set out as an Effective Date note under section 2701 of Title 33, Navigation and Navigable Waters.

TRANSFER OF FUNCTIONS

Functions vested in, or delegated to, Secretary of Energy and Department of Energy under or with respect to subsec. (g)(2) of this section, transferred to, and vested in, Secretary of the Interior, by section 100 of Pub. L. 97–257, 96 Stat. 841, set out as a note under section 7152 of Title 42, The Public Health and Welfare.

Functions of Secretary of the Interior to promulgate regulations under this subchapter which relate to fostering of competition for Federal leases, implementation of alternative bidding systems authorized for award of Federal leases, establishment of diligence requirements for operations conducted on Federal leases, setting of rates for production of Federal leases, and specifying of procedures, terms, and conditions for acquisition and disposition of Federal royalty interests taken in kind, transferred to Secretary of Energy by section 7152(b) of Title 42. Section 7152(b) of Title 42 was repealed by Pub. L. 97–100, title II, § 201, Dec. 23, 1981, 95 Stat. 1407, and functions of Secretary of Energy returned to Secretary of the Interior. See House Report No. 97–315, pp. 25, 26, Nov. 5, 1981.

WEST DELTA FIELD

Section 6004(b) of Pub. L. 101–380 provided that: "Section 5(j) of the Outer Continental Shelf Lands Act [43

U.S.C. 1334(j)], as added by this section, shall not be applicable with respect to Blocks 17 and 18 of the West Delta Field offshore Louisiana.''

KEY LARGO CORAL REEF PRESERVE

Secretary of the Interior to prescribe rules and regulations governing the protection and conservation of the coral and other mineral resources in the area designated Key Largo Coral Reef Preserve, see Proc. No. 3339, Mar. 15, 1960, 25 F.R. 2352, set out as a note under section 461 of Title 16, Conservation.

§ 1335. Validation and maintenance of prior leases

(a) Requirements for validation

The provisions of this section shall apply to any mineral lease covering submerged lands of the outer Continental Shelf issued by any State (including any extension, renewal, or replacement thereof heretofore granted pursuant to such lease or under the laws of such State) if—

(1) such lease, or a true copy thereof, is filed with the Secretary by the lessee or his duly authorized agent within ninety days from August 7, 1953, or within such further period or periods as provided in section 1336 of this title or as may be fixed from time to time by the Secretary;

(2) such lease was issued prior to December 21, 1948, and would have been on June 5, 1950, in force and effect in accordance with its terms and provisions and the law of the State issuing it had the State had the authority to issue such lease;

(3) there is filed with the Secretary, within the period or periods specified in paragraph (1) of this subsection, (A) a certificate issued by the State official or agency having jurisdiction over such lease stating that it would have been in force and effect as required by the provisions of paragraph (2) of this subsection, or (B) in the absence of such certificate, evidence in the form of affidavits, receipts, canceled checks, or other documents that may be required by the Secretary, sufficient to prove that such lease would have been so in force and effect;

(4) except as otherwise provided in section 1336 of this title hereof, all rents, royalties, and other sums payable under such lease between June 5, 1950, and August 7, 1953, which have not been paid in accordance with the provisions thereof, or to the Secretary or to the Secretary of the Navy, are paid to the Secretary within the period or periods specified in paragraph (1) of this subsection, and all rents, royalties, and other sums payable under such lease after August 7, 1953, are paid to the Secretary, who shall deposit such payments in the Treasury in accordance with section 1338 of this title;

(5) the holder of such lease certifies that such lease shall continue to be subject to the overriding royalty obligations existing on August 7, 1953;

(6) such lease was not obtained by fraud or misrepresentation;

(7) such lease, if issued on or after June 23, 1947, was issued upon the basis of competitive bidding;

(8) such lease provides for a royalty to the lessor on oil and gas of not less than 12½ per centum and on sulphur of not less than 5 per centum in amount or value of the production saved, removed, or sold from the lease, or, in any case in which the lease provides for a lesser royalty, the holder thereof consents in writing, filed with the Secretary, to the increase of the royalty to the minimum herein specified;

(9) the holder thereof pays to the Secretary within the period or periods specified in paragraph (1) of this subsection an amount equivalent to any severance, gross production, or occupation taxes imposed by the State issuing the lease on the production from the lease, less the State's royalty interest in such production, between June 5, 1950, and August 7, 1953 and not heretofore paid to the State, and thereafter pays to the Secretary as an additional royalty on the production from the lease, less the United States' royalty interest in such production, a sum of money equal to the amount of the severance, gross production, or occupation taxes which would have been payable on such production to the State issuing the lease under its laws as they existed on August 7, 1953;

(10) such lease will terminate within a period of not more than five years from August 7, 1953 in the absence of production or operations for drilling, or, in any case in which the lease provides for a longer period, the holder thereof consents in writing, filed with the Secretary, to the reduction of such period so that it will not exceed the maximum period herein specified; and

(11) the holder of such lease furnishes such surety bond, if any, as the Secretary may require and complies with such other reasonable requirements as the Secretary may deem necessary to protect the interests of the United States.

(b) Conduct of operations under lease; sulphur rights

Any person holding a mineral lease, which as determined by the Secretary meets the requirements of subsection (a) of this section, may continue to maintain such lease, and may conduct operations thereunder, in accordance with (1) its provisions as to the area, the minerals covered, rentals and, subject to the provisions of paragraphs (8)–(10) of subsection (a) of this section, as to royalties and as to the term thereof and of any extensions, renewals, or replacements authorized therein or heretofore authorized by the laws of the State issuing such lease, or, if oil or gas was not being produced in paying quantities from such lease on or before December 11, 1950, or if production in paying quantities has ceased since June 5, 1950, or if the primary term of such lease has expired since December 11, 1950, then for a term from August 7, 1953 equal to the term remaining unexpired on December 11, 1950, under the provisions of such lease or any extensions, renewals, or replacements authorized therein, or heretofore authorized by the laws of such State, and (2) such regulations as the Secretary may under section 1334 of this title prescribe within ninety days after making his determination that such lease meets the requirements of subsection (a) of this section: *Provided, however,* of such State against the United States arising under, or related to, section 8(g) of the Outer Continental Shelf Lands Act [43 U.S.C. 1337(g)], as it was in effect prior to the date of enactment of this Act [Apr. 7, 1986] and shall vest in such State the right to receive payments as set forth in this section.

''(c) Notwithstanding any other provision of this Act, the amounts due and payable to the State of Louisiana prior to October 1, 1986, under subtitle A of title VIII (Outer Continental Shelf and Related Programs) of this Act [title VIII does not contain a subtitle A, see Short Title of 1986 Amendment note set out under section 1301 of this title] shall remain in their separate accounts in the Treasury of the United States and continue to accrue interest until October 1, 1986, except that the $572,000,000 set forth in subsection 8004(b)(1)(A) of this section shall only accrue interest from April 15, 1986 to October 1, 1986, at which time the Secretary shall immediately distribute such sums with accrued interest to the State of Louisiana.''

§ 1338. Disposition of revenues

All rentals, royalties, and other sums paid to the Secretary or the Secretary of the Navy under any lease on the outer Continental Shelf for the period from June 5, 1950, to date, and thereafter shall be deposited in the Treasury of the United States and credited to miscellaneous receipts.

(Aug. 7, 1953, ch. 345, § 9, 67 Stat. 469.)

§ 1338a. Moneys received as a result of forfeiture by Outer Continental Shelf permittee, lessee, or right-of-way holder; return of excess amounts

Notwithstanding section 3302 of title 31, any moneys on and after November 5, 1990, received as a result of the forfeiture of a bond or other security by an Outer Continental Shelf permittee, lessee, or right-of-way holder which does not fulfill the requirements of its permit, lease, or right-of-way or does not comply with the regulations of the Secretary shall be credited to the royalty and offshore minerals management account of the Minerals Management Service to cover the cost to the United States of any improvement, protection, or rehabilitation work rendered necessary by the action or inaction that led to the forfeiture, to remain available until expended: *Provided further*, That any portion of the moneys so credited shall be returned to the permittee, lessee, or right-of-way holder to the extent that the money is in excess of the amount expended in performing the work necessitated by the action or inaction which led to their receipt or, if the bond or security was forfeited for failure to pay the civil penalty, in excess of the civil penalty imposed.

(Pub. L. 101–512, title I, Nov. 5, 1990, 104 Stat. 1926; Pub. L. 102–381, title I, Oct. 5, 1992, 106 Stat. 1386; Pub. L. 103–332, title I, Sept. 30, 1994, 108 Stat. 2508.)

CODIFICATION

Section enacted as part of the Department of the Interior and Related Agencies Appropriations Act, 1991, and not as part of the Outer Continental Shelf Lands Act which comprises this subchapter.

AMENDMENTS

1994—Pub. L. 103–332 struck out ''or payment of civil penalty'' after ''result of the forfeiture of a bond or other security'', substituted ''royalty and offshore minerals'' for ''leasing and royalty'', and struck out ''or imposition of the civil penalty'' after ''rendered necessary by the action or inaction that led to the forfeiture''.

1992—Pub. L. 102–381 substituted ''shall be credited to the leasing and royalty management account of the Minerals Management Service'' for ''shall be credited to this account''.

CHANGE OF NAME

Title I of Pub. L. 103–332, 108 Stat. 2508, provided in part: ''That where the account title 'Leasing and Royalty Management' appears in any public law, the words 'Leasing and Royalty Management' beginning in fiscal year 1995 and thereafter shall be construed to mean 'Royalty and Offshore Minerals Management'.''

EFFECTIVE DATE OF 1994 AMENDMENT

Title I of Pub. L. 103–332, 108 Stat. 2508, provided that the amendment made by Pub. L. 103–332 substituting ''royalty and offshore minerals'' for ''leasing and royalty'' is effective beginning in fiscal year 1995 and thereafter.

§ 1339. Repealed. Pub. L. 104–185, § 8(b), Aug. 13, 1996, 110 Stat. 1717

Section, act Aug. 7, 1953, ch. 345, § 10, 67 Stat. 469, related to requirements for refund of excess payments.

EFFECTIVE DATE OF REPEAL

Section 8(b) of Pub. L. 104–185 provided in part that the repeal of this section is effective Aug. 13, 1996.

APPLICABILITY OF REPEAL

Repeal of section not applicable to any privately owned minerals or with respect to Indian lands, see sections 9 and 10 of Pub. L. 104–185, set out as an Applicability of 1996 Amendment note under section 1701 of Title 30, Mineral Lands and Mining.

§ 1340. Geological and geophysical explorations

(a) Approved exploration plans

(1) Any agency of the United States and any person authorized by the Secretary may conduct geological and geophysical explorations in the outer Continental Shelf, which do not interfere with or endanger actual operations under any lease maintained or granted pursuant to this subchapter, and which are not unduly harmful to aquatic life in such area.

(2) The provisions of paragraph (1) of this subsection shall not apply to any person conducting explorations pursuant to an approved exploration plan on any area under lease to such person pursuant to the provisions of this subchapter.

(b) Oil and gas exploration

Except as provided in subsection (f) of this section, beginning ninety days after September 18, 1978, no exploration pursuant to any oil and gas lease issued or maintained under this subchapter may be undertaken by the holder of such lease, except in accordance with the provisions of this section.

(c) Plan approval; State concurrence; plan provisions

(1) Except as otherwise provided in this subchapter, prior to commencing exploration pursuant to any oil and gas lease issued or maintained under this subchapter, the holder thereof shall submit an exploration plan to the Secretary for

approval. Such plan may apply to more than one lease held by a lessee in any one region of the outer Continental Shelf, or by a group of lessees acting under a unitization, pooling, or drilling agreement, and shall be approved by the Secretary if he finds that such plan is consistent with the provisions of this subchapter, regulations prescribed under this subchapter, including regulations prescribed by the Secretary pursuant to paragraph (8) of section 1334(a) of this title, and the provisions of such lease. The Secretary shall require such modifications of such plan as are necessary to achieve such consistency. The Secretary shall approve such plan, as submitted or modified, within thirty days of its submission, except that the Secretary shall disapprove such plan if he determines that (A) any proposed activity under such plan would result in any condition described in section 1334(a)(2)(A)(i) of this title, and (B) such proposed activity cannot be modified to avoid such condition. If the Secretary disapproves a plan under the preceding sentence, he may, subject to section 1334(a)(2)(B) of this title, cancel such lease and the lessee shall be entitled to compensation in accordance with the regulations prescribed under section 1334(a)(2)(C)(i) or (ii) of this title.

(2) The Secretary shall not grant any license or permit for any activity described in detail in an exploration plan and affecting any land use or water use in the coastal zone of a State with a coastal zone management program approved pursuant to section 1455 of title 16, unless the State concurs or is conclusively presumed to concur with the consistency certification accompanying such plan pursuant to section 1456(c)(3)(B)(i) or (ii) of title 16, or the Secretary of Commerce makes the finding authorized by section 1456(c)(3)(B)(iii) of title 16.

(3) An exploration plan submitted under this subsection shall include, in the degree of detail which the Secretary may by regulation require—

(A) a schedule of anticipated exploration activities to be understaken;[1]

(B) a description of equipment to be used for such activities;

(C) the general location of each well to be drilled; and

(D) such other information deemed pertinent by the Secretary.

(4) The Secretary may, by regulation, require that such plan be accompanied by a general statement of development and production intentions which shall be for planning purposes only and which shall not be binding on any party.

(d) Drilling permit

The Secretary may, by regulation, require any lessee operating under an approved exploration plan to obtain a permit prior to drilling any well in accordance with such plan.

(e) Plan revisions; conduct of exploration activities

(1) If a significant revision of an exploration plan approved under this subsection is submitted to the Secretary, the process to be used for the approval of such revision shall be the same as set forth in subsection (c) of this section.

(2) All exploration activities pursuant to any lease shall be conducted in accordance with an approved exploration plan or an approved revision of such plan.

(f) Drilling permits issued and exploration plans approved within 90-day period after September 18, 1978

(1) Exploration activities pursuant to any lease for which a drilling permit has been issued or for which an exploration plan has been approved, prior to ninety days after September 18, 1978, shall be considered in compliance with this section, except that the Secretary may, in accordance with section 1334(a)(1)(B) of this title, order a suspension or temporary prohibition of any exploration activities and require a revised exploration plan.

(2) The Secretary may require the holder of a lease described in paragraph (1) of this subsection to supply a general statement in accordance with subsection (c)(4) of this section, or to submit other information.

(3) Nothing in this subsection shall be construed to amend the terms of any permit or plan to which this subsection applies.

(g) Determinations requisite to issuance of permits

Any permit for geological explorations authorized by this section shall be issued only if the Secretary determines, in accordance with regulations issued by the Secretary, that—

(1) the applicant for such permit is qualified;

(2) the exploration will not interfere with or endanger operations under any lease issued or maintained pursuant to this subchapter; and

(3) such exploration will not be unduly harmful to aquatic life in the area, result in pollution, create hazardous or unsafe conditions, unreasonably interfere with other uses of the area, or disturb any site, structure, or object of historical or archeological significance.

(h) Lands beneath navigable waters adjacent to Phillip Burton Wilderness

The Secretary shall not issue a lease or permit for, or otherwise allow, exploration, development, or production activities within fifteen miles of the boundaries of the Phillip Burton Wilderness as depicted on a map entitled ''Wilderness Plan, Point Reyes National Seashore'', numbered 612–90,000–B and dated September 1976, unless the State of California issues a lease or permit for, or otherwise allows, exploration, development, or production activities on lands beneath navigable waters (as such term is defined in section 1301 of this title) of such State which are adjacent to such Wilderness.

(Aug. 7, 1953, ch. 345, § 11, 67 Stat. 469; Pub. L. 95–372, title II, § 206, Sept. 18, 1978, 92 Stat. 647; Pub. L. 99–68, § 1(c), July 19, 1985, 99 Stat. 166.)

AMENDMENTS

1978—Pub. L. 95–372 designated existing provisions as subsec. (a)(1) and added subsecs. (a)(2) to (h).

CHANGE OF NAME

''Phillip Burton Wilderness'' was substituted for ''Point Reyes Wilderness'' in subsec. (h), pursuant to section 1(c) of Pub. L. 99–68.

[1] So in original. Probably should be ''undertaken;''.

TRANSFER OF FUNCTIONS

Functions of Secretary of the Interior to promulgate regulations under this subchapter which relate to fostering of competition for Federal leases, implementation of alternative bidding systems authorized for award of Federal leases, establishment of diligence requirements for operations conducted on Federal leases, setting of rates for production of Federal leases, and specifying of procedures, terms, and conditions for acquisition and disposition of Federal royalty interests taken in kind, transferred to Secretary of Energy by section 7152(b) of Title 42, The Public Health and Welfare. Section 7152(b) of Title 42 was repealed by Pub. L. 97–100, title II, § 201, Dec. 23, 1981, 95 Stat. 1407, and functions of Secretary of Energy returned to Secretary of the Interior. See House Report No. 97–315, pp. 25, 26, Nov. 5, 1981.

§ 1341. Reservation of lands and rights

(a) Withdrawal of unleased lands by President

The President of the United States may, from time to time, withdraw from disposition any of the unleased lands of the outer Continental Shelf.

(b) First refusal of mineral purchases

In time of war, or when the President shall so prescribe, the United States shall have the right of first refusal to purchase at the market price all or any portion of any mineral produced from the outer Continental Shelf.

(c) National security clause

All leases issued under this subchapter, and leases, the maintenance and operation of which are authorized under this subchapter, shall contain or be construed to contain a provision whereby authority is vested in the Secretary, upon a recommendation of the Secretary of Defense, during a state of war or national emergency declared by the Congress or the President of the United States after August 7, 1953, to suspend operations under any lease; and all such leases shall contain or be construed to contain provisions for the payment of just compensation to the lessee whose operations are thus suspended.

(d) National defense areas; suspension of operations; extension of leases

The United States reserves and retains the right to designate by and through the Secretary of Defense, with the approval of the President, as areas restricted from exploration and operation that part of the outer Continental Shelf needed for national defense; and so long as such designation remains in effect no exploration or operations may be conducted on any part of the surface of such area except with the concurrence of the Secretary of Defense; and if operations or production under any lease theretofore issued on lands within any such restricted area shall be suspended, any payment of rentals, minimum royalty, and royalty prescribed by such lease likewise shall be suspended during such period of suspension of operation and production, and the term of such lease shall be extended by adding thereto any such suspension period, and the United States shall be liable to the lessee for such compensation as is required to be paid under the Constitution of the United States.

(e) Source materials essential to production of fissionable materials

All uranium, thorium, and all other materials determined pursuant to paragraph (1) of subsection (b) of section 5 of the Atomic Energy Act of 1946, as amended, to be peculiarly essential to the production of fissionable material, contained, in whatever concentration, in deposits in the subsoil or seabed of the outer Continental Shelf are reserved for the use of the United States.

(f) Helium ownership; rules and regulations governing extraction

The United States reserves and retains the ownership of and the right to extract all helium, under such rules and regulations as shall be prescribed by the Secretary, contained in gas produced from any portion of the outer Continental Shelf which may be subject to any lease maintained or granted pursuant to this subchapter, but the helium shall be extracted from such gas so as to cause no substantial delay in the delivery of gas produced to the purchaser of such gas.

(Aug. 7, 1953, ch. 345, § 12, 67 Stat. 469.)

REFERENCES IN TEXT

Paragraph (1) of subsection (b) of section 5 of the Atomic Energy Act of 1946, as amended, referred to in subsec. (e), is par. (1) of section 5(b) of act Aug. 1, 1946, ch. 724, 60 Stat. 755, which was classified to section 1805 of Title 42, The Public Health and Welfare, prior to the general amendment of the Atomic Energy Act of 1946 by act Aug. 30, 1954, ch. 1073, 68 Stat. 921. See section 2014(z) of Title 42.

KEY LARGO CORAL REEF PRESERVE

Withdrawal of area designated Key Largo Coral Reef Preserve from disposition, see Proc. No. 3339, Mar. 15, 1960, 25 F.R. 2352, set out as a note under section 461 of Title 16, Conservation.

§ 1342. Prior claims as unaffected

Nothing herein contained shall affect such rights, if any, as may have been acquired under any law of the United States by any person in lands subject to this subchapter and such rights, if any, shall be governed by the law in effect at the time they may have been acquired: *Provided, however*, That nothing herein contained is intended or shall be construed as a finding, interpretation, or construction by the Congress that the law under which such rights may be claimed in fact applies to the lands subject to this subchapter or authorizes or compels the granting of such rights in such lands, and that the determination of the applicability or effect of such law shall be unaffected by anything herein contained.

(Aug. 7, 1953, ch. 345, § 14, 67 Stat. 470.)

§ 1343. Repealed. Pub. L. 105–362, title IX, § 901(*l*)(1), Nov. 10, 1998, 112 Stat. 3290

Section, acts Aug. 7, 1953, ch. 345, § 15, 67 Stat. 470; Pub. L. 95–372, title II, § 207, Sept. 18, 1978, 92 Stat. 648; Pub. L. 99–367, § 2(a), July 31, 1986, 100 Stat. 774, related to Secretary's annual report to Congress concerning outer Continental Shelf leasing and production program and promotion of competition in leasing.

erating shall have power to summon witnesses and to require the production of books, papers, documents, and any other evidence. Attendance of witnesses or the production of books, papers, documents, or any other evidence shall be compelled by a similar process, as in the district courts of the United States. Such Secretary, or his designee, shall administer all necessary oaths to any witnesses summoned before such investigation.

(Aug. 7, 1953, ch. 345, § 22, as added Pub. L. 95–372, title II, § 208, Sept. 18, 1978, 92 Stat. 655; amended Pub. L. 105–362, title IX, § 901(*l*)(2), Nov. 10, 1998, 112 Stat. 3290.)

AMENDMENTS

1998—Subsec. (g). Pub. L. 105–362 struck out subsec. (g) which read as follows: ''The Secretary shall, after consultation with the Secretary of the Department in which the Coast Guard is operating, include in his annual report to the Congress required by section 1343 of this title the number of violations of safety regulations reported or alleged, any investigations undertaken, the results of such investigations, and any administrative or judicial action taken as a result of such investigations, and the results of the diving studies conducted under section 1347(e) of this title.''

TRANSFER OF FUNCTIONS

For transfer of authorities, functions, personnel, and assets of the Coast Guard, including the authorities and functions of the Secretary of Transportation relating thereto, to the Department of Homeland Security, and for treatment of related references, see sections 468(b), 551(d), 552(d), and 557 of Title 6, Domestic Security, and the Department of Homeland Security Reorganization Plan of November 25, 2002, as modified, set out as a note under section 542 of Title 6.

REPORT AND RECOMMENDATIONS BY SECRETARY TO CONGRESS FOR TRAINING PROGRAM

Pub. L. 95–372, title VI, § 607, Sept. 18, 1978, 92 Stat. 697, required the Secretary of the Interior, in consultation with the Secretary of the Department in which the Coast Guard is operating, not later than ninety days after Sept. 18, 1978, to prepare and submit to the Congress a training program report concerning individuals employed on any artificial island, installation, or other device located on the Outer Continental Shelf and who, as part of their employment, operate or supervise the operation of pollution-prevention equipment.

§ 1349. Citizens suits, jurisdiction and judicial review

(a) Persons who may bring actions; persons against whom action may be brought; time of action; intervention by Attorney General; costs and fees; security

(1) Except as provided in this section, any person having a valid legal interest which is or may be adversely affected may commence a civil action on his own behalf to compel compliance with this subchapter against any person, including the United States, and any other government instrumentality or agency (to the extent permitted by the eleventh amendment to the Constitution) for any alleged violation of any provision of this subchapter or any regulation promulgated under this subchapter, or of the terms of any permit or lease issued by the Secretary under this subchapter.

(2) Except as provided in paragraph (3) of this subsection, no action may be commenced under subsection (a)(1) of this section—

(A) prior to sixty days after the plaintiff has given notice of the alleged violation, in writing under oath, to the Secretary and any other appropriate Federal official, to the State in which the violation allegedly occurred or is occurring, and to any alleged violator; or

(B) if the Attorney General has commenced and is diligently prosecuting a civil action in a court of the United States or a State with respect to such matter, but in any such action in a court of the United States any person having a legal interest which is or may be adversely affected may intervene as a matter of right.

(3) An action may be brought under this subsection immediately after notification of the alleged violation in any case in which the alleged violation constitutes an imminent threat to the public health or safety or would immediately affect a legal interest of the plaintiff.

(4) In any action commenced pursuant to this section, the Attorney General, upon the request of the Secretary or any other appropriate Federal official, may intervene as a matter of right.

(5) A court, in issuing any final order in any action brought pursuant to subsection (a)(1) or subsection (c) of this section, may award costs of litigation, including reasonable attorney and expert witness fees, to any party, whenever such court determines such award is appropriate. The court may, if a temporary restraining order or preliminary injunction is sought, require the filing of a bond or equivalent security in a sufficient amount to compensate for any loss or damage suffered, in accordance with the Federal Rules of Civil Procedure.

(6) Except as provided in subsection (c) of this section, all suits challenging actions or decisions allegedly in violation of, or seeking enforcement of, the provisions of this subchapter, or any regulation promulgated under this subchapter, or the terms of any permit or lease issued by the Secretary under this subchapter, shall be undertaken in accordance with the procedures described in this subsection. Nothing in this section shall restrict any right which any person or class of persons may have under any other Act or common law to seek appropriate relief.

(b) Jurisdiction and venue of actions

(1) Except as provided in subsection (c) of this section, the district courts of the United States shall have jurisdiction of cases and controversies arising out of, or in connection with (A) any operation conducted on the outer Continental Shelf which involves exploration, development, or production of the minerals, of the subsoil and seabed of the outer Continental Shelf, or which involves rights to such minerals, or (B) the cancellation, suspension, or termination of a lease or permit under this subchapter. Proceedings with respect to any such case or controversy may be instituted in the judicial district in which any defendant resides or may be found, or in the judicial district of the State nearest the place the cause of action arose.

(2) Any resident of the United States who is injured in any manner through the failure of any operator to comply with any rule, regulation, order, or permit issued pursuant to this

subchapter may bring an action for damages (including reasonable attorney and expert witness fees) only in the judicial district having jurisdiction under paragraph (1) of this subsection.

(c) Review of Secretary's approval of leasing program; review of approval, modification or disapproval of exploration or production plan; persons who may seek review; scope of review; certiorari to Supreme Court

(1) Any action of the Secretary to approve a leasing program pursuant to section 1344 of this title shall be subject to judicial review only in the United States Court of Appeal[1] for the District of Columbia.

(2) Any action of the Secretary to approve, require modification of, or disapprove any exploration plan or any development and production plan under this subchapter shall be subject to judicial review only in a United States court of appeals for a circuit in which an affected State is located.

(3) The judicial review specified in paragraphs (1) and (2) of this subsection shall be available only to a person who (A) participated in the administrative proceedings related to the actions specified in such paragraphs, (B) is adversely affected or aggrieved by such action, (C) files a petition for review of the Secretary's action within sixty days after the date of such action, and (D) promptly transmits copies of the petition to the Secretary and to the Attorney General.

(4) Any action of the Secretary specified in paragraph (1) or (2) shall only be subject to review pursuant to the provisions of this subsection, and shall be specifically excluded from citizen suits which are permitted pursuant to subsection (a) of this section.

(5) The Secretary shall file in the appropriate court the record of any public hearings required by this subchapter and any additional information upon which the Secretary based his decision, as required by section 2112 of title 28. Specific objections to the action of the Secretary shall be considered by the court only if the issues upon which such objections are based have been submitted to the Secretary during the administrative proceedings related to the actions involved.

(6) The court of appeals conducting a proceeding pursuant to this subsection shall consider the matter under review solely on the record made before the Secretary. The findings of the Secretary, if supported by substantial evidence on the record considered as a whole, shall be conclusive. The court may affirm, vacate, or modify any order or decision or may remand the proceedings to the Secretary for such further action as it may direct.

(7) Upon the filing of the record with the court, pursuant to paragraph (5), the jurisdiction of the court shall be exclusive and its judgment shall be final, except that such judgment shall be subject to review by the Supreme Court of the United States upon writ of certiorari.

(Aug. 7, 1953, ch. 345, § 23, as added Pub. L. 95–372, title II, § 208, Sept. 18, 1978, 92 Stat. 657; amended Pub. L. 98–620, title IV, § 402(44), Nov. 8, 1984, 98 Stat. 3360.)

[1] So in original. Probably should be "Appeals".

REFERENCES IN TEXT

The Federal Rules of Civil Procedure, referred to in subsec. (a)(5), are set out in the Appendix to Title 28, Judiciary and Judicial Procedure.

AMENDMENTS

1984—Subsec. (d). Pub. L. 98–620 struck out subsec. (d) which provided that except as to causes of action considered by the court to be of greater importance, any action under this section would take precedence on the docket over all other causes of action and would be set for hearing at the earliest practical date and expedited in every way.

EFFECTIVE DATE OF 1984 AMENDMENT

Amendment by Pub. L. 98–620 not applicable to cases pending on Nov. 8, 1984, see section 403 of Pub. L. 98–620, set out as a note under section 1657 of Title 28, Judiciary and Judicial Procedure.

§ 1350. Remedies and penalties

(a) Injunctions, restraining orders, etc.

At the request of the Secretary, the Secretary of the Army, or the Secretary of the Department in which the Coast Guard is operating, the Attorney General or a United States attorney shall institute a civil action in the district court of the United States for the district in which the affected operation is located for a temporary restraining order, injunction, or other appropriate remedy to enforce any provision of this subchapter, any regulation or order issued under this subchapter, or any term of a lease, license, or permit issued pursuant to this subchapter.

(b) Civil penalties; hearing

(1) Except as provided in paragraph (2), if any person fails to comply with any provision of this subchapter, or any term of a lease, license, or permit issued pursuant to this subchapter, or any regulation or order issued under this subchapter, after notice of such failure and expiration of any reasonable period allowed for corrective action, such person shall be liable for a civil penalty of not more than $20,000 for each day of the continuance of such failure. The Secretary may assess, collect, and compromise any such penalty. No penalty shall be assessed until the person charged with a violation has been given an opportunity for a hearing. The Secretary shall, by regulation at least every 3 years, adjust the penalty specified in this paragraph to reflect any increases in the Consumer Price Index (all items, United States city average) as prepared by the Department of Labor.

(2) If a failure described in paragraph (1) constitutes or constituted a threat of serious, irreparable, or immediate harm or damage to life (including fish and other aquatic life), property, any mineral deposit, or the marine, coastal, or human environment, a civil penalty may be assessed without regard to the requirement of expiration of a period allowed for corrective action.

(c) Criminal penalties

Any person who knowingly and willfully (1) violates any provision of this subchapter, any term of a lease, license, or permit issued pursuant to this subchapter, or any regulation or order issued under the authority of this subchapter designed to protect health, safety, or

(1) The methods you used for determining this information; and

(2) Your plans for treating, storing, and downhole disposal of these wastes at your drilling location(s).

(b) *Projected ocean discharges.* If any of your solid and liquid wastes will be discharged overboard, or are planned discharges from manmade islands:

(1) A table showing the name, projected amount, and rate of discharge for each waste type; and

(2) A description of the discharge method (such as shunting through a downpipe, etc.) you will use.

(c) *National Pollutant Discharge Elimination System (NPDES) permit.* (1) A discussion of how you will comply with the provisions of the applicable general NPDES permit that covers your proposed exploration activities; or

(2) A copy of your application for an individual NPDES permit. Briefly describe the major discharges and methods you will use for compliance.

(d) *Modeling report.* The modeling report or the modeling results (if you modeled the discharges of your projected solid or liquid wastes when developing your EP), or a reference to such report or results if you have already submitted it to the Regional Supervisor.

(e) *Projected cooling water intake.* A table for each cooling water intake structure likely to be used by your proposed exploration activities that includes a brief description of the cooling water intake structure, daily water intake rate, water intake through screen velocity, percentage of water intake used for cooling water, mitigation measures for reducing impingement and entrainment of aquatic organisms, and biofouling prevention measures.

§ 250.218 What air emissions information must accompany the EP?

The following air emissions information, as applicable, must accompany your EP:

(a) *Projected emissions.* Tables showing the projected emissions of sulphur dioxide (SO_2), particulate matter in the form of PM_{10} and $PM_{2.5}$ when applicable, nitrogen oxides (NO_X), carbon monoxide (CO), and volatile organic compounds (VOC) that will be generated by your proposed exploration activities.

(1) For each source on or associated with the drilling unit (including well test flaring and well protection structure installation), you must list:

(i) The projected peak hourly emissions;

(ii) The total annual emissions in tons per year;

(iii) Emissions over the duration of the proposed exploration activities;

(iv) The frequency and duration of emissions; and

(v) The total of all emissions listed in paragraphs (a)(1)(i) through (iv) of this section.

(2) You must provide the basis for all calculations, including engine size and rating, and applicable operational information.

(3) You must base the projected emissions on the maximum rated capacity of the equipment on the proposed drilling unit under its physical and operational design.

(4) If the specific drilling unit has not yet been determined, you must use the maximum emission estimates for the type of drilling unit you will use.

(b) *Emission reduction measures.* A description of any proposed emission reduction measures, including the affected source(s), the emission reduction control technologies or procedures, the quantity of reductions to be achieved, and any monitoring system you propose to use to measure emissions.

(c) *Processes, equipment, fuels, and combustibles.* A description of processes, processing equipment, combustion equipment, fuels, and storage units. You must include the characteristics and the frequency, duration, and maximum burn rate of any well test fluids to be burned.

(d) *Distance to shore.* Identification of the distance of your drilling unit from the mean high water mark (mean higher high water mark on the Pacific coast) of the adjacent State.

(e) *Non-exempt drilling units.* A description of how you will comply with § 250.303 when the projected emissions of SO_2, PM, NO_X, CO, or VOC, that will be generated by your proposed exploration activities, are greater than the respective emission exemption amounts ''E'' calculated using the formulas in § 250.303(d). When MMS requires air quality modeling, you must use the guidelines in Appendix W of 40 CFR part 51 with a model approved by the Director. Submit the best available meteorological information and data consistent with the model(s) used.

(f) *Modeling report.* A modeling report or the modeling results (if § 250.303 requires you to use an approved air quality model to model projected air emissions in developing your EP), or a reference to such a report or results if you have already submitted it to the Regional Supervisor.

§ 250.219 What oil and hazardous substance spills information must accompany the EP?

The following information regarding potential spills of oil (see definition under 30 CFR 254.6) and hazardous substances (see definition under 40 CFR part 116) as applicable, must accompany your EP:

(a) *Oil spill response planning.* The material required under paragraph (a)(1) or (a)(2) of this section:

(1) An Oil Spill Response Plan (OSRP) for the facilities you will use to conduct your exploration activities prepared according to the requirements of 30 CFR part 254, subpart B; or

(2) Reference to your approved regional OSRP (see 30 CFR 254.3) to include:

(i) A discussion of your regional OSRP;

(ii) The location of your primary oil spill equipment base and staging area;

(iii) The name(s) of your oil spill removal organization(s) for both equipment and personnel;

(iv) The calculated volume of your worst case discharge scenario (see 30 CFR 254.26(a)), and a comparison of the appropriate worst case discharge scenario in your approved regional OSRP with the worst case discharge scenario that could result from your proposed exploration activities; and

(v) A description of the worst case discharge scenario that could result from your proposed exploration activities (see 30 CFR 254.26(b), (c), (d), and (e)).

(b) *Modeling report.* If you model a potential oil or hazardous substance spill in developing your EP, a modeling report or the modeling results, or a reference to such report or results if you have already submitted it to the Regional Supervisor.

§ 250.220 If I propose activities in the Alaska OCS Region, what planning information must accompany the EP?

If you propose exploration activities in the Alaska OCS Region, the following planning information must accompany your EP:

(a) *Emergency plans.* A description of your emergency plans to respond to a blowout, loss or disablement of a drilling unit, and loss of or damage to support craft.

(b) *Critical operations and curtailment procedures.* Critical operations and curtailment procedures for your exploration activities. The procedures must identify ice conditions, weather, and other constraints under which the exploration activities will either be curtailed or not proceed.

§ 250.221 What environmental monitoring information must accompany the EP?

The following environmental monitoring information, as applicable, must accompany your EP:

(a) *Monitoring systems.* A description of any existing and planned monitoring systems that are measuring, or will measure, environmental conditions or will provide project-specific data or information on the impacts of your exploration activities.

(b) *Incidental takes.* If there is reason to believe that protected species may be incidentally taken by planned exploration activities, you must describe how you will monitor for incidental take of:

(1) Threatened and endangered species listed under the ESA and

(2) Marine mammals, as appropriate, if you have not already received authorization for incidental take as may be necessary under the MMPA.

(c) *Flower Garden Banks National Marine Sanctuary (FGBNMS).* If you propose to conduct exploration activities within the protective zones of the FGBNMS, a description of your provisions for monitoring the impacts of an facility's daily operations report, as appropriate, and reported to the District Manager.

[53 FR 10690, Apr. 1, 1988, as amended at 56 FR 32099, July 15, 1991. Redesignated at 63 FR 29479, May 29, 1998]

§ 250.301 Inspection of facilities.

(a) Drilling and production facilities shall be inspected daily or at intervals approved or prescribed by the District Manager to determine if pollution is occurring. Necessary maintenance or repairs shall be made immediately. Records of such inspections and repairs shall be maintained at the facility or at a nearby manned facility for 2 years.

[53 FR 10690, Apr. 1, 1988, as amended at 62 FR 13996, Mar. 25, 1997. Redesignated at 63 FR 29479, May 29, 1998]

§ 250.302 Definitions concerning air quality.

For purposes of §§ 250.303 and 250.304 of this part:

Air pollutant means any combination of agents for which the Environmental Protection Agency (EPA) has established, pursuant to section 109 of the Clean Air Act, national primary or secondary ambient air quality standards.

Attainment area means, for any air pollutant, an area which is shown by monitored data or which is calculated by air quality modeling (or other methods determined by the Administrator of EPA to be reliable) not to exceed any primary or secondary ambient air quality standards established by EPA.

Best available control technology (BACT) means an emission limitation based on the maximum degree of reduction for each air pollutant subject to regulation, taking into account energy, environmental and economic impacts, and other costs. The BACT shall be verified on a case-by-case basis by the Regional Supervisor and may include reductions achieved through the application of processes, systems, and techniques for the control of each air pollutant.

Emission offsets means emission reductions obtained from facilities, either onshore or offshore, other than the facility or facilities covered by the proposed Exploration Plan or Development and Production Plan.

Existing facility is an OCS facility described in an Exploration Plan or a Development and Production Plan submitted or approved prior to June 2, 1980.

Facility means any installation or device permanently or temporarily attached to the seabed which is used for exploration, development, and production activities for oil, gas, or sulphur and which emits or has the potential to emit any air pollutant from one or more sources. All equipment directly associated with the installation or device shall be considered part of a single facility if the equipment is dependent on, or affects the processes of, the installation or device. During production, multiple installations or devices will be considered to be a single facility if the installations or devices are directly related to the production of oil, gas, or sulphur at a single site. Any vessel used to transfer production from an offshore facility shall be considered part of the facility while physically attached to it.

Nonattainment area means, for any air pollutant, an area which is shown by monitored data or which is calculated by air quality modeling (or other methods determined by the Administrator of EPA to be reliable) to exceed any primary or secondary ambient air quality standard established by EPA.

Projected emissions means emissions, either controlled or uncontrolled, from a source(s).

Source means an emission point. Several sources may be included within a single facility.

Temporary facility means activities associated with the construction of platforms offshore or with facilities related to exploration for or development of offshore oil and gas resources which are conducted in one location for less than 3 years.

Volatile organic compound (VOC) means any organic compound which is emitted to the atmosphere as a vapor. The unreactive compounds are exempt from the above definition.

[53 FR 10690, Apr. 1, 1988, as amended at 56 FR 32100, July 15, 1991. Redesignated and amended at 63 FR 29479, 29485, May 29, 1998]

§ 250.303 Facilities described in a new or revised Exploration Plan or Development and Production Plan.

(a) *New plans.* All Exploration Plans and Development and Production Plans shall include the information required to make the necessary findings under paragraphs (d) through (i) of this section, and the lessee shall comply with the requirements of this section as necessary.

(b) *Applicability of § 250.303 to existing facilities.* (1) The Regional Supervisor may review any Exploration Plan or Development and Production Plan to determine whether any facility described in the plan should be subject to review under this section and has the potential to significantly affect the air quality of an onshore area. To make these decisions, the Regional Supervisor shall consider the distance of the facility from shore, the size of the facility, the number of sources planned for the facility and their operational status, and the air quality status of the onshore area.

(2) For a facility identified by the Regional Supervisor in paragraph (b)(1) of this section, the Regional Supervisor shall require the lessee to refer to the information required in § 250.218 or § 250.249 of this part and to submit only that information required to make the necessary findings under paragraphs (d) through (i) of this section. The lessee shall submit this information within 120 days of the Regional Supervisor's determination or within a longer period of time at the discretion of the Regional Supervisor. The lessee shall comply with the requirements of this section as necessary.

(c) *Revised facilities.* All revised Exploration Plans and Development and Production Plans shall include the information required to make the necessary findings under paragraphs (d) through (i) of this section. The lessee shall comply with the requirements of this section as necessary.

(d) *Exemption formulas.* To determine whether a facility described in a new, modified, or revised Exploration Plan or Development and Production Plan is exempt from further air quality review, the lessee shall use the highest annual-total amount of emissions from the facility for each air pollutant calculated in § 250.249(a) or § 250.218(a) of this part and compare these emissions to the emission exemption amount ''E'' for each air pollutant calculated using the following formulas: $E=3400D^{2/3}$ for carbon monoxide (CO); and $E=33.3D$ for total suspended particulates (TSP), sulphur dioxide (SO_2), nitrogen oxides (NO_X), and VOC (where E is the emission exemption amount expressed in tons per year, and D is the distance of the proposed facility from the closest onshore area of a State expressed in statute miles). If the amount of these projected emissions is less than or equal to the emission exemption amount ''E'' for the air pollutant, the facility is exempt from further air quality review required under paragraphs (e) through (i) of this section.

(e) *Significance levels.* For a facility not exempt under paragraph (d) of this section for air pollutants other than VOC, the lessee shall use an approved air quality model to determine whether the projected emissions of those air pollutants from the facility result in an onshore ambient air concentration above the following significance levels:

SIGNIFICANCE LEVELS: AIR POLLUTANT CONCENTRATIONS (µG/M³)

Air pollutant	Averaging time (hours)				
	Annual	24	8	3	1
SO_2	1	5	......	25	....
TSP	1	5	......	....	....
NO_2	1	....	......	....	....
CO	....	....	500	....	2,000

(f) *Significance determinations.* (1) The projected emissions of any air pollutant other than VOC from any facility which result in an onshore ambient air concentration above the significance level determined under paragraph (e) of this section for that air pollutant, shall be deemed to significantly affect the air quality of the onshore area for that air pollutant.

(2) The projected emissions of VOC from any facility which is not exempt under paragraph (d) of this section for that air pollutant shall be deemed to significantly affect the air quality of the onshore area for VOC.

(g) *Controls required.* (1) The projected emissions of any air pollutant other than VOC from any facility, except a temporary facility, which significantly affect the quality of a nonattainment area, shall be fully reduced. This shall be done through the application of BACT and, if additional reductions are necessary, through the application of additional emission controls or through the acquisition of offshore or onshore offsets.

(2) The projected emissions of any air pollutant other than VOC from any facility which significantly affect the air quality of an attainment or unclassifiable area shall be reduced through the application of BACT.

(i) Except for temporary facilities, the lessee also shall use an approved air quality model to determine whether the emissions of TSP or SO_2 that remain after the application of BACT cause the following maximum allowable increases over the baseline concentrations established in 40 CFR 52.21 to be exceeded in the attainment or unclassifiable area:

MAXIMUM ALLOWABLE CONCENTRATION INCREASES (μG/M³)

Air pollutant	Averaging times		
	Annual mean [1]	24-hour maximum	3-hour maximum
Class I:			
TSP	5	10	....
SO_2	2	5	25
Class II:			
TSP	19	37	....
SO_2	20	91	512
Class III:			
TSP	37	75	....
SO_2	40	182	700

[1] For TSP—geometric; For SO_2—arithmetic.

No concentration of an air pollutant shall exceed the concentration permitted under the national secondary ambient air quality standard or the concentration permitted under the national primary air quality standard, whichever concentration is lowest for the air pollutant for the period of exposure. For any period other than the annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one onshore location.

(ii) If the maximum allowable increases are exceeded, the lessee shall apply whatever additional emission controls are necessary to reduce or offset the remaining emissions of TSP or SO_2 so that concentrations in the onshore ambient air of an attainment or unclassifiable area do not exceed the maximum allowable increases.

(3)(i) The projected emissions of VOC from any facility, except a temporary facility, which significantly affect the onshore air quality of a nonattainment area shall be fully reduced. This shall be done through the application of BACT and, if additional reductions are necessary, through the application of additional emission controls or through the acquisition of offshore or onshore offsets.

(ii) The projected emissions of VOC from any facility which significantly affect the onshore air quality of an attainment area shall be reduced through the application of BACT.

(4)(i) If projected emissions from a facility significantly affect the onshore air quality of both a nonattainment and an attainment or unclassifiable area, the regulatory requirements applicable to projected emissions significantly affecting a nonattainment area shall apply.

(ii) If projected emissions from a facility significantly affect the onshore air quality of more than one class of attainment area, the lessee must reduce projected emissions to meet the maximum allowable increases specified for each class in paragraph (g)(2)(i) of this section.

(h) *Controls required on temporary facilities.* The lessee shall apply BACT to reduce projected emissions of any air pollutant from a temporary facility which significantly affect the air quality of an onshore area of a State.

(i) *Emission offsets.* When emission offsets are to be obtained, the lessee must demonstrate that the offsets are equivalent in nature and quantity to the projected emissions that must be reduced after the application of BACT; a binding commitment exists between the lessee and the owner or owners of the source or sources; the appropriate air quality control jurisdiction has been notified of the need to revise the State Implementation Plan to include the information regarding the offsets; and the required offsets come from sources which affect the air quality of the area significantly affected by the lessee's offshore operations.

(j) *Review of facilities with emissions below the exemption amount.* If, during the review of a new, modified, or revised Exploration Plan or Development and Production Plan, the Regional Supervisor determines or an affected State submits information to the Regional Supervisor which demonstrates, in the judgment of the Regional Supervisor, that projected emissions from an otherwise exempt facility will, either individually or in combination with other facilities in the area, significantly affect the air quality of an onshore area, then the Regional Supervisor shall require the lessee to submit additional information to determine whether emission control measures are necessary. The lessee shall be given the opportunity to present information to the Regional Supervisor which demonstrates that the exempt facility is not significantly affecting the air quality of an onshore area of the State.

(k) *Emission monitoring requirements.* The lessee shall monitor, in a manner approved or prescribed by the Regional Supervisor, emissions from the facility. The lessee shall submit this information monthly in a manner and form approved or prescribed by the Regional Supervisor.

(l) *Collection of meteorological data.* The Regional Supervisor may require the lessee to collect, for a period of time and in a manner approved or prescribed by the Regional Supervisor, and submit meteorological data from a facility.

[53 FR 10690, Apr. 1, 1988; 53 FR 19856, May 31, 1988; 53 FR 26067, July 11, 1988. Redesignated and amended at 63 FR 29479, 29485, May 29, 1998; 70 FR 51518, Aug. 30, 2005]

§ 250.304 Existing facilities.

(a) *Process leading to review of an existing facility.* (1) An affected State may request that the Regional Supervisor supply basic emission data from existing facilities when such data are needed for the updating of the State's emission inventory. In submitting the request, the State must demonstrate that similar offshore and onshore facilities in areas under the State's jurisdiction are also included in the emission inventory.

(2) The Regional Supervisor may require lessees of existing facilities to submit basic emission data to a State submitting a request under paragraph (a)(1) of this section.

(3) The State submitting a request under paragraph (a)(1) of this section may submit information from its emission inventory which indicates that emissions from existing facilities may be significantly affecting the air quality of the onshore area of the State. The lessee shall be given the opportunity to present information to the Regional Supervisor which demonstrates that the facility is not significantly affecting the air quality of the State.

(4) The Regional Supervisor shall evaluate the information submitted under paragraph (a)(3) of this section and shall determine, based on the basic emission data, available meteorological data, and the distance of the facility or facilities from the onshore area, whether any existing facility has the potential to significantly affect the air quality of the onshore area of the State.

(5) If the Regional Supervisor determines that no existing facility has the potential to significantly affect the air quality of the onshore area of the State submitting information under paragraph (a)(3) of this section, the Regional Supervisor shall notify the State of and explain the reasons for this finding.

(6) If the Regional Supervisor determines that an existing facility has the potential to significantly affect the air quality of an onshore area of the State submitting information under paragraph (a)(3) of this section, the Regional Supervisor shall require the lessee to refer to the information requirements under § 250.218 or 250.249 of this part and submit only that information required to make the necessary findings under paragraphs (b) through (e) of this section. The lessee shall submit this information within 120 days of the Regional Supervisor's determination or within a longer period of time at the discretion of the Regional Supervisor. The lessee shall comply with the requirements of this section as necessary.

(b) *Exemption formulas.* To determine whether an existing facility is exempt from further air quality review, the

PART 1500—PURPOSE, POLICY, AND MANDATE

AUTHORITY: NEPA, the Environmental Quality Improvement Act of 1970, as amended (42 U.S.C. 4371 *et seq.*), sec. 309 of the Clean Air Act, as amended (42 U.S.C. 7609) and E.O. 11514, Mar. 5, 1970, as amended by E.O. 11991, May 24, 1977).

SOURCE: 43 FR 55990, Nov. 28, 1978, unless otherwise noted.

§ 1500.1 Purpose.

(a) The National Environmental Policy Act (NEPA) is our basic national charter for protection of the environment. It establishes policy, sets goals (section 101), and provides means (section 102) for carrying out the policy. Section 102(2) contains ''action-forcing'' provisions to make sure that federal agencies act according to the letter and spirit of the Act. The regulations that follow implement section 102(2). Their purpose is to tell federal agencies what they must do to comply with the procedures and achieve the goals of the Act. The President, the federal agencies, and the courts share responsibility for enforcing the Act so as to achieve the substantive requirements of section 101.

(b) NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. Most important, NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail.

(c) Ultimately, of course, it is not better documents but better decisions that count. NEPA's purpose is not to generate paperwork—even excellent paperwork—but to foster excellent action. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment. These regulations provide the direction to achieve this purpose.

§ 1500.2 Policy.

Federal agencies shall to the fullest extent possible:

(a) Interpret and administer the policies, regulations, and public laws of the United States in accordance with the policies set forth in the Act and in these regulations.

(b) Implement procedures to make the NEPA process more useful to decisionmakers and the public; to reduce paperwork and the accumulation of extraneous background data; and to emphasize real environmental issues and alternatives. Environmental impact statements shall be concise, clear, and to the point, and shall be supported by evidence that agencies have made the necessary environmental analyses.

(c) Integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively.

(d) Encourage and facilitate public involvement in decisions which affect the quality of the human environment.

(e) Use the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment.

(f) Use all practicable means, consistent with the requirements of the Act and other essential considerations of national policy, to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects of their actions upon the quality of the human environment.

§ 1500.3 Mandate.

Parts 1500 through 1508 of this title provide regulations applicable to and binding on all Federal agencies for implementing the procedural provisions of the National Environmental Policy Act of 1969, as amended (Pub. L. 91–190, 42 U.S.C. 4321 *et seq.*) (NEPA or the Act)

Act are infused into the ongoing programs and actions of the Federal Government. It shall provide full and fair discussion of significant environmental impacts and shall inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment. Agencies shall focus on significant environmental issues and alternatives and shall reduce paperwork and the accumulation of extraneous background data. Statements shall be concise, clear, and to the point, and shall be supported by evidence that the agency has made the necessary environmental analyses. An environmental impact statement is more than a disclosure document. It shall be used by Federal officials in conjunction with other relevant material to plan actions and make decisions.

§ 1502.2 Implementation.

To achieve the purposes set forth in § 1502.1 agencies shall prepare environmental impact statements in the following manner:

(a) Environmental impact statements shall be analytic rather than encyclopedic.

(b) Impacts shall be discussed in proportion to their significance. There shall be only brief discussion of other than significant issues. As in a finding of no significant impact, there should be only enough discussion to show why more study is not warranted.

(c) Environmental impact statements shall be kept concise and shall be no longer than absolutely necessary to comply with NEPA and with these regulations. Length should vary first with potential environmental problems and then with project size.

(d) Environmental impact statements shall state how alternatives considered in it and decisions based on it will or will not achieve the requirements of sections 101 and 102(1) of the Act and other environmental laws and policies.

(e) The range of alternatives discussed in environmental impact statements shall encompass those to be considered by the ultimate agency decisionmaker.

(f) Agencies shall not commit resources prejudicing selection of alternatives before making a final decision (§ 1506.1).

(g) Environmental impact statements shall serve as the means of assessing the environmental impact of proposed agency actions, rather than justifying decisions already made.

§ 1502.3 Statutory requirements for statements.

As required by sec. 102(2)(C) of NEPA environmental impact statements (§ 1508.11) are to be included in every recommendation or report.

On proposals (§ 1508.23).

For legislation and (§ 1508.17).

Other major Federal actions (§ 1508.18).

Significantly (§ 1508.27).

Affecting (§§ 1508.3, 1508.8).

The quality of the human environment (§ 1508.14).

§ 1502.4 Major Federal actions requiring the preparation of environmental impact statements.

(a) Agencies shall make sure the proposal which is the subject of an environmental impact statement is properly defined. Agencies shall use the criteria for scope (§ 1508.25) to determine which proposal(s) shall be the subject of a particular statement. Proposals or parts of proposals which are related to each other closely enough to be, in effect, a single course of action shall be evaluated in a single impact statement.

(b) Environmental impact statements may be prepared, and are sometimes required, for broad Federal actions such as the adoption of new agency programs or regulations (§ 1508.18). Agencies shall prepare statements on broad actions so that they are relevant to policy and are timed to coincide with meaningful points in agency planning and decisionmaking.

(c) When preparing statements on broad actions (including proposals by more than one agency), agencies may find it useful to evaluate the proposal(s) in one of the following ways:

(1) Geographically, including actions occurring in the same general location, such as body of water, region, or metropolitan area.

(2) Generically, including actions which have relevant similarities, such

may be incorporated by reference unless it is reasonably available for inspection by potentially interested persons within the time allowed for comment. Material based on proprietary data which is itself not available for review and comment shall not be incorporated by reference.

§ 1502.22 Incomplete or unavailable information.

When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking.

(a) If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement.

(b) If the information relevant to reasonably foreseeable significant adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known, the agency shall include within the environmental impact statement:

(1) A statement that such information is incomplete or unavailable; (2) a statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment; (3) a summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment, and (4) the agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community. For the purposes of this section, ''reasonably foreseeable'' includes impacts which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason.

(c) The amended regulation will be applicable to all environmental impact statements for which a Notice of Intent (40 CFR 1508.22) is published in the FEDERAL REGISTER on or after May 27, 1986. For environmental impact statements in progress, agencies may choose to comply with the requirements of either the original or amended regulation.

[51 FR 15625, Apr. 25, 1986]

§ 1502.23 Cost-benefit analysis.

If a cost-benefit analysis relevant to the choice among environmentally different alternatives is being considered for the proposed action, it shall be incorporated by reference or appended to the statement as an aid in evaluating the environmental consequences. To assess the adequacy of compliance with section 102(2)(B) of the Act the statement shall, when a cost-benefit analysis is prepared, discuss the relationship between that analysis and any analyses of unquantified environmental impacts, values, and amenities. For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis and should not be when there are important qualitative considerations. In any event, an environmental impact statement should at least indicate those considerations, including factors not related to environmental quality, which are likely to be relevant and important to a decision.

§ 1502.24 Methodology and scientific accuracy.

Agencies shall insure the professional integrity, including scientific integrity, of the discussions and analyses in environmental impact statements. They shall identify any methodologies used and shall make explicit reference by footnote to the scientific and other sources relied upon for conclusions in the statement. An agency may place discussion of methodology in an appendix.

a judicial action which is not final, the agency shall so specify.

§ 1506.4 Combining documents.

Any environmental document in compliance with NEPA may be combined with any other agency document to reduce duplication and paperwork.

§ 1506.5 Agency responsibility.

(a) *Information.* If an agency requires an applicant to submit environmental information for possible use by the agency in preparing an environmental impact statement, then the agency should assist the applicant by outlining the types of information required. The agency shall independently evaluate the information submitted and shall be responsible for its accuracy. If the agency chooses to use the information submitted by the applicant in the environmental impact statement, either directly or by reference, then the names of the persons responsible for the independent evaluation shall be included in the list of preparers (§ 1502.17). It is the intent of this paragraph that acceptable work not be redone, but that it be verified by the agency.

(b) *Environmental assessments.* If an agency permits an applicant to prepare an environmental assessment, the agency, besides fulfilling the requirements of paragraph (a) of this section, shall make its own evaluation of the environmental issues and take responsibility for the scope and content of the environmental assessment.

(c) *Environmental impact statements.* Except as provided in §§ 1506.2 and 1506.3 any environmental impact statement prepared pursuant to the requirements of NEPA shall be prepared directly by or by a contractor selected by the lead agency or where appropriate under § 1501.6(b), a cooperating agency. It is the intent of these regulations that the contractor be chosen solely by the lead agency, or by the lead agency in cooperation with cooperating agencies, or where appropriate by a cooperating agency to avoid any conflict of interest. Contractors shall execute a disclosure statement prepared by the lead agency, or where appropriate the cooperating agency, specifying that they have no financial or other interest in the outcome of the project. If the document is prepared by contract, the responsible Federal official shall furnish guidance and participate in the preparation and shall independently evaluate the statement prior to its approval and take responsibility for its scope and contents. Nothing in this section is intended to prohibit any agency from requesting any person to submit information to it or to prohibit any person from submitting information to any agency.

§ 1506.6 Public involvement.

Agencies shall:

(a) Make diligent efforts to involve the public in preparing and implementing their NEPA procedures.

(b) Provide public notice of NEPA-related hearings, public meetings, and the availability of environmental documents so as to inform those persons and agencies who may be interested or affected.

(1) In all cases the agency shall mail notice to those who have requested it on an individual action.

(2) In the case of an action with effects of national concern notice shall include publication in the FEDERAL REGISTER and notice by mail to national organizations reasonably expected to be interested in the matter and may include listing in the *102 Monitor.* An agency engaged in rulemaking may provide notice by mail to national organizations who have requested that notice regularly be provided. Agencies shall maintain a list of such organizations.

(3) In the case of an action with effects primarily of local concern the notice may include:

(i) Notice to State and areawide clearinghouses pursuant to OMB Circular A–95 (Revised).

(ii) Notice to Indian tribes when effects may occur on reservations.

(iii) Following the affected State's public notice procedures for comparable actions.

(iv) Publication in local newspapers (in papers of general circulation rather than legal papers).

(v) Notice through other local media.

(vi) Notice to potentially interested community organizations including small business associations.

§ 1508.6 Council.

Council means the Council on Environmental Quality established by title II of the Act.

§ 1508.7 Cumulative impact.

Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

§ 1508.8 Effects.

Effects include:

(a) Direct effects, which are caused by the action and occur at the same time and place.

(b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.

§ 1508.9 Environmental assessment.

Environmental assessment:

(a) Means a concise public document for which a Federal agency is responsible that serves to:

(1) Briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact.

(2) Aid an agency's compliance with the Act when no environmental impact statement is necessary.

(3) Facilitate preparation of a statement when one is necessary.

(b) Shall include brief discussions of the need for the proposal, of alternatives as required by section 102(2)(E), of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.

§ 1508.10 Environmental document.

Environmental document includes the documents specified in § 1508.9 (environmental assessment), § 1508.11 (environmental impact statement), § 1508.13 (finding of no significant impact), and § 1508.22 (notice of intent).

§ 1508.11 Environmental impact statement.

Environmental impact statement means a detailed written statement as required by section 102(2)(C) of the Act.

§ 1508.12 Federal agency.

Federal agency means all agencies of the Federal Government. It does not mean the Congress, the Judiciary, or the President, including the performance of staff functions for the President in his Executive Office. It also includes for purposes of these regulations States and units of general local government and Indian tribes assuming NEPA responsibilities under section 104(h) of the Housing and Community Development Act of 1974.

§ 1508.13 Finding of no significant impact.

Finding of no significant impact means a document by a Federal agency briefly presenting the reasons why an action, not otherwise excluded (§ 1508.4), will not have a significant effect on the human environment and for which an environmental impact statement therefore will not be prepared. It shall include the environmental assessment or a summary of it and shall note any other environmental documents related to it (§ 1501.7(a)(5)). If the assessment is included, the finding need not

DTS#1065 1101-02a(2)

Shell Oil Company
Marvin E. Odum
President
One Shell Plaza
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Houston, TX 77252-2463

June 24, 2009

The Honorable Kenneth L. Salazar
Secretary of the Interior
U.S. Department of the Interior
1849 C Street, NW
Room 6156
Washington, DC 20240

Re: Shell Offshore Inc.
2010 Exploration Plans for Alaska OCS

Dear Mr. Secretary,

When you and I met in April, I offered to brief you on Shell's 2010 exploration plans for the Beaufort (Camden Bay) and Chukchi Seas after the plans had been submitted to the Department of Interior (DOI). Because our schedules have not allowed for a meeting, I would like to provide information in this letter.

Before describing our 2010 exploration drilling plans, I would like to make two points. First, the resource potential in Alaska's OCS is huge. Exploration should be permitted in order to validate the promising seismic data that we have gathered. Second, the suggestion by some that another Environmental Impact Statement (EIS) is required before an Alaska OCS exploration plan can be approved should be rejected. An EIS is not required at the lease exploration stage.

The Outer Continental Shelf Lands Act (OCSLA) establishes the regulatory framework for offshore leasing, exploration and development. It identifies four distinct stages (formulation of a five-year leasing plan; lease sales; lease exploration; and lease development and production) and assigns each phase discrete informational, review and approval criteria. By statute, at the lease exploration stage, review of an exploration plan must be completed on an expedited schedule, and approval (with modifications and further review as necessary to ensure compliance with the OCSLA, implementing regulations, and the lease) is to be granted *unless* MMS makes a specific finding that serious harm or damage would result. Given the history of exploration activities completed in the Arctic without harm or damage to the marine environment, and the extensive body of studies and analyses supporting those earlier Arctic exploration programs, no such finding is reasonable in regard to Shell's proposed plans.

I am taking the liberty of attaching a detailed description of the OCSLA framework. This paper describes the thorough and robust regulatory requirements of the OCSLA and other applicable federal statutes that ensure offshore activities are conducted in an environmentally responsible manner. The paper also reviews the historic Arctic OCS exploration activities, scientific studies and NEPA analyses that support Shell's proposed 2010 exploration plans. I highlight the fact that, pursuant to the OCSLA, before any development and production activities occur on an offshore lease, additional NEPA analyses must be done, including a new EIS.

Overview: Shell's 2010 Exploration Plans

Both the Chukchi Exploration Plan and the Camden Bay Plan propose a single season of exploration drilling activities. The drilling operations will be conducted using the latest drilling technologies and techniques. Shell will use the *Discoverer* drillship, a modern drillship purpose-built for operating in Arctic OCS waters with state-of-the-art drilling and well control equipment. Additional vessels for ice management, anchor handling, and crew transport and supplies will support the *Discoverer*. An oil spill response barge and tug will be staged nearby with a full complement of crew and oil spill response equipment. Additional vessels will implement Shell's marine mammal monitoring and mitigation program and support scientific research efforts. All support vessels will be ice-class and specifically equipped for operating in Arctic waters.

Camden Bay: 2010 Exploration Plan

In its Camden Bay Plan, which is discussed in greater detail in the attached paper, Shell has proposed and analyzed the impacts of two potential exploration wells at locations more than 12 miles offshore in the Beaufort Sea. Over the past 30 years, 12 exploration wells have been drilled in the immediate vicinity of these two sites without harm or damage to the marine environment. The Camden Bay Plan includes a mid-season break in activities to accommodate the fall subsistence whale hunts of the villages of Kaktovik and Nuiqsut.

Chukchi Sea: 2010 Exploration Plan

As described in the attached paper, Shell has proposed and analyzed the impacts of five potential exploration well locations in its Chukchi Plan. All of these well locations are more than 60 statute miles offshore in the Chukchi Sea. Five exploration wells have been previously drilled in the general area of Shell's proposed locations without harm or damage to the marine environment.

Weather and/or ice conditions in the Chukchi and Beaufort Seas (as well as at the specific locations) will dictate Shell's exploration operations. Shell's two separate Plans are intended to provide alternatives in the event it cannot access priority locations. Given the short season for Arctic operations, even assuming Shell encounters no adverse weather and/or ice conditions or other unanticipated delays, Shell could not drill more than three of the proposed wells in the Beaufort and Chukchi Seas combined.

In closing, I invite you to meet with the Shell Alaska team when you are in the state this summer to understand more fully the work that they have underway. Pete Slaiby, General Manager of Shell Alaska, would welcome the opportunity to meet with you to discuss both Shell's business plans as well as the engagements we continue to have with stakeholders in the communities in which we are working.

I look forward to seeing you again soon. In the meantime, please do not hesitate to contact me if I can be of assistance to you on this or any other matter.

Very truly yours,

Marvin E. Odum

Attachment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
SEATTLE, WASHINGTON

STATEMENT OF BASIS FOR PROPOSED OUTER CONTINENTAL SHELF PREVENTION OF SIGNIFICANT DETERIORATION PERMIT NO. R10OCS/PSD-AK-2010-01

SHELL OFFSHORE INC.
FRONTIER DISCOVERER DRILLSHIP
BEAUFORT SEA EXPLORATION DRILLING PROGRAM

Date of Proposed Permit: February 17, 2010 repository for these materials. The barge itself would not emit air pollutants but would need to be delivered and removed from the site using a tug. The tug emission units have not been included in the emission inventory or modeling analysis. However, Shell has stated that the barge will be delivered before drilling begins and removed after drilling has ceased. The impacts from this activity should be similar to impacts from the anchor setting and retrieval activities which also occur before an after drilling.

If Shell utilizes a tug/barge combination, the requirements are contained in Condition N which prohibits any emissions from the barge and prohibits the tug from attaching to the Discoverer.

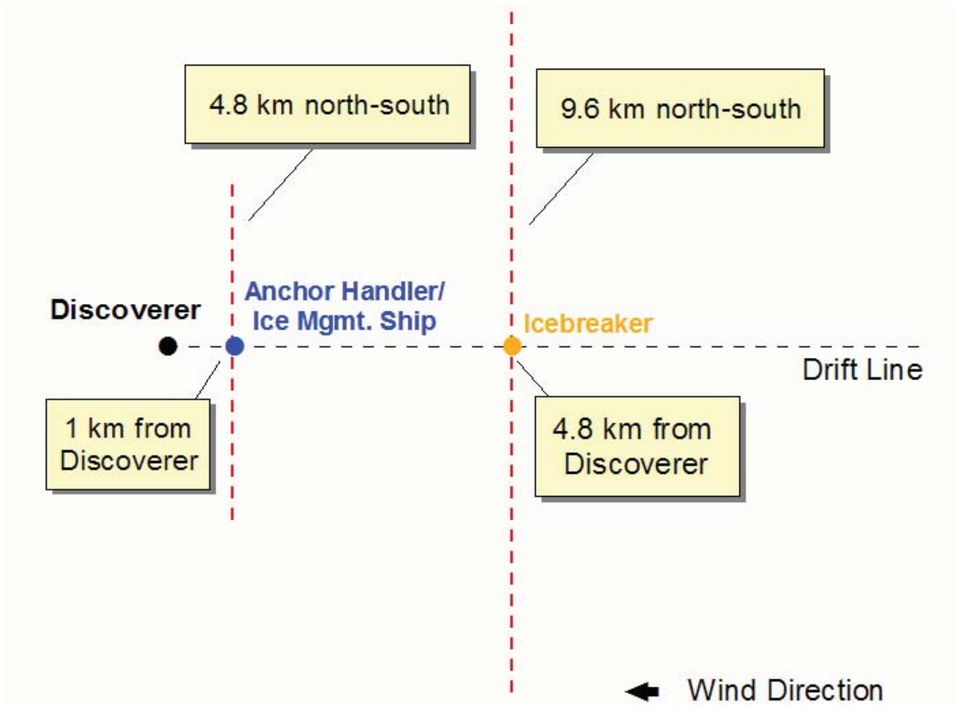
3.5 Ice Management and Anchor Handling Fleet

Shell's ice management and anchor handling fleet is expected to consist of two leased ships: an icebreaker (referred to in the permit as Icebreaker #1) and an anchor handler/icebreaker (referred to in the permit as Icebreaker #2). The purpose of this fleet is to manage the ice in the area of the Discoverer, which involves deflecting or in extreme cases breaking up any ice floes that could impact the ship when it is drilling, and to handle the ship's anchors during connection to and disconnection from the seabed.

The ice floe frequency and intensity is unpredictable and could range from no ice to ice sufficiently dense that the fleet has insufficient capacity and the Discoverer would need to disconnect from its anchors and move off site. Based on statistics on ice at the Sivulliq drill site in the Beaufort Sea, Shell estimates that ice breaking capability in its lease holdings in Lease Area lease sales 195 (March 2005) and 202 (April 2007) in the Beaufort Sea would only be required 38 percent of the time. For the remainder of the time the ice management and anchor handling fleet would be beyond the 25-mile radius from the Discoverer in a warm stack mode (anchored and occupied).

The primary driver of the ice floe is the wind, so the ice management ships are typically upwind of the Discoverer when managing the ice. Figure 3-1 depicts the approximate locations of the primary icebreaker and the anchor handler/ice management vessel when used to break one-year ice.

Figure 3-1: Ice Management and Anchor Handling Ships Locations for Breaking of One Year Ice



For addressing one-year ice, Icebreaker #1 will typically be positioned from 4,800 meters to 19,000 meters upwind on the drift line and Icebreaker #2 will be located from 1,000 meters to 9,600 meters upwind from the Discoverer. In the case of thick ice, the width of the Icebreaker #1 swath will be about 3 miles (4.8 kilometers) to either side of the drift line and Icebreaker #2 will be moving laterally 1.5 miles (2.4 kilometers) to either side of the drift line. The actual vessel distances will be determined by the ice floe speed, size, thickness, and character, and wind forecast. Although 2-meter-thick first-year ice is not expected, it might occur and the ice management fleet would be moving at near full speed to fragment this ice. Occasionally there may be multi-year ice ridges which are expected to be broken at a much slower speed than used for first-year ice. Multi-year ice may be broken by riding up onto the ice so that the weight of the icebreaker on top of the ice breaks it.

Shell will be leasing Icebreaker #1 from year to year. Consequently, the vessel used as Icebreaker #1 may change from year to year. In order to accommodate this uncertainty, Shell has requested that the permit allow for a generic Icebreaker #1. Furthermore, the fleet could consist of either two vessels or only one vessel, depending on availability of ships and ice conditions. At present, there are only a limited number of eligible ships. Murmansk Shipping of Russia operates one vessels – the Vladimir Ignatjuk. Viking leases four vessels – the Odin, the Tor, the Balder and the Vidor. The Talagy is available from Smit, and lastly, the Nordica and Fennica are operated by Finstaship.

The emission sources from all of these icebreaker class vessels consist of diesel engines for propulsion power, general purpose generators, boilers and incinerators. To accommodate the requested flexibility, Shell has developed a single generic equipment list for Icebreaker #1 that cannot be exceeded for any vessel. Table 3-3 shows the maximum aggregate ratings for each category of equipment for Icebreaker #1.

Table 3-3: Maximum Aggregate Rating of Emission Sources for Icebreaker #1

Description	Make and Model	Maximum Aggregate Rating
Propulsion Engines	Various	28,400 hp
Generator Engine(s)	Various	2,800 hp
Heat Boiler(s)	Various	10 MMBtu/hr
Incinerator	Various	154 lbs/hr

To execute Icebreaker #2 duties, Shell will use one of two vessels – either the Tor Viking or a new icebreaker being built to their specifications by Edison Chouest. Each of these vessels will be equipped with SCR on the main engines, which will result in a substantial reduction of NO_X. (Shell Beaufort Permit Application 01/18/10). The latter vessel has not been named yet but is referred to by the shipbuilder as Hull 247. Throughout this permit documentation, this vessel is also referred to as Hull 247, with the intent that all permit conditions for Icebreaker #2 continue to apply to the vessel, even once it has had its name changed from Hull 247 to its permanent name. Table 3-4 shows the maximum aggregate ratings for each category of equipment for Icebreaker #2.

Table 3-4: Maximum Aggregate Rating of Emission Sources for Icebreaker #2

Description	Make and Model	Maximum Aggregate Rating
Tor Viking		
Propulsion Engines	Various	17,660 hp
Generator Engine(s)	Various	2,336 hp
Heat Boiler(s)	Various	1.37 MMBtu/hr
Incinerator	Various	151 lbs/hr
Hull 247		
Propulsion Engines	Various	24,000 kW
Heat Boiler(s)	Various	4.00 MMBtu/hr
Incinerator	Various	151 lbs/hr

Marine propulsion engines, such as those used on the icebreakers, have a different emission profile than the more common engines found on board the Discoverer. The most cited reference on emissions from marine engines is a document published by Lloyds Register. However, a more recent publication compares emission factors from Lloyds with more recent emissions data from the Swedish Environmental Research Institute (Corbett 11/23/04). To ensure that the emissions factors used in the emission inventory for this project were adequately conservative, EPA compared these data with emissions data from AP-42 (see Reference Table 3 in Appendix A) and used the highest value for each pollutant.

In addition, Shell has requested limits on $PM_{2.5}$ of 40.2 lbs/hr and on PM_{10} of 45.8 lbs/hr (Shell Beaufort Permit Application 01/18/10) on Icebreaker #1, and 11.4 lbs/hr and 11.7 lbs/hr, respectively, for Icebreaker #2. The proposed permit requires candidate icebreakers to have their emission units tested prior to each drilling season. If a candidate vessel's uncontrolled emissions of $PM_{2.5}$ or PM_{10} are above these values, then the vessel cannot be used as either Icebreaker #1 or Icebreaker #2. Conditions O.1 and P.1 contain these equipment capacity and emission limits for the two icebreakers.

In calculating emissions from the emission sources on board the icebreakers, all sources, except the propulsion engines, were assumed to operate at 100 percent of rated capacity. The propulsion engines were represented at operating at no more than 80 percent of rated capacity. Consequently, these restrictions are imposed in Conditions O.2 and P.2.

Based on the emissions calculations and resultant modeling, Shell has determined a maximum usage for the icebreakers. The emissions, fuel and power output limits associated with this scenario are contained in Conditions O.3, O.4, O.5, O.6, P.3, P.4, P.5 and P.6. The fuel and power output limits in Condition O.5, O.6, P.5 and P.6 will also serve to limit emissions of the other pollutants, such as CO. The fuel limits on the icebreakers are based on Shell's estimate of its need for icebreaking capacity and ensure that emissions from the icebreakers will not exceed the modeled emissions scenarios.

Based on Shell's application, there is no scenario where either of the icebreakers is attached to the drillship, thereby becoming part of the OCS source.[11] Consequently, the permit contains Conditions O.8 and P.10 that prohibit such attachment. The permit does allow each icebreaker to approach near the Discoverer for purposes of transferring equipment and crew to and from the Discoverer. Otherwise, Condition O.7 requires Icebreaker #1 to, consistent with the modeling analysis, operate outside of a 4800 meter long cone centered on the centerline of the Discoverer. Similarly, Condition P.7 requires Icebreaker #2 to operate outside of a 1000 meter long cone centered on the centerline of the Discoverer, except during anchor handling operations (Condition P.8) and bow washing (Condition P.9). The air quality impact analysis was based on these operating scenarios and therefore the permit contains emission limits to impose these restrictions. The icebreakers are allowed to transit through their respective cones as these transit events will be of short duration and at low loads as they will not be conducting icebreaking activities within the cones. Modeled impacts from transit events in the area would therefore be expected to be lower than the worst case scenario.

In order to assure compliance with the emission limits, both icebreakers are required to test their emission sources each drilling season as provided in Conditions O.10 and P.12. Conditions O.11 and P13 require Shell to conduct monitoring, recordkeeping and reporting to assure compliance with the substantive conditions of Sections O and P of the permit.

[11] As discussed in Section 2.5.1 above, EPA does not consider Icebreaker #2 to be physicially attached to the Discoverer within the meaning of the definition of "OCS source" in 40 C.F.R. § 55.2 during the time it is assisting the Discoverer in the anchor setting and retrieval process.

IN THE UNITED STATES COURT OF APPEALS FOR THE NINTH CIRCUIT

Nos. 09-73942, 09-73944, 10-70166, 10-70368

NATIVE VILLAGE OF POINT HOPE, ALASKA WILDERNESS LEAGUE, CENTER FOR BIOLOGICAL DIVERSITY, DEFENDERS OF WILDLIFE, NATIONAL AUDUBON SOCIETY, NATURAL RESOURCES DEFENSE COUNCIL, NORTHERN ALASKA ENVIRONMENTAL CENTER, OCEANA, OCEAN CONSERVANCY, PACIFIC ENVIRONMENT, RESISTING ENVIRONMENTAL DESTRUCTION ON INDIGENOUS LANDS, SIERRA CLUB, and THE WILDERNESS SOCIETY,

ALASKA ESKIMO WHALING COMMISSION and INUPIAT COMMUNITY OF THE ARCTIC SLOPE,

Petitioners,

v.

KEN SALAZAR, Secretary of the Interior, and MINERALS MANAGEMENT SERVICE,

Respondents,

SHELL OFFSHORE INC., SHELL GULF OF MEXICO INC., and STATE OF ALASKA,

Respondents-Intervenors

ON CONSOLIDATED PETITIONS FOR REVIEW OF DECISIONS OF MINERALS MANAGEMENT SERVICE, PURSUANT TO 43 U.S.C. § 1349(c)

BRIEF OF RESPONDENTS

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TABLE OF CONTENTS

Page

Page

Page

Page

1. There Is No Credible Evidence That Planned Drilling in the Beaufort Sea Will Interfere with the Bowhead's Use of Important Feeding or Resting Areas.

Petitioners heavily rely (AEWC Br. 21-23, 25, 46; NVPH Br. 8-9) on a single statement found in the NMFS 2008 BiOp, which considered the impact of all potential oil and gas exploration activities in the Beaufort and Chukchi Seas, including seismic surveys.[6] NMFS stated that (ER1354):

> Depending on their timing, location, and number, these activities potentially could produce sufficient noise and disturbance that whales might avoid an area of high value to them and suffer consequences of biological significance. These consequences would be of particular concern if such areas included those used for feeding or resting by large numbers of individuals or by females and calves.

Petitioners allege that the area around the proposed Beaufort Sea well sites "provide[s] important feeding and resting habitat for bowhead whales, particularly mothers and calves, during their fall migration," and contend that MMS was

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[6] Petitioners often rely on general statements by NMFS and others regarding impacts from oil and gas activities, without specifying which types of activities are the subject of the statements. This can be misleading, because the concerns raised often have to do with seismic surveys, which are not involved here. The record clearly indicates that exploratory drilling such as proposed here produces continuous sound, and is less disturbing to whales and other species, than seismic surveys. *See* ER169 ("[m]onitoring of previous OCS exploration drilling in the Camden Bay area and sound modeling indicate that the level of sound expected to be produced by the proposed exploration drilling and support operations is very low compared to high-energy seismic survey sound sources"); *see also* ER17, 169.

required to consider the possibility that bowheads might be "excluded" from this allegedly important feeding and resting area. AEWC Br. 9; NVPH Br. 23-25.

MMS considered the issue of bowhead feeding behavior. The Beaufort EA recognizes that bowheads are expected to be found feeding in both deep and shallow waters areas of the Beaufort Sea, and that "they may be found feeding near drill site locations." ER213, Table 3.1.2-4. Indeed, "bowhead whales may be found feeding throughout the Beaufort Sea," but "considering the limited size of the area potentially affected by the proposed activities relative to the total area of the Beaufort Sea OCS," MMS does not expect any population-level effects. ER210-11. The EIS to which the Beaufort EA tiers (*see* ER229) contains an extensive discussion of bowhead feeding behavior, summarizing the scientific studies on this issue as well as knowledge gained from Native subsistence hunters. ER1624-29. The EIS finds that "[i]t is likely that bowheads continue to feed opportunistically where food is available as they migrate across the Alaskan Beaufort Sea." ER1624. It finds based on studies that, "[t]he average bowhead does not spend much time in the eastern Alaskan Beaufort Sea and, thus, does not feed there extensively." ER1627. The EIS describes a 2002 study by Richardson and Thompson of bowhead feeding in the eastern and central Beaufort Sea, including the Canadian and the eastern Alaskan Beaufort, which found that this area generally provides only a small percentage (average of 2.4%, with a maximum of 7%) of bowhead's annual energy requirements, and that use of the area for feeding varies widely in time and space, depending on zooplankton availability and other factors. ER1629. The 2008 NMFS BiOp also contains a thorough summary and analysis of studies on bowhead feeding. ER1314-1317. It similarly concludes that "[a]vailable data indicate that bowhead whales feed in both the Chukchi and Beaufort Sea Planning Areas and that this use varies in degree among years, among individuals, and among areas," and that "[i]t is likely that bowheads continue to feed opportunistically where food is available as they move through or about the Alaskan Beaufort Sea." ER1314. None of the studies indicate that the area where Shell intends to drill has particular importance for bowhead whales for feeding. In contrast, studies have suggested that a region west of Point Barrow is a "focal feeding area for bowheads." ER1310, 1314.

Petitioners cannot point to a single study that concludes that the area around Shell's Beaufort Sea prospects is an important bowhead feeding area. Petitioners simply cite the results of bowhead monitoring from 2007 and 2008, done in conjunction with seismic surveys, indicating that feeding was a common behavior among bowheads in that area in these two years. *See* ER1411 (data on 45 bowheads gathered in the Central Beaufort during the period August 22 - October

3, 2007, indicated that "feeding was the most commonly recorded activity (51%; Fig. 5.83) with traveling (27%) and resting (13%) also frequently observed"; ER1286 (data on 13 bowhead whales in Camden Bay area during September showed "feeding was the most commonly observed activity (77% of observations), followed by resting (15%), and traveling (8%)"). As the 2007 monitoring report noted, however, "the areas where seismic surveys were conducted in 2007 have not been heavily used by feeding whales during earlier years and long-term studies have noted relatively low sighting rates of bowheads in that area." ER1413. MMS was aware of these monitoring reports (*see* SER271 and ER213), but reasonably did not find that they showed that the areas around Shell's proposed drill sites were "important" feeding areas for bowhead. The surveys simply confirm that bowheads may use any area for feeding when food is plentiful. Observation of feeding behavior in a particular area does not lead to a conclusion that the area is an "important" feeding area.

Moreover, petitioners err in suggesting (NVPH Br. 24) that exploratory drilling "excludes" bowheads from areas where they might otherwise feed. The studies show that individual whales react differently to noise – some approach very close to the drilling, while others stay away – and experts have concluded that even where oil and gas activities have been conducted in the same area for several years, "the exclusion hypothesis is likely invalid." Sale 193 EIS at IV-106 (citing Ward and Pessah (1988)), SER672.

As noted *supra* at 27-28, a challenger cannot attack an EA by simply pointing to isolated bits of data that might support a different conclusion than the agency's. *See Bering Strait Citizens for Responsible Resource Development v. Corps of Engineers*, 524 F.3d 938, 957 (9th Cir. 2008) (adequacy of an EA is not brought into question "'[s]imply because a challenger can cherry pick information and data out of the administrative record to support its position'") (quoting from *Native Ecosystems Council*, 428 F.3d at 1240). Here, petitioners have simply cherry picked two data points out of a large record in an attempt to cast uncertainty on MMS's conclusion that the area around Shell's planned drilling is not significantly different from other areas of the Beaufort Sea where bowheads may feed. The fact that petitioners draw a different conclusion from the data does not suggest that the agency's conclusion is arbitrary or capricious. *See Wetlands Action Network v. Corps of Engineers*, 222 F.3d at 1120-21; *Greenpeace Action v. Franklin*, 14 F.3d 1324, 1333 (9th Cir. 1992).

Lacking record support for their theory that bowheads will be "excluded" from important feeding and resting areas, the AEWC petitioners rely heavily on a non-record declaration of a wildlife biologist, Robert Suydam, prepared for this litigation. AEWC Br. 10-14, 28, 32-35, 43-44. This reliance is improper. As noted *supra* at 18-19, the statute that provides this Court with jurisdiction over the petition provides that review of MMS's action in approving an EP shall be "solely on the record made before the Secretary." 43 U.S.C. §1349(c)(6). The APA, which provides the standard of review for EAs and FONSIs, similarly requires that review be limited to the record before the agency. *Camp v. Pitts*, 411 U.S. 138, 142 (1973) (judicial review of agency action is confined to the administrative record already in existence); *Southwest Ctr. For Biological Diversity v. USFS*, 100 F.3d 1443, 1450 (9th Cir. 1996) (same). Although this Court has "crafted narrow exceptions to this general rule," it has emphasized that courts should grant requests to expand the administrative record only in limited circumstances. *Lands Council v. Powell*, 395 F.3d 1019, 1030 (9th Cir. 2005). "Were the federal courts routinely or liberally to admit new evidence when reviewing agency decisions, it would be obvious that the federal courts would be proceeding, in effect, *de novo* rather than with the proper deference to agency process, expertise, and decision-making." *Id. See City of Las Vegas v. Federal Aviation Administration*, 570 F.3d 1109, 1116 (9th Cir. 2009) (in denying petition for review, Court refuses to consider non-record documents attacking EA).

Petitioners have made no attempt to show that any of the "narrow exceptions" to the general rule confining review to the administrative record are present here. Accordingly, any argument that the administrative record is deficient in this case and requires supplementation is waived. *Greenwood v. Fed. Aviation Admin.*, 28 F.3d 971, 977 (9th Cir. 1994) ("We review only issues which are argued specifically and distinctly in a party's opening brief.").[7/]

2. There is no Credible Evidence That the Beaufort Drill Sites Are of Particular Importance for Bowhead Mothers and Calves.

Petitioners also err in charging that "MMS also failed to consider or disclose the potential impacts to mothers and calves." AEWC Br. 24; *see also* NVPH Br. 33, 39. The EISs to which the EAs tier both consider the relevant issues relating to bowhead cows and calves. *See* Beaufort multi-sale EIS, ER 1622, 1629; Chukchi Sale 193 EIS at ER1446, 1447, SER647-48, 652-53, 655, 663-64, 667-69. MMS's analysis of this issue led it to the conclusion that cow-calf pairs could be particularly vulnerable to seismic surveys when they are migrating north through the spring lead system. SER668. MMS accordingly imposed a stipulation on

[7/] The same problem is presented by the declaration of Megan Williams, relied on by the AEWC petitioners at Br. 54-56, and that declaration should also be disregarded. We do not object to declarations introduced solely to demonstrate petitioners' standing, but object to any attempt to use statements in those declarations to support particular merits arguments. See, *e.g.*, AEWC Br. 12.

May 19, 2010

Via Electronic Mail

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Re: Take of Marine Mammals Incidental to a Camden Bay Exploration Drilling Program in the Beaufort Sea, Alaska

Dear Mr. Payne and Mr. Lecky,

The Inupiat Community of the Arctic Slope (ICAS) writes in support of the comments submitted by the Alaska Eskimo Whaling Commission (AEWC) regarding the application submitted by Shell Offshore Inc. (Shell) for an Incidental Harassment Authorization (IHA) for exploratory activities in the Beaufort Sea this summer under the Marine Mammal Protection Act (MMPA). *See* 75 Fed. Reg. 20482 (April 19, 2010). Thank you for the opportunity to provide input on Shell's application.

As you know, ICAS is a regional tribal government for eight villages on the North Slope that depend upon marine mammals that live and migrate through the Chukchi and Beaufort Seas. ICAS has a long history of opposition to offshore oil and gas activities in the Arctic because of the well-documented threats to our subsistence activities and the resources that have sustained us since time immemorial. In light of the current events in the Gulf of Mexico, we stress our long-standing concern with oil and gas activities in the Arctic where the ability to clean-up spilt oil is neither proven nor simple in light of the ice, wind, and extreme weather that exists. Until it proven that oil spilt in the Arctic can be cleaned up, we recommend that the National Marine Fisheries Service (NMFS) deny Shell's application for work in Camden Bay this summer.

We also make this recommendation in light of NMFS and the Minerals Management Service's (MMS) decision to undertake a comprehensive environmental review of the site-specific impacts of oil and gas activities in the Beaufort and Chukchi Seas to determine how many, if any, such activities can be authorized during a given open water season. As discussed below, allowing Shell's exploration activities to proceed this summer in conjunction with extensive seismic surveys and other activities that will have untold cumulative impacts on marine life, is irresponsible. NMFS would be authorizing activities under the MMPA before it has given full consideration to the cumulative impacts to marine life. The cart should not be put before the horse in this manner, especially when the unstudied and un-quantified impacts to marine life threaten the ability of North Slope residents to sustain themselves.

In addition to the concerns raised by AEWC, we also question NMFS's ability to determine that Shell's proposed activities "will not have an unmitigable adverse impact on the availability" of the species or stock "for subsistence uses," 16 U.S.C. § 1371(a)(5)(D), in light of the other activities that will occur this summer and impact marine life. These activities include:

- 4D surveys in Russian waters where we are learning from telemetry data that many bowhead whales migrate to in the fall;

- 2D and 3D surveys in the Canadian Beaufort sea where many bowhead whales can be found during the summer;[1]

- The State Department (along with other U.S. agencies including NMFS/NOAA and MMS) and the Canadian government's seismic surveying to determine the extent of the Arctic continental shelf;

- Shell's proposal to conduct shallow hazard, site clearance, ice gouge, strudel scour, and marine surveys in certain lease blocks in the Beaufort and Chukchi Seas during the summer of 2010. 75 Fed. Reg. 27708 (May 18, 2010). These surveys will include the use of seismic and another vessel. *Id.* at 27709-10.

We ask that NMFS explain how it can conclude that Shell's exploration activities "will not have an unmitigable adverse impact on the availability" of the species or stock "for subsistence uses," 16 U.S.C. § 1371(a)(5)(D), when the impacts of all these activities are added together. Our communities have experienced the dire consequences to marine life from Shell's seismic operations alone. The community at Point Hope noted that for the last two years Tom cod disappeared from the waters around their village. While the fish have returned this year, they are too small to feed their community. Community members saw beached fish after seismic operations occurred and heard reports of regions in the sea where krill had all died. The fish and krill support marine mammals and all of this marine life sustains our people. We recommend against approving all of these activities for one summer especially since earlier seismic surveys alone impacted our communities and their ability to feed themselves.

Additionally, ICAS points out that Native communities in Alaska have long been ignored in the race to find and develop offshore oil and gas resources. Despite a multitude of local knowledge of marine species gained from both subsistence users (such as whaling crews) and local scientists and wildlife departments, the U.S. government has consistently failed to comply

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[1] ICAS has documented at least twenty-five applications for seismic in these areas during an eleven year period.

with legal requirements that require consultation with local Native communities *as* proposals are being developed that affect native environments. Instead, both federal agencies and the entities they permit make only token gestures at consultations with Native groups offering them only the opportunity for involvement *after* proposals are developed and *after* local knowledge would serve a useful purpose.

It is the policy of the United States that "[w]hen undertaking to formulate and implement policies that have tribal implications, agencies shall . . . consult with tribal officials as to the need for Federal standards and any alternatives that would limit the scope of Federal standards or otherwise preserve the prerogatives and authority of Indian tribes." Executive Order 13175 § 3(c)(3). Despite this explicit government-to-government consultation requirement, NMFS has failed to consult with governing bodies of Native people who will be and have been affected by the decisions NMFS is making under the MMPA. NMFS must explain why it has neglected to sit down with Native governing bodies when making decisions that directly impact the ability of communities to sustain themselves. NMFS must meet with ICAS and local Native villages on a government-to-government basis to discuss IHA applications as well as appropriate mitigation and monitoring requirements well before notice is provided of the applications so we can play a role in developing the agency's proposal.

ICAS incorporates by reference the comments submitted by the Alaska Eskimo Whaling Commission (AEWC) with respect to the rest of the issues raised by Shell's IHA application and NMFS's preliminary findings. Thank for your consideration of these comments. Please contact me if you have any questions or are willing to meet with ICAS on a government-to-government basis.

Sincerely,

George Edwardson 5/19/10

George Edwardson
President

**ALASKA WILDERNESS LEAGUE – AUDUBON ALASKA –
CENTER FOR BIOLOGICAL DIVERSITY – DEFENDERS OF WILDLIFE –
EARTHJUSTICE – GREENPEACE – NATURAL RESOURCES DEFENSE COUNCIL –
NORTHERN ALASKA ENVIRONMENTAL CENTER – OCEANA – OCEAN CONSERVANCY – PACIFIC ENVIRONMENT – REDOIL – SIERRA CLUB –
THE WILDERNESS SOCIETY – WORLD WILDLIFE FUND**

May 19, 2010

Michael Payne, Chief
Permits, Conservation, and Education Division
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National Marine Fisheries Service
1315 East-West Highway
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Re: Takes of Marine Mammals Incidental to Specified Activities; Exploration Drilling Program Near Camden Bay, Beaufort Sea, 75 Fed. Reg. 20,482 (April 19, 2010)

Dear Mr. Payne:

The undersigned groups submit the following comments on the National Marine Fisheries Service's (NMFS) April 19, 2010, proposed incidental harassment authorization (IHA) pursuant to the Marine Mammal Protection Act (MMPA). NMFS has proposed allowing the incidental take of six marine mammal species resulting from Shell Offshore Inc.'s exploration drilling activities in the Beaufort Sea that are scheduled to begin in July 2010. 75 Fed. Reg. 20,482 (April 19, 2010). NMFS should deny Shell's application.

NMFS' regulations for the Arctic preclude the issuance of an IHA if the proposed activity creates the "potential" for death or serious injury. As evidenced by the continuing BP disaster in the Gulf of Mexico, exploratory drilling creates the very real risk of serious harm to marine mammals. That potential is always present, but it is magnified in this instance given that the causes of the blowout in the Gulf remain unknown, and there is no demonstrated capacity to control or clean up a spill in the Arctic. At a minimum, there must be an analysis of the technological, operational, and regulatory failures that may have occurred in the Gulf before drilling can be allowed in Camden Bay. The federal government should not grant any approvals for exploration drilling until such an independent review is complete.

Nowhere is the need for better science, oversight, and planning more evident than the Arctic, where a large spill of crude oil would have devastating consequences. There is a recognized dearth of scientific information about the Beaufort Sea and a complete lack of response and rescue capability. More data about the marine ecosystem are needed to evaluate the potential impacts from industrial activities. If a spill were to occur now, the lack of baseline scientific information would make it nearly impossible to evaluate the full scope of the harm.

Even absent a catastrophic spill, the impacts of the proposed exploration drilling on endangered bowhead whales, as well as the corresponding potential effects on Alaska Native communities, exceed the protective standards imposed by the MMPA. Shell proposes to drill in a feeding and resting area for bowheads, and the proposed IHA is not consistent with the agency's established concern for activities that take place in key marine mammal habitat. Nor has NMFS considered how the effects of drilling – including the potential effects of stress and delayed migration – will combine with other industrial activities in the Arctic, such as Shell's Chukchi exploration and planned 2010 seismic surveys. Even considering Shell's Beaufort drilling in isolation, NMFS cannot justify its conclusion that the harassment of close to 14% of the Western Arctic bowhead population satisfies the MMPA's "small numbers" limitation. The agency's error in this regard is compounded by NMFS' unjustified decision to exclude from its analysis noise from Shell's expected ice management activities. The proposed IHA also fails to include sufficient mitigation to reduce impacts to the "least practicable." NMFS has not adequately considered whether a 120-dB safety zone is appropriate and has not evaluated limitations that would avoid disturbing the peak of the bowhead migration.

Finally, in light of the draft programmatic Environmental Impact Statement (EIS) for oil and gas activities in the Arctic currently being developed, NMFS should not authorize marine mammal harassment incident to Shell's exploratory drilling. The National Environmental Policy Act (NEPA) prohibits piecemeal approvals while a programmatic EIS process is ongoing, except under strictly prescribed circumstances not found here. Moving forward risks undermining the overarching review contained in the EIS that will establish appropriate standards for future oil and gas activities. Moreover, incorporating the proposed drilling into that process will reinforce NMFS' commitment to create a five-year Arctic Action Plan that will include efforts to improve the management of ocean and coastal resources.

I. MARINE MAMMAL PROTECTION ACT

NMFS' proposed authorization to Shell does not comply with the requirements of the MMPA. Congress enacted the MMPA in 1972 in response to widespread concern that "certain species and population stocks of marine mammals are, or may be, in danger of extinction or depletion as a result of man's activities[.]" 16 U.S.C. § 1361(1). The legislative history states that the purpose of the MMPA is to manage marine mammals "for their benefit and not for the benefit of commercial exploitation." H. Rep. No. 92-707 (1972), *reprinted in* 1972 U.S.C.C.A.N., pp. 4144, 4154. The primary mechanism by which the MMPA protects marine mammals is through the implementation of a "moratorium on the taking" of marine mammals. 16 U.S.C. § 1371(a). Under the MMPA, the term "take" is broadly defined to mean "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." *Id.* §1362(13). "Harassment" is further defined to include acts of "torment" or "annoyance" that have the "potential" to injure a marine mammal or marine mammal stock in the wild or have the potential to "disturb" them "by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering." *Id.* § 1362(18); *see also* 50 C.F.R. § 216.3 (defining "Level A" and "Level B" harassment).

The MMPA provides several narrow exceptions to the moratorium on take. Relevant here, NMFS may, upon request, authorize take in the form of harassment by an IHA for a period of not more than one year, provided certain conditions are met. An activity: (i) must be "specified" and limited to a "specific geographical region," (ii) must result in the incidental take of only "small numbers of marine mammals of a species or population stock," (iii) can have no more than a "negligible impact" on species and stocks, and (iv) cannot have "an unmitigatable adverse impact on the availability of such species or stock for taking for subsistence uses" by Alaska Natives. In issuing an authorization, NMFS must provide for the monitoring and reporting of such takings and must prescribe methods and means of effecting the "least practicable impact" on the species or stock and its habitat. 16 U.S.C. § 1371(a)(5)(D). Finally, an activity in the Arctic cannot have the "potential to result in serious injury or mortality[.]" 50 C.F.R. § 216.107. As discussed below, NMFS has not demonstrated that the proposed IHA will meet the standards imposed by the MMPA and its governing regulations.

A. Potential for Serious Injury

As noted, for activities in the Arctic, NMFS' regulations strictly limit its authority to issue an IHA. If there is even the "potential" for serious injury or mortality of a marine mammal, take can be authorized only through 5-year incidental take regulations and subsequent letters of authorization. *See* 50 C.F.R. § 216.107(a).

The ongoing disaster in the Gulf highlights the reality that exploratory drilling "ha[s] the potential" to result in serious injury or mortality and that such drilling "may result in incidental takings . . . of marine mammals by harassment, serious injury, death or a combination thereof." 50 C.F.R. §§ 216.107(a); 216.105. The likelihood of a spill is significant enough that Minerals Management Service (MMS) regulations require companies to prepare oil spill response plans as part of their proposed exploration plans. *See, e.g.*, 30 C.F.R. § 250.219 (oil spill information that must accompany an exploration plan); 30 C.F.R. § 254 (requirements for preparing spill-response plans). Shell's IHA application notes that, during the 2010 drilling season, Shell's fleet will include vessels to respond to a spill. *See* Shell Offshore Inc., 2010 Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska, Appendix E (2009 IHA App.) at 3 (June 2009).

Further, NOAA itself recognizes the risk of oil spills in the Arctic from OCS activities. In a September 9, 2009, letter to MMS, NOAA stated its belief that "no leasing should occur in the Arctic Sea under [MMS' Proposed OCS Oil and Gas Leasing Program for 2010-2015] until additional information is gathered and additional research is conducted and evaluated regarding oil spill risk; adequate response and preparedness to spills in the Arctic; and possible human dimension impacts on Alaska Native cultures from oil and gas exploration activities and potential oil spills." NOAA, Comments on the U.S. Department of the Interior / Minerals Management Service Draft Proposed Outer Continental Shelf Oil and Gas Leasing Program for 2010-2015, at 5 (September 9, 2009). NOAA was rightfully concerned because "[o]ffshore oil production poses a spill risk" and "[a] spill could have severe consequences on living marine resources at a regional or population level scale, as well as significant socioeconomic effects." *Id*.

Of equal importance, it is becoming clear that multiple failures – involving both technological safeguards and regulatory oversight – occurred leading up to the Gulf of Mexico spill. NMFS cannot proceed here without a better understanding of the root causes of the accident. The MMPA is exceptionally protective, and as the D.C Circuit has repeatedly stated, "it is clear that 'the Act was to be administered for the benefit of the protected species rather than for the benefit of commercial exploitation.'" *Kokechik Fishermen's Ass'n v. Sec'y of Commerce*, 839 F.2d 795, 800 (D.C. Cir. 1988) (citing *Comm. for Humane Legislation, Inc. v. Richardson*, 540 F.2d 1141, 1148 (D.C. Cir. 1976)). In order to certify that there is no "potential" for serious harm, more information is required. At a minimum, NMFS cannot approve the IHA application until the government has completed its analyses of the Gulf disaster. To assure a comprehensive and deliberative review, this must include the independent commission that the White House earlier this week committed itself to establish.

NMFS cannot ignore this risk based on its stated belief that the MMPA does not authorize the issuance of authorizations for unlawful activities. *See, e.g.*, 66 Fed. Reg. 65,923, 65,925 (Dec. 21, 2001) (noting that oil spills are considered a violation of the Clean Water Act). NMFS' definition of "take" does not distinguish between acts that result from illegal activity and those that do not. 50 C.F.R. § 216.3. And, as recognized by the D.C. Circuit, "[i]t is the duty of the Secretary to take a systemic view of an activity's effect on marine mammals." *Kokechik*, 839 F.2d at 802. The agency may not authorize the take of some marine mammals resulting from an activity and ignore others. *Id*.

Because Shell's planned activities have the potential to result in serious injury or mortality, NMFS must authorize the marine mammal harassment via regulation and the issuance of letters of authorization. *See* 50 C.F.R. § 216.107. NMFS cannot escape the fact that there is a potential for marine mammals to be taken by oil spills as a result of Shell's planned activities this summer.

B. Negligible Impact

The Beaufort is home to numerous species of marine mammals and fish species, as well as Native communities whose people have lived with and depended on the sea since time immemorial. Among the marine mammal species likely to be affected by the proposed drilling are whales (bowhead, gray, and beluga), seals (ringed, spotted, and bearded), and polar bears. Bowhead whales, listed as endangered under the Endangered Species Act, are of particular concern. Of the five recognized stocks of bowhead whales, the Western Arctic stock is critical to the future of the entire species. Each spring, this stock migrates through the Bering Strait into the Chukchi Sea, then east through the Alaskan Beaufort to summer feeding grounds in the Canadian Beaufort. Each fall, the whales migrate back along the same route.

Bowhead whales are particularly susceptible to harm from anthropogenic noise in the marine environment. NMFS and MMS have found that a 120-dB noise can cause a response in bowhead whales generally and that female baleen whales with young show a heightened response to noise and disturbance, as compared to other segments of the population. MMS, Final Programmatic Environmental Assessment, Arctic Ocean Outer Continental Shelf Seismic Surveys – 2006 (PEA), at 111 (June 2006) (noting studies showing heightened response); s*ee also* MMS, Environmental Assessment, Shell Offshore, Inc. 2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska (Beaufort EA), at 53 (October 2009) (noting that "[i]ndividual beluga and bowhead whales are expected to avoid areas with sound levels greater than 100 dB").

Dr. David Bain, a biologist who specializes in the behavioral ecology of marine mammals and has focused a substantial portion of his work on audition, sound production, and other aspects of the acoustic ecology, has reviewed the proposed IHA and provided a statement. Dr. Bain concluded that NMFS underestimates the number of whales effected, understates the impact to whales, and fails to assess serious cumulative impacts. The statement is attached as Exhibit 1. Recent research described in Dr. Bain's statement indicates that cetaceans may be more sensitive to noise in the marine environment than previously realized. *See* Ex 1 at 2-5.

Shell's proposed drilling would produce noise at and above the levels of concern for marine mammals, potentially exposing thousands of bowhead whales. Even more marine mammals would be affected by behavioral changes caused by received levels below 120 dB.

1. Impacts due to the location of the drilling

Whether noise disturbances from oil and gas activities result in a biologically significant impact depends on the "timing, location, and number" of the disturbances. NMFS, Biological Opinion for Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska and Authorization for Small Takes Under the Marine Mammal Protection Act (2008 BiOp), at 86 (July 2008). Concentrations of loud noise and disturbance activities during the open water period

> have the potential to cause large numbers of [bowhead] whales to avoid using areas for resting and feeding for long periods of time (days to months) while the noise producing activities continue.

Id. at 89. The consequences of this avoidance "would be of particular concern if [inaccessible] areas included those used for feeding or resting by large numbers of individuals or by females and calves." *Id*. at 86; *see also id.* at 47 ("Increased noise levels could . . . alter normal behavior, such as causing avoidance behavior that keeps animals from an important area or displace a migration route farther from shore."). Due to the "potential for noise disturbance to displace whales from important feeding areas," NMFS has advised that "special scrutiny should be given to seismic and drilling operations which may impact these areas." *Id*. at 99; *see also id.* at 68 (stating that "[s]mall deflections in individual bowhead-swimming paths and a reduction in use of possible bowhead-feeding areas near exploration units may result in adverse effects on the species").

Camden Bay has been repeatedly identified as a resting and feeding area for migrating bowheads. *See* Ljungblad, D., Moore, S. and Clarke, J.T., *Assessment of Bowhead Whale Feeding Patterns in the Alaskan Beaufort and Northeastern Chukchi Seas via Aerial Surveys, Fall 1979-84*, 36 Rep. Int. Whal. Comm'n 265, 270 (1986) (feeding whales seen in "four of the six years north of Camden Bay and Prudhoe Bay"); Ljungblad, D., Moore, S. and Clarke, J.T., *Bowhead Whale (Balaena Mysticetus) Spatial and Temporal Distribution in Central Beaufort Sea During Late Summer and Early Fall 1979-86,* Rep. 39 Int. Whal. Comm'n , 283, 289 (1989) (feeding bowheads seen north of Camden Bay in 1982 and 1984); *see also* Ex. 1 at 9. Whaling captains from Nuiqsut and Kaktovik "consistently report bowhead whales feeding, resting, and caring for young in Camden Bay waters." Alaska Eskimo Whaling Commission, *Summary of Key Research,* at 1 (Aug. 2009), (attached as Exhibit 2).

Recent monitoring has reaffirmed the past usage. In 2008, Shell conducted aerial surveys in support of seismic activities at its Torpedo and nearby Masva prospects. LGL, Marine Mammal Monitoring and Mitigation During Open Water Seismic Exploration by Shell Offshore Inc., in the Chukchi and Beaufort Seas, July-October 2008: 90-Day Report, at 9-3 (Jan. 2009). Based on those whales whose activity could be characterized, just over 75% were determined to be feeding, with 15% resting. *Id*. at 9-51. In 2007, Shell conducted aerial surveys associated with seismic activity on its Sivilluq prospect. *See* LGL, Marine Mammal Monitoring and Mitigation During Open Water Seismic Exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July-November 2007: 90 Day Report, at 5-92 (Jan. 2008). It estimated that just over 50% of the bowheads were feeding, with approximately 10% resting. *Id.* at 5-109. Based on the number of observed whales, as many as 4,826 whales may have been present in the Camden Bay area in mid-September. *Id*. at 5-100. *See also* Shell Offshore, Inc., 2010 Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska, Appendix H (2009 Shell EIA), at 130-31 (Shell's Environmental Impact Analysis noting that in "2007 and 2008 bowhead whales also used areas near Camden Bay to feed during the migration"). The industry's joint monitoring report for activities in 2006 noted a third of the whales in Camden Bay were using the area for resting. LGL, Joint Monitoring Program in the Chukchi and Beaufort Seas, July-November 2006, at 8-14 (Table 8.3) (Nov. 2007).

In the proposed IHA, NMFS maintains that avoidance of Camden Bay will result only in the expenditure of "some extra energy" to find alternative feeding grounds. 75 Fed. Reg. at 20,505; *see also* 20,494; 20,506 (stating that "other feeding grounds exist elsewhere"). This dismissal not only runs counter to NMFS' long-standing practice but also ignores existing science. *See* Ex. 1 at 9-11.

NMFS issued its biological opinion for oil and gas activities in the Arctic just two years ago. At that time, the agency was fully aware that bowhead feeding areas in the Arctic are dynamic and that multiple locations can serve as feeding grounds. NMFS identified some specific areas, but recognized that others may be important. In fact, NMFS included an explicit conservation recommendation instructing MMS to "continue to investigate the use of the Chukchi and Beaufort Seas by feeding bowhead whales, and assess the importance of this feeding to the health and well being of these animals." 2008 BiOp at 117. NMFS' added caution for activities that could impact feeding or resting areas was not limited only to those areas cited in the opinion. *See, e.g. id*. at 86. It simply stated that biologically significant effects may result if, for example, large numbers of individuals or females with calves are affected. *Id*.[1]

The 2008 opinion's concern with limiting the number of displaced whales – and the elevated concern for cow-calf pairs – is consistent with the agency's past regulatory decisionmaking in the Arctic. In 2006, NMFS issued a finding of no significant impact for multiple seismic operations in the Arctic based on the imposition of a 120-dB safety zone for 4 or more cow-calf pairs and a 160-dB safety zone for aggregations of feeding whales. *See* 71 Fed. Reg. 66,912, 66,913 (Nov. 17, 2006) (noting that the 120-dB requirement was "essential" to

[1] Although NMFS has begun ESA consultation related to the issuance of an IHA, a final biological opinion is not yet available to the public.

NMFS' finding of no significant impact). Since then, the agency has consistently required similar protections for seismic activities in the Beaufort. As NMFS and MMS stated in their 2007 Draft Programmatic EIS, "protective measures should be designed to reduce the potential for disruption of biologically significant behaviors or help ensure that whales do not avoid important key habitat areas (*and thus potentially negate a negligible impact finding under the MMPA*)[.]" MMS / NOAA, Draft Programmatic EIS, Seismic Surveys in the Beaufort and Chukchi Seas, Alaska (DPEIS), at II-8 (2007) (emphasis added); *see also* PEA at 111 ("To the extent that information exists, we have highlighted potential effects that could affect the use of areas used for calving, feeding, resting, and breeding by large numbers of whales."). NMFS has not provided any new evidence to warrant a reversal of the agency's past practice. Absent a substantial justification, NMFS cannot abandon its established approach by simply assuming that whales can find an alternative feeding ground if unable to use the Camden Bay site.

As discussed in more detail in the attached statement of Dr. David Bain, the existing science supports the notion that excluding individuals from feeding and resting areas is likely to have significant consequences. Ex. 1 at 9-11. Whales typically forage where prey density is more than three times higher than average prey density, and when whales are displaced from optimal habitat, those individuals will move to poorer feeding areas or compete for food in comparable habitat. Bain, D. E. 2002a. *A model linking energetic effects of whale watching to killer whale (Orcinus orca) population dynamics*. Contract report submitted to Orca Relief Citizens' Alliance. Similarly, missed resting opportunities can increase the need for additional feeding. Ex 1 at 11-12. The potential for harm is particularly acute for a population that is nearing its carrying capacity, like the Western Arctic stock of bowhead whales. Ex. 1 at 17-19. As a population nears carrying capacity, there is increased competition for food among individuals. Disturbance has the effect of causing the population to behave as though it is even closer to carrying capacity than it would be in the absence of the disturbance. *Id.*.

Moreover, the proposed IHA does not fully consider the scope of the potential bowhead exclusion because it ignores the effects of vessel noise. In particular, ice breakers operate miles from the drillship, and the sound they produce would substantially expand the reach of the project's effects. Shell's original IHA application for this season determined that including ice management would more than triple the area exposed to sound of 120-dB. 2009 IHA App. at 22; *see also* discussion, *infra*. As long as this element is ignored, NMFS cannot justify a non-negligible finding.

In sum, missed feeding and resting opportunities impair the energy balance of affected individuals, slowing their growth, delaying the onset of sexual maturity, and consequently reducing the recruitment of calves to the population. Ex. 1 at 20; *see also* Lockyer, C. 1984. *Review of baleen whale (Mysticeti) reproduction and implications for management*, Rep. Int. Whal. Commn (Spec. Iss. 6):27-50. The suggestion contained in the proposed IHA that bowheads can easily find an alternative feeding site during their migration is not supported by existing studies, represents a unsupported reversal of NMFS' established approach to protecting bowheads, and does not consider the potential consequences to a population approaching carrying capacity.

2. *Impacts due to stress and migratory deflections*

At high levels, anthropogenic noise can cause temporary or permanent hearing damage to marine mammals. But marine mammals can also suffer long-term impacts attributable to exposure to lower levels of noise.

Noise exposure is likely to result in stress, and stress can impair an animal's immune system. Ex. 1 at 12-13; Wright, A.J., et al. 2007. *Do marine mammals experience stress related to anthropogenic noise?* Intl. J. Comp. Psych. 20:274-316; Rolland, R. M., P. K. Hamilton, S. D. Kraus, B. Davenport, R. M. Gillett, and S. K. Wasser. 2006. *Faecal sampling using detection dogs to study reproduction and health in North Atlantic right whales* (Eubalaena glacialis). J. Cetacean Res. Manage. 8:121–125 and Romano, T. A., M. J. Keogh, C. Kelly, P. Feng, L. Berk, C. E. Schlundt, D. A. Carder and J. J. Finneran. 2004. Although NMFS assumes that marine mammals would not be exposed to strong sounds for long enough that significant physiological stress would develop, 75 Fed. Reg. at 20,492, stress can occur even in the absence of any behavioral change or exclusion from habitat. The consequences will depend on the duration of exposure, population condition, and other factors like exposure to pathogens and immunosuppressing compounds. Indeed, the Navy has conservatively assumed in its EISs for active sonar training that any effect sufficient to cause hearing loss or produce a behavioral response sufficient to cause take under the MMPA will also produce a stress-response and contribute to a marine mammal's allostatic load. *See e.g.*, Navy. 2008. *Southern California Range Complex: Environmental Impact Statement/ Overseas Environmental Impact Statement*, at 3.9-102. NMFS has too quickly eliminated stress from consideration.

NMFS should also consider impacts to bowhead whales deflected from their migratory route. Such a deflection constitutes a significant disruption of normal migratory behavior. Ex 1 at 8. Once bowheads are deflected, it is unknown how long or how far they travel before returning to their normal migratory pathway. It is likely that this deflection at least extends to the 120-dB contour, but actual deflection may begin at even lower sound levels. Richardson, W.J., Miller, G.W., and Greene, C.R. 1999. *Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea.* J. Acoust. Soc. Am. 106: 2281. The consequences of extending the whales' migratory route and requiring the expenditure of additional energy must be considered. *See* Wright, A.J., et al. 2007. *Do marine mammals experience stress related to anthropogenic noise?* In making this determination, NMFS must include all sources of noise – in particular, ice breaking vessels – that will result in potential harassment. Vessel noise is discussed in more detail, *infra*.

3. *Impacts due to other activities*

NMFS cannot assure that permitted activities will have no more than negligible impacts on the stock of bowhead whales without looking at all of the oil activities scheduled to take place this summer in the Arctic Ocean. As a result of its failure to look beyond Shell's proposed activities, NMFS understates the potential effect on bowhead whales. The Western Arctic population of bowhead whales relies on habitat in both the Chukchi and the Beaufort seas and is particularly susceptible to disturbance from industrial activity. NMFS cannot accurately assess the potential for harm from Shell's proposed marine mammal harassment in the Beaufort without considering effects in the context of the other activities occurring in the Arctic. As Dr. Bain notes, "Cumulative effects on the population are likely to increase at a steeper than linear rate. That is, doubling exposure to disturbance is likely to more than double population level effects." Ex. 1 at 19. Without taking this into account, NMFS' estimates of take are inaccurate.

According to NMFS' Alaska Stock Assessment Report, the "accumulation of impacts from vessels, seismic exploration, and drilling are of concern across the North Slope of Alaska," Angliss, R. P., and B. M. Allen, *Alaska marine mammal stock assessments*, U.S. Dep. Commerce., NOAA Tech. Memo, NMFS AFSC-193, at 258 (2009). The National Research Council (NRC) has advised agencies to assess cumulative effects to the population from multiple effects to multiple individual animals:

> At the individual level, the biological significance of an effect must be judged by changes in the ability of an animal to grow, survive, and reproduce. The population effect involves the cumulative impact on all individuals affected.
>
> …
>
> Population consequences of behavioral change result from the accumulation of responses of individuals.

NRC, Marine Mammal Populations and Ocean Noise, Determining When Noise Causes Biologically Significant Effects (NRC Report), 19-20 (2005). The peer review panel created for the recent Open Water meeting agreed that there is a need "for better analysis of the potentially interacting influences of multiple oil and gas activities co-occurring in time and space[.]" Expert Panel Review of Monitoring and Mitigation Protocols in Applications for Incidental Take Authorizations Related to Oil and Gas Exploration, Including Seismic Surveys, in the Chukchi and Beaufort Seas, at 9 (March 2010).

First, it is essential that NMFS consider the combined impacts of Shell's related proposal to drill in the Chukchi. As NMFS is aware, Shell intends to use the same equipment to drill up to three wells at five possible drill sites off the Chukchi coast within the bowhead whale migratory corridor. *See* 75 Fed. Reg. 25,730 (May 7, 2010). Considering the two plans in isolation leads to an incomplete assessment of effects. Members of the same bowhead population will be affected by drilling in both seas. Ex. 1 at 16.

NMFS should consider not only Shell's additional drilling operations but also the potential for Shell's ships to travel between the two seas during the peak of the bowhead fall migration. Ex. 1 at 19. If the vessels were to do so, they would go through the path of the migrating whales at one if its narrowest points around the tip of Point Barrow. Moving vessels cause scattering, which disrupts social groups and could separate calves from their caregivers, a result that the NRC has warned should be avoided. *See* NRC Report at 83, Box 4-1 ("Very low thresholds should be considered for any disturbance that might separate a dependent infant from its caregivers.").

In its EA on Shell's Chukchi Sea exploration plans, MMS implicitly recognized the potential impact of the vessel movement, stating "[i]f Shell transits to the Chukchi Sea from the Beaufort Sea during the fall bowhead whale migration. . .Shell should meet with the Barrow Whaling Captains to coordinate the *Discover*'s transit route . . . to prevent any deflection of the bowhead whale migration and any conflicts with Barrow's fall whaling season." MMS, Environmental Assessment, Shell 2010 Exploration Drilling Program Burger, Crackerjack and SW Shoebill Prospects, Chukchi Sea, Outer Continental Shelf Alaska, at 96 (Dec. 2009). NMFS cannot assume that the future intent to prevent interruption of the migration would be successful and should consider this impact on bowhead whales.

Second, NMFS must consider the impact of 2010 seismic surveys. There are at least three pending applications for seismic surveys planned for Arctic in 2010, one 2D survey in the Beaufort Sea and one 3D survey in the Chukchi Sea, as well as shallow hazard / ice gouge surveying by Shell in both seas. The 3D and 2D surveys were discussed at this year's Open Water meeting and the applications are available on MMS's website. NMFS recently published a proposed IHA for Shell's surveys. The 3D survey will use a 6-gun array with a volume of 3,000 cubic inches and 12 streamers. The 2D survey will take place during some portion of Shell's drilling using a source array totaling 4,330 cubic inches.

Together, these activities create the risk of an acoustic gauntlet within the bowhead migratory corridor and the Camden Bay feeding and resting area. Ex. 1 at 15-17. NMFS' biological opinion warns of just this "considerable increase in noise" associated with oil and gas exploration: "seismic, vessel traffic and icebreaker operation, drilling and construction, and support activities" create the risk that whales will avoid high value areas and suffer consequences of biological significance. 2008 BiOp at 86. NMFS, however, avoids looking at these activities as a whole (discussed here) or diminishes their effects to the point that they are eliminated from further consideration (discussed for vessel noise, *infra*).

Without a comprehensive analysis, NMFS cannot fully assess the effects of Shell's Camden Bay drilling on the bowhead population. Because multiple impacts on members of the same population have synergistic effects, even if NMFS could properly conclude that the individual impacts of drilling in the Beaufort are negligible (and we do not believe that it can), when considered in combination it could result in a non-negligible impact to bowhead whales. Ex. 1 at 15-17.

NMFS' assertion that these impacts can be ignored is inconsistent with the MMPA. The MMPA is intended to give the benefit of the doubt to the species and allows NMFS to issue IHAs only when it can be assured that the impacts on the stock will be negligible. In the case of multiple activities throughout the bowhead's range this summer, the cumulative impacts of the activities is more than a sum of the parts. Without considering this, the proposed IHA understates the effects and violates the MMPA.

C. <u>Small Numbers</u>

The MMPA prohibits NMFS from authorizing the take of more than "small numbers" of marine mammals. 16 U.S.C. § 1371(a)(5)(D)(i). Critically, the MMPA definition of harassment is focused on "*potential* harassment," which supports the conclusion that all of the animals in a population are harassed "if there is the potential for the act to disrupt the behavioral patterns of the most sensitive individual in the group." *Natural Res. Def. Council v. Evans*, 279 F. Supp. 2d 1129, 1157 (N.D. Cal. 2003) (emphasis added; in *dicta*); *see also* 16 U.S.C. § 1362(18)(A)(ii) (defining harassment to include any act of pursuit, torment, or annoyance that "has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns"). Recent amendments to the MMPA emphasize this point by requiring a stronger showing of disturbance for only two specified categories of activities. *See id*. § 1362(18)(B)(ii) (defining harassment for a military readiness activity or scientific research activity as one that "disturbs or is likely to disturb" marine mammals to a point that natural behavioral patterns are "abandoned or significantly altered").

Here, NMFS proposes authorizing the harassment of 1,968 bowhead whales. Close to 2,000 whales, or approximately 14% of the Western Arctic bowhead population, does not represent either "small" numbers of marine mammals nor a "small" proportion of the affected stock. A "definition of 'small number' that permits the potential taking of as much as 12% of the population of a species is plainly against Congress' intent." *Natural Res. Def. Council*, 279 F. Supp. 2d at 1152. NMFS' proposed authorization, as written, is plainly contrary to the MMPA small numbers limitation.[2]

Even this calculation of harassment significantly underestimates the number of affected whales because it excludes disturbance from icebreaking vessels and relies on an inappropriately high threshold for harassment.

First, as NMFS recognizes, Shell may encounter ice in Camden Bay. Shell's has observed that ice floes and pack ice "usually can be found anywhere offshore in the Beaufort," and ice can be blown in "during any part of the drilling season." 2009 Shell EIA at 49. A study of a fall drilling project in 1991 at the Galahad prospect, near Sivulliq and Torpedo in Camden Bay, indicated that ice management during the project was common. M.L. Gallagher, K.D. Brewer, & J.D. Hall, *Galahad Exploration Prospect, Site Specific Monitoring Plan*, Amoco Production Co. (May 5, 1992) at 24. *See also* Shell Offshore Inc., Revised Request for the Establishment of Safety Zones for the Frontier Discoverer Drill Ship and the Semi Submersible Drill Unit Kulluk in the Beaufort Sea, Alaska (March 30, 2007) at 2 (attached as Exhibit 3) (noting that ice conditions similar to those in 2006 for Camden Bay would require that the drill rigs be "constantly ice managed"). According to NMFS, Shell has stated in a personal communication that no ice breaking will take place. Shell maintains that, unless there is an immediate safety hazard at the drill sites, it will stop operations and move off-site rather than break ice. NMFS cannot rely on this informal assurance alone in eliminating ice breaking from consideration. Moreover, Shell's statement on its face acknowledges that ice breaking may be

[2] Moreover, NMFS adopted Shell's estimate of 1,968 whales harassed without independently examining the underlying facts. *See* Ex. 1 at 6-7. Shell estimates that it will be working in Camden Bay for 40 days during the bowhead migration. This number assumes that no migratory whales are present before August 25th. In support of this assumption, Shell cites one overflight on August 19, 2008, which recorded no whales. NMFS should consider more data before concluding that no migratory whales will be present in August. Further, Shell assumes that it will reinitiate operations on September 15. However, Shell could resume drilling sooner if the whale hunt concludes before this date. Similarly, Shell assumes it will conclude its operations on October 24th, but its drill plan approved by MMS allows drilling to continue until October 31, 2010. NMFS should base its analysis on the assumption that Shell could be operating for all of October and the majority of September.

necessary. Without more, NMFS is not justified in entirely excluding the possibility of ice breaking.

The proposed IHA goes on to exclude the noise produced as a result of any additional "ice management" as well. The proposal suggests first-year ice is the type "most likely" to be encountered by Shell and asserts that management of first year ice requires only "slow movements" of the ship using "lower power and therefore slower propeller rotation speed" at approximately 15-20 percent of its rotation capacity. 75 Fed. Reg. at 20,484; *see also id*. at 20,486. Consequently, propeller operation will be "similar to that of vessels under normal operations and will not be used at 100 percent power as is the case in other situations rising to the level of a taking[.]" *Id*. at 20,484.

It is unclear what evidence NMFS relies upon to conclude that ice management falls below the threshold for the "potential" harassment of marine mammals. Shell's final revised IHA application does nothing to bolster NMFS' claims, stating instead that "[i]ce management would be expected to produce the most intense sounds associated with exploration drilling." Shell Offshore, Inc., Application for IHA for Non-Lethal Taking of Whales and Seals in Conjunction with Planned 2010 Exploration Drilling Program near Camden Bay in the Beaufort Sea, Alaska, at 45 (March 2010). Indeed, Shell has provided specific information to the Environmental Protection Agency that appears to conflict with NMFS' belief. Shell's Clean Air Act application states that first-year ice "is most efficiently managed at *continuous high speed* which involves the *highest continuous power production*[.]" Shell Offshore Inc., Outer Continental Shelf Pre-Construction Air Permit Application, Frontier Discoverer, Beaufort Sea Exploration Drilling Program at 26 (Jan. 2010) (footnote omitted; emphasis added). Nor is the proposed IHA itself consistent on this point. *Compare* 75 Fed. Reg. at 20,484 (NMFS asserting that ice management propeller rotation "will be similar to that of vessels under normal operations") *with* 20,493 (noting reported source levels "for vessels during ice-management have ranged from 175 dB to 185 dB").

By using engine power as the metric, NMFS' avoids the simple inquiry mandated by the MMPA: does the activity have the potential to harass marine mammals? NMFS has previously found that a 120-dB threshold for harassment is applicable to intermittent sounds such as ice management. 73 Fed. Reg. 31,816, 31,823 (June 4, 2008) (proposed IHA for Shell drilling). There are indications that pushing ice – especially the noise produced by initially moving an ice floe – will exceed that level. Greene, Charles, *Responses of Bowhead Whales to an Offshore Drilling Operation in the Alaskan Beaufort Sea, Autumn 1986: Acoustic Studies of Underwater Noise and Localization of Whale Calls* (1987); *see also* MMS, Final EIS, Beaufort Sea Planning Area, Oil and Gas Lease Sales 186, 195, and 202 at IV-68 (2003) (noting a study predicting "that roughly half of the bowhead whales would show avoidance response to an icebreaker *pushing ice* at a range of 4.6-20 kilometers . . . when the sound to noise ratio is 30 decibels" (emphasis added)). NMFS' effort to equate ice management to normal vessel traffic is misguided because NMFS provides no evidence for its assumptions about ice management noise. Nor is this standard appropriate – NMFS should consider whether the effects of the increased vessel traffic associated with Shell's project triggers the MMPA.[3]

This inquiry is fundament to determining the scope of the potential harassment. Ice breakers operate 10-15 miles from the drillship, substantially expanding the sonic footprint of the project. Shell's original IHA application for this season indicated that including ice management would more than triple the area exposed to 120-dB. 2009 IHA App. at 22. In the past, ice management activities have added considerably to the number of harassed bowhead whales when evaluating exploratory drilling. 73 Fed. Reg. at 31,822 (estimating 4,315 bowhead whales exposed to sounds of 120-dB). As it stands, the proposal's failure to include any harassment attributable to ice breaking and ice management is unjustified.[4]

Second, recent research on cetaceans' reactions to noise in the marine environment indicates that most species are much more sensitive than previously understood. Ex. 1 at 2-5. Based on the new data, Dr. Bain recommends a threshold for harassment of bowheads lower than 120-dB. *Id*. If NMFS applies this more appropriate threshold, it will find that many more whales are likely to be harassed by Shell's proposed drilling and associated activities. *Id*.

D. <u>Least Practicable Impact Mitigation</u>

Pursuant to the MMPA, an IHA must prescribe "means of effecting the least practicable impact" on a species or stock and its habitat. 16 U.S.C. § 1371(a)(5)(D)(ii)(I). As is clear from the language chosen by Congress, the emphasis is on reducing the impact to the lowest level possible. NMFS has previously recognized that "practicable" qualifies "impact" not "means." When defending the conditions of an IHA against an industry challenge, the agency argued that the "emphasis of the inquiry, thus, is on "the practicability of further reductions in harm (*i.e.*, can the reductions be achieved) rather than the economic costs of the 'means' used to obtain those reductions." Defendants' Opposition to Plaintiff's Motion to Stay at 22, *ConocoPhillips v. NMFS*, Case 3:06-cv-00198-RRB (D. AK).

In the past, NMFS has typically required multiple safety zones through the IHA process to protect marine mammals in the Beaufort Sea from the harmful effects of seismic surveying. Safety zones are imposed to protect against the risk of serious injury as well as to avoid harm to the population. Previous IHAs required shut downs / power downs based on the presence of 10 or more whales engaging in biologically significant behavior (such as feeding) or the presence of 4 or more cow-calf pairs. Although spatial-temporal based exclusions are generally preferable given the difficulties of real-time marine mammal monitoring, these measures comport with the frequently expressed concerns of both NMFS and MMS that, in order to avoid population level effects, activities should avoid disrupting biologically significant activities, particularly when

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[3] In addition to bowhead whales, the extent of the impact on beluga whales is also heavily influenced by the proposal's flawed evaluation of the potential effects of ice management activities. The number of potentially harassed beluga whales dropped significantly from Shell's original estimate of 78 whales to NMFS' current estimate of just 1.

[4] Although the proposed IHA notes that Shell will conduct sound-source verification of its ice management vessels that fact alone is not a substitute for appropriate mitigation to avoid potentially serious effects. Later monitoring cannot cure the defects in the proposal as written.

cow-calf pairs are present. *See* PEA at 110-111 (noting sensitivity of baleen whale cow-calf pairs and as well as potential effects when key habitat is affected).

Despite the possible exposure of close to 2,000 whales to Level B harassment, the IHA does not adequately consider whether safety zones would assist in reducing impact to the lowest level practicable. NMFS states only that power downs are impracticable in the drilling context "without posing other risks." 75 Fed. Reg. at 20,495. This conclusion is not supported by any citation and in fact conflicts with NMFS' decision in 2007 to require safety zones for Shell's exploratory drilling to address cow-calf pairs and feeding whales. More is needed in order to comply with the MMPA.

NMFS should also consider time and space limitations on drilling in order to reduce harm. There is general consensus that spatial-temporal avoidance of high value habitat represents one of the best means to diminish potential impacts.[5] In this case, avoiding activities during the peak of the bowhead migration within the Beaufort migratory corridor must be considered by NMFS before issuing any IHA.

E. Subsistence

The MMPA also requires that any incidental take authorized will not have "an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses" by Alaska Natives. 16 U.S.C. § 1371(a)(5)(D)(i)(II). NMFS must ensure that Shell's activities do not reduce the availability of any affected population or species to a level insufficient to meet subsistence needs. 50 C.F.R. § 216.103.

In addition to the other issues already noted in these comments, NMFS should also evaluate the potential impacts of future activities in both oceans and the acknowledged uncertainty regarding the effects of noise in the marine environment. The importance of the bowhead whale to coastal communities and its acknowledged sensitivity to noise impacts strongly favor a precautionary approach. For these reasons, NMFS has not adequately supported its MMPA finding as to subsistence resources. *See* 50 C.F.R. § 216.104(c) (best available science standard for subsistence finding).

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[5] *See, e.g.*, Agardy, T., Aguilar Soto, N., Cañadas, A., Engel, M., Frantzis, A., Hatch, L., Hoyt, E., Kaschner, K., LaBrecque, E., Martin, V., Notarbartolo di Sciara, G., Pavan, G., Servidio, A., Smith, B., Wang, J., Weilgart, L., Wintle, B., and Wright, A., *A global scientific workshop on spatio-temporal management of noise*. Report of workshop held in Puerto Calero, Lanzarote, June 4-6, 2007 (2007); ECS Working Group: Dolman, S., Aguilar Soto, N., Notabartolo di Sciara, G., Andre, M., Evans, P., Frisch, H., Gannier, A., Gordon, J., Jasny, M., Johnson, M., Papanicolopulu, I., Panigada, S., Tyack, P., and Wright, A., *Technical report on effective mitigation for active sonar and beaked whales* (2009) (working group convened by European Cetacean Society); OSPAR Commission, *Assessment of the environmental impact of underwater noise* (2009) (report issued as part of OSPAR Biodiversity Series, London, UK).

II. NATIONAL ENVIRONMENTAL POLICY ACT

NMFS and MMS have acknowledged the potential for cumulative, longer-term impacts to marine mammals resulting from expanded oil and gas activity. The agencies first addressed this problem in the context of a projected increase in seismic activity and now must address the predictable increase in expected exploratory drilling. As a result, the cumulative, long-term effects of increased noise and other impacts from oil and gas activity must be properly addressed before further activity is authorized. A number of the undersigned groups raised this issue to NMFS previously, most recently in a letter dated February 12, 2010. We repeat the main points here.

NMFS and MMS have begun a comprehensive analysis, but they have not yet finished the job. In 2006, the agencies published notice of their intent to prepare a programmatic EIS in order to assess the entire program of seismic survey permitting throughout the Beaufort and Chukchi Seas. 71 Fed. Reg. 66,912 (Nov. 17, 2006). According to the notice, the agencies determined that a programmatic EIS was necessary because of an anticipated increase in permitting and the determination that impacts needed to be analyzed over "a longer time frame" than had been addressed in previous single season assessments. *Id.* at 66,913. In spring 2007, the agencies issued a draft programmatic EIS that reinforced their earlier conclusions. NMFS and MMS continued to recognize that seismic surveys have "potential significant impacts on marine mammals, other Arctic marine life, and native subsistence lifestyles" due to the "reasonably foreseeable proposed offshore oil and gas seismic surveys off Alaska." 72 Fed. Reg. 17,117, 17,117 (Apr. 6, 2007).

The agencies have not yet completed the programmatic EIS. In October 2009, NMFS published a notice along with MMS, announcing that new information had become available since the DPEIS was published, in particular, "renewed interest in exploratory drilling in both the Chukchi and Beaufort Seas, " and that therefore the agencies "are withdrawing the 2007 DPEIS" and initiating a new process that will consider and incorporate this new information. 74 Fed. Reg. 55,539, 55,539 (Oct. 28, 2009). On February 8, NMFS published a second notice announcing its intent to prepare an EIS "to analyze the environmental impacts of issuing Incidental Take Authorizations (ITAs) . . . to the oil and gas industry for the taking of marine mammals incidental to offshore exploration activities (e.g., seismic surveys and exploratory drilling) in Federal and state waters of the U.S. Chukchi and Beaufort Seas off Alaska" and opening the official scoping period for this EIS. 75 Fed. Reg. 6,175, 6,175 (Feb. 8, 2010). According to the notice:

> For the purposes of complying with NEPA and to achieve greater administrative efficiency in its ITA program, NMFS has determined the need to prepare an EIS that will analyze a range of oil and gas exploratory actions and that will satisfy the requirements of the [CEQ]'s NEPA regulations and the NOAA NEPA administrative order 216-6. The proposed EIS would cover known and reasonably foreseeable projects requiring ITAs in the U.S. Arctic regions for future years, until such time that a revision of the document is necessary.

Id. at 6,176. The factors that contributed to NMFS' decision that a programmatic EIS is needed include the receipt of applications for exploratory drilling, as well as anticipated future applications, that were not analyzed in the withdrawn DPEIS, and the need to analyze a longer timeframe "in order to most effectively and fully evaluate the potential for cumulative impacts." *Id.*

In short, the agencies have reaffirmed their previous determination that a programmatic EIS process is necessary to address the overall, cumulative impacts of increased oil and gas activity in the Arctic Ocean and intend to incorporate into that analysis new scientific information each has obtained as well as new information about projected seismic and exploratory drilling activity in both seas.

This approach is consistent with the mandate of NEPA. NEPA "emphasizes the importance of coherent and comprehensive up-front environmental analysis to ensure informed decision making" so that "'the agency will not act on incomplete information, only to regret its decision after it is too late to correct.'" *Blue Mountains Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1216 (9th Cir. 1998) (quoting *Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 371 (1989)). Conducting an upfront, "coherent and comprehensive" analysis of the environmental impacts of expanded seismic <u>and</u> drilling activities – now that drilling is increasing as well – in the Alaskan Arctic Ocean will enable the agencies to make informed decisions and provide adequate protection for the affected resources.

NEPA regulations make clear that NMFS should not proceed with authorizations for individual projects like the Shell drilling proposals until its programmatic EIS is complete. Specifically, agencies are explicitly prohibited from undertaking any major action covered by a program EIS that is underway:

> While work on a required program environmental impact statement is in progress and the action is not covered by an existing program statement, agencies shall not undertake in the interim any major Federal action covered by the program which may significantly affect the quality of the human environment . . . .

40 C.F.R. § 1506.1(c).[6] NMFS and MMS have made it clear that the programmatic EIS is necessary for an adequate evaluation of the environmental impacts of approving currently proposed and reasonably foreseeable oil and gas exploration activity in the Beaufort and Chukchi Seas. Work on that PEIS, moreover, has been in progress since 2006. The primary effect of the recent notices withdrawing the 2007 draft PEIS and initiating a new EIS process is to expand the scope of that process to reflect the "renewed interest in exploratory drilling" along with other relevant new information. 74 Fed. Reg. at 55,539. In light of this ongoing program EIS process, it would be

[6] The regulation requires any activity covered by the program to meet a stringent three-part test in order to qualify for an exception to the general rule: it must be justified independently of the program; accompanied by an adequate environmental impact statement; and cannot prejudice the ultimate decision on the program. 40 C.F.R. § 1506.1(c). The proposed drilling fails to meet any of the requirements. Shell's proposed drilling is inseparable from the issues to be addressed in the Program EIS; it was accompanied only by an Environmental Assessment; and it must be considered in the larger context to avoid compromising future options for protecting vulnerable resources in the Arctic.

unlawful for NMFS to authorize marine mammal harassment associated with new exploration drilling. Only by evaluating as a whole the cumulative, long-term impacts of noise associated with expanding levels of seismic exploration and exploratory drilling can the full and potentially synergistic effects of the various individual projects be understood and adequately protective mitigation measures put in place.

The programmatic EIS should complement NMFS' commitment to create a five-year Arctic Action Plan that will include efforts to improve management of ocean and coastal resources. 75 Fed. Reg. 25,843 (May 10, 2010). We encourage NMFS to take the opportunity to thoroughly review both the industrial activities and the marine resources of the Arctic. Ultimately, the Action Plan and the EIS should ensure that widely acknowledged information gaps relating to the Arctic are filled and that all decisions are made in the context of a comprehensive plan for the region. Given these potentially groundbreaking plans, it is premature to issue IHAs that commit to a path of increasing exploitation of the Arctic.

III. ALTERNATIVE APPROACHES

One alternative approach to NMFS' piecemeal consideration of IHAs would be to create a sound budget for the Arctic, limiting the total amount of sound introduced into the water. Doing so would ensure that the effects of multiple noise sources do not create impacts that exceed the thresholds established by the MMPA. The sound budget should include any noise source that could contribute to a potential take, not just drillships and ice management vessels. Other oil and gas activities, such as overflights and support vessel traffic, could contribute to an overall sound level that has the potential to adversely affect marine mammals. This point was emphasized in the peer review comments for the 2010 Open Water meeting:

> Panel members emphasized the need for more "comprehensive ecosystem assessments" and they used that term to refer to the interaction and collective impact of all human activities and environmental phenomena to which an individual or population is exposed in a well-defined spatial region during a specific period of time.
>
> 2010 Peer Review at 9.

NMFS' proposed IHA inappropriately dismisses the impacts of these activities without analyzing whether they act in an additive or synergistic fashion with other noise sources. *See* 75 Fed. Reg. at 20,484 (discounting impacts of crew change and resupply activities as "normal vessel traffic"). Instead of dismissing the impacts of relatively smaller sources of sound, NMFS should account for and regulate those sources, and a sound budget may be the most appropriate tool for doing so.

As noted in these comments, in addition to the proposed IHA for Shell's drilling activities in the Beaufort Sea, NMFS has received IHA applications for multiple oil and gas related activities in the Beaufort and Chukchi seas this summer. If these activities are authorized and proceed as planned, migratory species such as the bowhead whale may encounter multiple activities at different times in either sea during the course of their migration. As discussed, NMFS must consider potential effects of the sound generated from all of those activities.

Establishing a sound budget that places an overall limit on noise would assist NMFS in reducing the potential for unanticipated harm.

Even without a comprehensive sound budget, NMFS could impose limits on the total number of activities permitted in the Arctic during the open-water season. Allowing only one or two noise generating activities each year could reduce the potential for take and would facilitate additional monitoring of the impacts of noise, since multiple noise sources make it very difficult to study the effect of specific sound sources.

CONCLUSION

For the above reasons, Shell's request for an IHA for marine mammal harassment incident to exploratory drilling in the Beaufort Sea should be denied. Thank you for your consideration of these comments.

Respectfully,

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Pacific Environment

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Exhibit 1

Comments of Dr. David E. Bain on Take of Marine Mammals Incidental to Specified Activities; taking marine mammals incidental to a marine drilling program

I am submitting this statement regarding the proposed Incidental Harassment Authorization (IHA) for Shell's exploratory drilling project in the Beaufort Sea. I am currently a contracting scientist for the National Marine Fisheries Service. I received my B.A. with majors in Biology and Psychobiology with Physics in 1980 and Ph.D. in Biology in 1989 from the University of California at Santa Cruz. I have authored over 30 peer-reviewed papers and reports on the behavioral ecology of marine mammals, especially of killer whales (*Orcinus*). A substantial portion of this work has been concerned with audition, sound production, and other aspects of the acoustic ecology of these species. I have conducted studies for the National Marine Mammal Laboratory and other branches of the National Marine Fisheries Service, Minerals Management Service, and U.S. Geological Survey on the impacts of acoustic disturbance on individuals and populations of marine mammals. Reports based on these and other disturbance related studies have been published in books and peer-reviewed journals and presented at scientific meetings of the International Whaling Commission, the Society for Marine Mammalogy, and the Acoustical Society of America.

I have reviewed the National Marine Fisheries Service's ("NMFS") proposed IHA, relevant parts of the Shell 2010 Camden Bay Drilling EA, the 2009 Shell Camden Bay FONSI, the Shell 2010 Chukchi Sea Drilling EA, the 2010 Shell Chukchi Sea FONSI, the Statoil 2010 Chukchi Seismic IHA Application, the July 2008 Bowhead Biological Opinion, "An Update on Feeding by Bowhead Whales near an Offshore Seismic Survey in the Central Beaufort Sea" (IWC SC/61/BRG3), and key papers cited by these documents. The conclusions I draw and the opinions I express are supported by texts and research that are generally accepted as reliable by experts in my field. Based on my review, for reasons outlined below, I believe the proposed drilling project poses a serious risk of harm to bowhead whales. The project will affect a large number of bowhead whales and is likely to adversely effect belugas as well.

The proposed drilling has the potential to adversely affect the Bering-Chukchi-Beaufort stock (BCBS) of the bowhead whale. The recovery of the BCBS stock is in contrast to the recovery of other stocks. There is no evidence that other bowhead stocks have increased, although data are limited (Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2008. Balaena mysticetus. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 04 March 2010). The Sea of Okhotsk stock may have been exposed to excessive harvest as part of illegal Soviet whaling. All stocks face potential impact from entanglement, vessel collisions, and disturbance (Angliss, R. P., and B. M. Allen. 2009. Alaska marine mammal stock assessments, 2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS AFSC-193, 258 pp.). Maintaining the BCBS bowheads is the best way to ensure survival of the species as a whole. Protecting them from expanding threats such as oil exploration and drilling, and the associated activities that may have limited the recovery of other stocks, is an important step in sustaining this species.

The number of animals likely to be impacted is underestimated.

First I will consider reasons why use of the 120 dB threshold for behavioral effects on cetaceans no longer reflects the best available science. Second, I will review the methods used to estimate the number of individuals likely to be taken within the zone of influence, once it is properly determined, and show how these are likely to result in underestimates as well.

The threshold for behavioral impacts.

Some individual bowheads are disturbed by low levels of noise, and will avoid the drill sites by many tens of kilometers when noise is at a maximum. Most individuals are likely to be displaced by a couple tens of kilometers. Some belugas and harbor porpoises have been shown to react strongly to noise from icebreakers or seismic surveys, respectively, at distances greater than 60 km from the source. However, because individual reactions are variable, some individuals are not easily displaced by noise, and will be exposed to noise levels which may cause temporary or permanent hearing loss. While NMFS only considered individuals within the 120 dB contour as subject to harm, in fact, lower levels of noise have been to shown to deflect migrating bowheads and exclude them from habitat.

NMFS based its use of a 120 dB contour primarily on studies of bowheads and gray whales. These studies were conducted based on whales close to noise sources. The 120 dB contour was commonly the level at which 50% of the animals exposed to noise showed observable changes in behavior, such as deflection of the travel path away from the source.

There are two problems with this interpretation of the data. First, this implies that 50% of the whales observed responded to levels lower than 120 dB. That is, 120 dB is not a threshold for a species but a median value of thresholds of individuals. The likelihood that individuals will be taken by exposure to noise levels below 120 dB declines with received level, but does not approach zero until the received level approaches the limit of audibility. Second, individuals that responded to levels much lower than 120 dB were not included in these studies, as they did not approach close enough to be observed. The IHA cites numerous subsequent studies of marine mammals responding to noise at levels far below 120 dB, but NMFS did not update the threshold in light of the best available science.

The data of Calambokidis *et al.* (Calambokidis, J., D. E. Bain and S. D. Osmek. 1998. Marine mammal research and mitigation in conjunction with air gun operation for the USGS "SHIPS" seismic surveys in 1998. Contract Report submitted to the Minerals Management Service) on Dall's and harbor porpoises illustrate well the problem with basing results on a platform that only allows observation near the noise source. They used multiple platforms to observe responses to airguns in the Salish Sea in Washington and British Columbia. The platforms included the large vessel towing the airguns, aerial surveys, and a small vessel that operated at long distances from the airguns.

From the airgun vessel, initial sightings only occurred within 3 km of the vessel, and approximately 90% of all porpoises seen were Dall's porpoises. None of the harbor porpoise groups contained more than two individuals.

In contrast, the majority of porpoises seen in aerial surveys were harbor porpoises. This suggests that harbor porpoises were actually the more abundant species along the trackline, and that a far larger proportion of the harbor porpoise population than Dall's porpoise population avoided the airgun vessel's study area. That is, conclusions based on the handful of harbor porpoises that were approached by the airgun vessel would not have been representative of the vast majority of the species.

This point was confirmed by the observations from the small vessel. Observations from the small vessel revealed the median received level at which harbor porpoises were observed was far lower than the level for Dall's porpoises, and the responses of harbor porpoises were nevertheless stronger than for Dall's porpoises observed at higher received levels than those at which harbor porpoises were observed (Bain, D.E. and R. Williams. 2006. Long-range effects of airgun noise on marine mammals: responses as a function of received sound level and distance. IWC SC/58/E35).

I believe the segregation of populations by noise tolerance (and physical ability to avoid the noise source) provides an explanation for why some studies detect marine mammals close to noise sources, and others show responses to received levels in the neighborhood of 90 dB or less at great distances. More extensive analysis of existing data, and perhaps new data, will be required to get a better handle on the proportion of individuals within a population likely to be taken by a given received level of noise. Further work will be needed to elucidate nuances of how those probabilities are influenced by non-noise factors such as location, activity state, or individual factors like age, sex, reproductive status, health status, group composition, and previous experience with noise exposure.

Similarly, data support a threshold below 120 dB for effects on belugas, and data from species not likely to be exposed in significant numbers in the Beaufort, such as killer whales and harbor porpoises, further indicate that 120 dB is too high a threshold for effects. Killer whales avoided vessel noise at about the 105 dB threshold (Williams, R., D. E. Bain, J. K. B. Ford and A. W. Trites. 2002a. Behavioural responses of killer whales to a “leapfrogging” vessel. J. Cet. Res. Manage. 4:305-310), and numerous studies have shown harbor porpoises respond to noise down to levels of 90 dB or below.

Methods for estimating quantitative impact.

The analysis in the proposed IHA does not accurately reflect the potential impact to whales. The drill sites are central to the migration route of bowhead whales. As a result, a large proportion of the population will be exposed to the drilling project. The Camden Bay sites are in a location where the migration corridor is narrow. This will require nearly all bowheads passing by a drill site while it is active to be exposed to biologically significant levels of noise.

While the effort to consider migration represents a significant step toward an accurate estimate of the number of bowheads likely to be taken, the estimate in the IHA is still biased low, and conditions could lead to additional underestimates. For example, the timing of the start of the fall migration through the Camden Bay is not reported due to limited data. Presumably, it would start prior to the start of whaling. Thus, elevated counts due to whales moving through the area prior to the onset of whaling would lead to the number of whales being taken being underestimated. Further, while the IHA assumes an end to drilling on October 24, the drilling permit extends until October 31. If drilling actually continues past October 24, large numbers of additional whales would be taken. It is also possible that whaling would be completed early. If this resulted in drilling resuming prior to September 15, additional whales would be taken not accounted for in the IHA.

As noted above, many bowheads are affected by noise levels below 120 dB. Thus, by only considering the proportion of the population that passes within the 120 dB contour, the number of bowheads to be taken is underestimated.

Further, it is unclear that using depths is the most accurate way to describe the migration corridor. Without knowing whether other factors such as distance from shore or distance from the ice edge are important, it is impossible to state whether the model is accurate, is likely to underestimate, or is likely to overestimate takes.

This problem in estimating takes is exacerbated by the flexibility in the drilling schedule, which allows for a wide range in the number of bowheads affected depending on the actual timing of the work.

The distance at which individuals will avoid the drill site will vary with a number of factors. How much noise drilling operations will make will vary with conditions. In particular, managing ice requires production of high levels of noise (Richardson, W. J., Jr. C.R. Green., R. Malme and C. I. Thomson. 1995. Marine mammals and noise. Academic Press. San Diego).

Ice management is likely to be especially disturbing for three reasons. First, the noise source is variable and moving. It is not possible to habituate to a variable noise source.

Second, the noise produced in ice management tends to be louder than other noise sources involved in drilling.

Third, icebreaking produces noise that results in stronger responses by belugas than other noise sources with comparable received levels.

Although the significance of ice management is downplayed in the IHA, if it occurs frequently enough that animals don't have the opportunity to resume their normal distribution and behavior between ice management bouts, the effects will be similar to that from continuous ice management.

Qualitative Impacts.

While the exact number of bowheads likely to be affected is unclear due to inaccuracies in the model's assumptions, the types of effects likely to occur can be specified. Bowheads are likely to be displaced from Camden Bay during the summer. This will result in a loss of resting and feeding areas to bowheads that otherwise might have resided there. In turn, this will reduce growth and reproduction, and increase vulnerability to disease and perhaps predation.

During the fall migration, whales will be displaced from the main migration route. This will increase the distance they need to travel. It is likely to disrupt some rest and feeding that would have occurred while bowheads passed by the Camden Bay area, and the increased travel distance will likely reduce the time available to rest during the migration.

During both periods, stress is likely to result from noise exposure, and in turn that can lead to reproductive failure and increased vulnerability to disease.

Even successful avoidance of significant noise exposure may have negative survival consequences. Although many noise exposure protocols consider movement of animals out of the area an acceptable outcome, as the animals are not exposed to high levels of noise, such movement requires expenditure of significant amounts of energy. Assuming animals were in optimal habitat, moving out of that habitat is likely to have consequences, such as reduced foraging efficiency. This is of particular importance in the Arctic, where nutrients from fresh water sources, ice cover, bottom topography, currents, and other factors influence prey density (National Research Council. 2003. Cumulative environmental effects of oil and gas activities on Alaska’s North Slope. National Academies Press. 288 pp., Minerals Management Service. 2004. Environmental Assessment Proposed Oil and Gas Lease Sale 195 Beaufort Sea Planning

Area. OCS EIS/EA MMS 2004-028). Such factors vary temporally, resulting in the location of patches of high quality habitat varying through time. Feeding studies noted that prey density averaged 230 mg/m^3, while feeding appears to require a density of 800 mg/m^3 (Minerals Management Service. 2004. Environmental Assessment Proposed Oil and Gas Lease Sale 195 Beaufort Sea Planning Area. OCS EIS/EA MMS 2004-028). Such highly productive patches are likely to be rare, so displacement from these areas would negatively affect individuals.

The waters near the Camden Bay drill site include an important feeding area (Koski, W.R., Funk, D.W., Ireland, D. S., Lyons, C., Christie, K., Macrander, A.M. and Blackwell, S.B. 2009. An Update on Feeding by Bowhead Whales near an Offshore Seismic Survey in the Central Beaufort Sea. International Whaling Commission Scientific Committee Report *SC/61/BRG3)*. Industrial noise associated with drilling will deflect whales away from this feeding area. The loss of feeding areas will reduce food intake. Taken together, these two factors will impair the energy balance of affected individuals (see Bain, D. E. 2002. A model linking energetic effects of whale watching to killer whale (*Orcinus orca*) population dynamics. Contract Report submitted to Orca Relief Citizens' Alliance). When whales are displaced from optimal habitat, rates of energy acquisition are reduced. Whales typically forage where prey density is at least four times higher than average prey density. Thus, displacement from optimal foraging habitat may result in a four-fold reduction in food intake.

The actual situation may be worse, as foraging may be abandoned altogether when conditions are poor. For example, killer whales are 40% less likely to forage at all when vessels are nearby (Lusseau, D., D. E. Bain , R. Williams, and J. C. Smith. 2009. Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. Endang. Species Res. 6:

211–221.), perhaps because vessel noise masks echoes from prey, making the probability of foraging successfully negligible (Bain, D. E. and M. E. Dahlheim. 1994. Effects of masking noise on detection thresholds of killer whales. In (T. R. Loughlin, ed.) Marine Mammals and The Exxon Valdez. Academic Press. N.Y. 243-256). While bowheads do not rely on echolocation, these results do indicate cetaceans do sometimes abandon foraging due to noise. The likely reduction in food intake due to reduced foraging effort is significant to food limited populations (e.g., killer whales: Ford, J. K. B., G. M. Ellis and P. F. Olesiuk. 2005. Linking prey and population dynamics: did food limitation cause recent declines of 'resident' killer whales (*Orcinus orca*) in British Columbia? Can. Sci. Advisory Sec. Res. Doc. 2005/042. 31 pp., Olesiuk, P.F., G.M. Ellis, and J.K.B. Ford. 2005. Life history and population dynamics of northern resident killer whales (*Orcinus orca*) in British Columbia. Canadian Science Advisory Secretariat Research Document 2005/ 045. http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2005/RES2005_045_e.pdf, Fisheries and Oceans Canada. 2008. Recovery Strategy for the Northern and Southern Resident killer whales (*Orcinus orca*) in Canada. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. Ix. + 81 pp).

Reduced feeding opportunities will lead to less successful calf recruitment. Bowhead whales are a slow growing species (Angliss, R. P., and B. M. Allen. 2009. Alaska marine mammal stock assessments, 2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS AFSC-193, 258 pp.). Impairing the energy balance will slow growth further. In turn, this will lead to delayed onset of sexual maturity. A consequence of this will be reduced recruitment of calves to the population. In addition**,** lactation requires approximately twice as much energy expenditure by new mothers than by non-reproductive females (Oftedal, O.T. 1997. Lactation in whales and dolphins: evidence of divergence between baleen- and toothed species. J. Mammary Gland Biol. Neoplasia 2:205-30). As a result, bowheads spend years storing the energy needed to reproduce successfully. Impairing the energy balance will increase the interval between successful calf recruitment (Lockyer, C. 1984. Review of baleen whale (Mysticeti) reproduction and implications for management. Rep. Int. Whal. Commn (Spec. Iss. 6):27-50). In turn, this will result in a reduction in the number of calves recruited to the population.

Reduced feeding opportunities can also reduce adult survival. Bowheads are a long-lived species, with some individuals living well over 100 years (George, J. C., J. Zeh, R. Suydam and C. Clark. 2004. Abundance and population trend (1978-2001) of Western Arctic bowhead whales surveyed near Barrow, Alaska. Marine Mammal Science, 20(4):755-773). Such a long lifespan requires successfully overcoming disease. Many diseases inhibit feeding until the immune system overcomes the infection. To survive this period of non-feeding, individuals must have an adequate blubber layer. Impaired energy balance reduces the probability that an individual will survive an infection. In turn, this would lead to additional mortalities in the population. Further, females who die young will not produce as many calves asthey would have if they lived a normal lifespan.

The proposed activity may also adversely effect whales by interfering with resting. The waters near the Camden Bay drill site include an important resting area (Koski, W.R., Funk, D.W., Ireland, D. S., Lyons, C., Christie, K., Macrander, A.M. and Blackwell, S.B. 2009. An Update on Feeding by Bowhead Whales near an Offshore Seismic Survey in the Central Beaufort Sea. International Whaling Commission Scientific Committee Report *SC/61/BRG3).*

The noise associated with drilling and drilling support will likely divert whales away from this area. The loss of use of resting areas such as Camden Bay will require greater energy expenditure. Whales typically are active part of the time and rest part of the time. Traveling around a noise source replaces resting with active time. Marine mammals typically have a metabolic scope of about 6. That is, energy consumption at rest is about six times lower than fast travel. In killer whales, travel at moderate speeds requires expenditure of about twice the energy as resting (Kriete, B. 1995. Bioenergetics in the killer whale, *Orcinus orca*. Ph.D. Thesis, University of British Columbia, Vancouver, BC. 138pp).

Stress from noise exposure can also lead to reduced survival. Stress concurrent with Level B harassment would have additional population consequences. Stress may occur in the absence of behavioral change, or the absence of change in significant behavioral patterns such as foraging or nursing, or exclusion from optimal habitat. Lusseau *et al.* (Lusseau D., Slooten E. & Currey R.J. 2006. Unsustainable dolphin watching activities in Fiordland, New Zealand. Tourism in Marine Environments 3: 173-178.) concluded disturbance caused a decline in and posed a significant threat to the survival of the bottlenose dolphin population in Doubtful Sound, New Zealand. While they noted vessel strikes were occurring (Level A takes), cumulative behavioral effects (Level B takes) due to exposure to noise levels not capable of directly causing immediate injury or death were believed to be the primary threat to the population.

Noise exposure is likely to result in stress to bowhead whales, and stress can impair the immune system (Rolland, R. M., P. K. Hamilton, S. D. Kraus, B. Davenport, R. M. Gillett, and S. K. Wasser. 2006. Faecal sampling using detection dogs to study reproduction and health in North Atlantic right whales (Eubalaena glacialis). J. Cetacean Res. Manage. 8:121–125 and

Romano, T. A., M. J. Keogh, C. Kelly, P. Feng, L. Berk, C. E. Schlundt, D. A. Carder and J. J. Finneran. 2004. Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Can J. Fish. Aquat. Sci. 61:1124-1134) resulting in an increase in mortality from disease.

In addition to avoidance and stress, the industrial noise associated with drilling and ice management can mask sounds in the natural environment. Masking will impair their ability to hear vocalizations. Vocalizations are important for finding mates. Failure to find mates could result in a reduction in calf recruitment. Echoes from vocalizations are likely to provide important information on ice thickness. Failure to correctly assess ice thickness could result in an increase in mortality. Predators can be detected at greater distances acoustically than visually by healthy individuals. Masking would increase vulnerability to predation, which in turn could increase mortality.

Belugas also occur in both the Chukchi and Camden Bay drilling areas during summer and autumn. Mothers with young would be expected in greater numbers than older males in the habitat closest to the drill sites. Like bowheads, belugas rely on hearing for navigation, communication, and avoiding predation. In addition, belugas use echolocation to find prey (Au, W. W. L. 1993. The sonar of dolphins. Springer-Verlag, New York. 277 pp.). That is, masking of echolocation signals by noise, temporary threshold shifts, and permanent threshold shifts will impair the ability of belugas to find food. This mechanism for harm is in addition to impaired ability to find food due to displacement from high quality feeding areas (Southall, B.L., A. E. Bowles, W.T. Ellison, J. J. Finneran, R. L. Gentry, C. R. Greene Jr., D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, P. L. Tyack. 2007. Criteria for behavioral disturbance. Aquatic Mammals. 33:446-473 and Finneran, J. J., C. E. Schlundt, R. Dear, D. A. Carder and S. H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. J. Acoust. Soc. Amer. 111:2920-2940). Belugas are known to be highly disturbed by icebreaker noise over 50 km away. In contrast, the IHA estimates the number of belugas to be affected only out to the 120 dB contour. This seriously underestimates the number of belugas to be affected not only due to the underestimate of the area of the zone of influence but also due to higher densities of belugas 50 km offshore of the drill site than within 7.4 km of the drill site (see Moore, S. E., D. P. DeMaster, and P. K. Dayton. 2000. Cetacean habitat selection in the Alaskan Arctic during summer and autumn. Arctic. 53:432– 447). Masking of communication signals is also likely to be a problem at this distance. Although beluga communication signals contain high-frequency components that are less vulnerable to masking by low frequency noise than low-frequency components, the high-frequency components are directional and attenuate faster than low-frequency components. That is, the omni-directional low-frequency component used for long distance communication among widely spaced belugas is vulnerable to masking (see Miller, P. J. O. 2006. Diversity in sound pressure levels and estimated active space of resident killer whale vocalizations. J Comp Physiol A Neuroethol Sens Neural Behav Physiol. 192:449-59 and Bain, D. E. and M. E. Dahlheim. 1994. Effects of masking noise on detection thresholds of killer whales. In (T. R. Loughlin, ed.) Marine Mammals and The Exxon Valdez. Academic Press. N.Y. 243-256). Beluga females are likely to require two to four times as much food while lactating to successfully rear a calf than while pregnant (Oftedal, O.T. 1997. Lactation in whales and dolphins: evidence of divergence between baleen- and toothed-species. J. Mammary Gland Biol.

Neoplasia 2:205-30 and see Bain, D. E. and J. Olhiser. 1994. Factors affecting food intake of killer whales and dolphins. Paper presented to the International Marine Animal Trainers AssociationConference. Tacoma, WA). Unlike bowheads, belugas cannot store sufficient blubber to successfully rear calves when food intake is reduced. In addition to lactation, wake riding is an important mechanism for transferring energy from the mother to a calf. The energetic cost of this increases dramatically with increased swimming speed as may occur in the event of flight from disturbance. Like bowheads, not all belugas flee from noise sources all the time. That is, some belugas may be exposed to injurious levels of noise (Camden Bay EA and National Research Council. 2003. Ocean noise and marine mammals. National Academies Press. Washington, DC. 192 pp.).

Population censuses of the Eastern Chukchi and Beaufort stocks of belugas have not been conducted in the last ten years. Therefore, population trends are unknown. In contrast to bowheads, no evidence of population growth was seen when censuses were still being conducted (Angliss, R. P., and B. M. Allen. 2009. Alaska marine mammal stock assessments, 2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS AFSC-193, 258 p.). In summary, drilling will not take place within the core of the beluga distribution or migration route, but the belugas most likely to occur near the drill sites, mothers with calves under six months of age, are the most vulnerable to harm from the project.

Cumulative Effects.

Cumulative effects are of further concern. “The accumulation of impacts from vessels, seismic exploration, and drilling are of concern across the North Slope of Alaska,” according to the Alaska Stock Assessment Report (Angliss, R. P., and B. M. Allen. 2009. Alaska marine mammal stock assessments, 2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS AFSC-193, 258 p.).

There are two ways effects can accumulate. One, the same individual may be exposed to multiple stressors. Two, many individuals in the same population may be exposed to a stressor, and then compete with each other more intensely to try to offset the impact of that stressor.

In addition to drilling in the Beaufort, NMFS is considering drilling in the Chukchi, and multiple seismic surveys in the Chukchi and a seismic survey in the Beaufort. Due to the duration of these activities, an individual may be exposed more than once within a given project, and could easily be exposed to disturbance by multiple projects.

That is, when looking at the biological impact on bowhead whales, drilling in the Beaufort cannot be considered separately from other planned activities, including similar activities in the Chukchi Sea, Statoil's 3D seismic testing scheduled to occur in the Chukchi this summer, and Shell's proposed seismic activities in both seas.

It is incorrect to assume that activities in the Chukchi are far enough away to preclude impacts to the same individuals. The drilling plan allows for flexibility in the drilling schedule. As a result individual bowheads may be exposed multiple times. Although the average swimming speed may be high enough that a bowhead could swim from one site to the other faster than the drill ship would change sites, bowheads do not necessarily swim continuously and in a straight line. That is, they may stop to rest and feed. Their course may be indirect due to natural factors and as they avoid sources of disturbance. Such detours would allow the drill ship to relocate faster than some individual bowheads. Repeated exposure of the same individual to multiple disturbance events increases the risk of long-term harm relative to single exposures.

The other consideration is that there will be little difference in the effect on the population regardless of whether many individuals are affected a small number of times or a small number of individuals are affected many times or for a prolonged period of time. The relative degree of exposure among individuals determines which individuals are likely to bear the burden of the population scale effects. That is, individuals extensively affected are less likely to be able to overcome the impact, whereas individuals little affected are more likely to be able to overcome the impact at the expense of non-exposed individuals as they more aggressively try to obtain the additional resources needed to offset short-term effects.

Individuals within a population near carrying capacity are more likely to die or experience reduced reproduction than individuals in populations well below carrying capacity, when exposed to disturbance (Bain, D. E. 2002a. A model linking energetic effects of whale watching to in killer whale (Orcinus orca) population dynamics. Contract report submitted to Orca Relief Citizens' Alliance). That is, individuals in this bowhead population are quite vulnerable to harm from disturbance due to the proposed drilling project.

The number of individuals that would be added to the population in the absence of disturbance can be estimated using the equation:

$$N/\quad t = rN \quad 1- \quad N/K$$

where N is the current population size, K is the carrying capacity, r is the intrinsic rate of increase (i.e., the rate at which the population would grow in the absence of intraspecific competition), and θ is a shape parameter that specifies how population consequences of intraspecific competition vary with population size (Olesiuk, P. F., G. M. Ellis and J. K.B. Ford.

2005. Life History and Population Dynamics of Northern Resident Killer Whales (Orcinus orca) in British Columbia. CSAS Research Document 2005/045. 1-81).

Excluding whales from feeding areas effectively reduces K. In turn, this reduces the rate of population increase. This is equivalent to removing individuals from the population. Excluding whales from resting areas requires individuals to expend more energy. Thus they need to eat more to survive. This effectively increases the amount of intraspecific competition, and hence reduces K. In turn, this reduces the rate of population increase. This is equivalent to removing individuals from the population. When the shape parameter is 1, the per capita growth rate peaks when the population is at 50% of carrying capacity. However, for marine mammals, the shape parameter tends to be large. That is, intraspecific competition does not become important until the population size is closer to carrying capacity than 50%. However, intraspecific competition becomes much more important near carrying capacity when the shape parameter is large than when it is small. Disturbance has the effect of causing the population to behave as though it is closer to carrying capacity than it would in the absence of disturbance. As a result, the population consequences of disturbance are much stronger when the population is near carrying capacity than when it is depleted.

The above implies that population growth in the presence of disturbance is not a sign that disturbance is unimportant. Rather, depleted populations are capable of some growth in conditions that are obviously harmful to populations closer to carrying capacity (Bain, D. E. 2002a. A model linking energetic effects of whale watching to in killer whale (Orcinus orca) population dynamics. Contract report submitted to Orca Relief Citizens' Alliance). Bowheads are believed to be nearing carrying capacity now, but would have been depleted when the population was still growing in the presence of disturbance (Angliss, R. P., and B. M. Allen. 2009. Alaska marine mammal stock assessments, 2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS AFSC-193, 258 pp.). That is, the depleted population was capable of growth in the presence of disturbance in the 1990's, but an increase in disturbance to the population now, while it appears to be near carrying capacity, could result in slowed growth or a loss of individuals.

Cumulative effects on the population are likely to increase at a steeper than linear rate. That is, doubling exposure to disturbance is likely to more than double population level effects (the life or death effects, Bain, D. E. 2002a. A model linking energetic effects of whale watching to in killer whale (Orcinus orca) population dynamics. Contract report submitted to Orca Relief Citizens' Alliance).

The increase in vessel traffic associated with this project increases the risk of ship strike. Bowheads are known to be struck by ships (Angliss, R. P., and B. M. Allen. 2009. Alaska marine mammal stock assessments, 2008. U.S. Dep. Commer., NOAA Tech. Memo. NMFS AFSC-193, 258 p.), and ship strike has become a leading source of mortality in the closely related North Atlantic Right Whale (Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors 2009. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2008. NOAA Tech Memo NMFS NE 210; 440 pp.)

Summary and Conclusions

In summary, the proposed IHA is for thousands of bowhead whales and this constitutes between ten and twenty percent of the population. Viewed in raw numbers or as a percentage, this would not seem to qualify as a "small take." (In human terms, between ten and twenty percent of the US population would be 30-60 million people.) Further, the numbers and percentage are likely to be underestimates. Due to the large number of individuals likely to experience short-term behavioral effects, and the likelihood that the population is at or near its carrying capacity, it is reasonably likely that annual recruitment will be reduced and survival rates will decline. If any other proposed projects are approved, the number of individuals likely to be taken would increase, and a stronger decline in recruitment and survival rates would be expected and become even more likely. The proposed mitigation measures have the potential to reduce the number of marine mammals exposed to sound levels capable of causing immediate injury or death, but not eliminate them altogether. Restricting the drilling season to times when protected species are least likely to be present or are likely to be present in small numbers is a mitigation measure available to NMFS which might allow the agency to ensure only small numbers of marine mammals are taken, and that impact on the population through the disturbance mechanism remains minimal.

Dated: May 19, 2010

David E. Bain

David E. Bain, Ph.D.

Exhibit 2

SUMMARY OF KEY RESEARCH ON BOWHEAD WHALE IMPACTS DUE TO OFFSHORE OIL AND GAS ACTIVITY DURING THE BEAUFORT SEA FALL OPEN WATER SEASON AND BOWHEAD WHALE USE OF THE ALASKAN BEAUFORT SEA DURING FALL WESTWARD MIGRATION

August 2009

NOTE: All results corroborate observations reported by AEWC whaling captains prior to research being conducted. Whaling captains' observations are used by the North Slope Borough, NMFS, and operators to identify research needs related to offshore impacts. While not exhaustive, the information here provides a summary of key research results regarding fall bowhead whale use of the Alaskan Beaufort Sea and offshore oil and gas development impacts. The very small number of research citations provided here demonstrates the very limited amount of baseline research available on bowhead whale use of the Beaufort Sea habitat.

BOWHEAD WHALE USE OF THE BEAUFORT SEA DURING FALL WESTWARD MIGRATION.

CAMDEN BAY: Whaling captains from Nuiqsut and Kaktovik consistently report bowhead whales feeding, resting, and caring for young in Camden Bay waters. Aerial surveys have also documented feeding in Camden Bay (Moore et al. 1989).

EASTERN, MIDDLE, AND WESTERN BEAUFORT: Bowhead whales feed regularly in the nearshore waters of the eastern, central and western Alaskan Beaufort Sea during September-October. This entire region should be considered an integral part of the summer- autumn feeding range of bowhead whales (Lowry, et al., 2004, p. 221; Conclusion).

BOWHEAD WHALE DISTURBANCE EFFECTS DUE TO OFFSHORE DRILLING AND ICE MANAGEMENT IN THE BEAUFORT SEA, CAMDEN BAY (See NRC, 2003, p. 100; Richardson, et al., 1995, p. 276.; *Attachment 1*) .

HAMMERHEAD/SIVULLIQ 1986 (with little ice management): "Zone of avoidance" by fall migrating bowhead whales appeared to extend 15-25 km (9-15 mi) from the drill ship. No whales were detected closer than 9.5 km (6 mi) from the drillship (received sound at 15 km was 105-130 dB), few were seen closer than 15 km (9 mi), and one whale was observed for 6.8 hours as it swam in an arc of about 25 km (15 mi) around the drillship (LGL and Greeneridge 1987).

CORONA 1986 : Received sound levels at 15 km (9 mi) were reported to be 105-125 dB (LGL and Greeneridge 1987).

KUVLUM 1992 (with daily ice management): Whales began to deflect at about 32 km (19 mi) away from the drill rig (Brewer et al. 1993). Whaling captains reported behavioral changes (swimming patterns and respiratory rates) at 20+ miles. (See Attachment 1).

KUVLUM 1993: The whales were nearly excluded from an area within 20 km (12 mi) of the drilling platform (Davies 1997, Hall et al. 1994).

BOWHEAD WHALE DISTURBANCE EFFECTS DUE TO OFFSHORE GEOPHYSICAL ACTIVITY IN THE BEAUFORT SEA, CAMDEN BAY (See LGL Ltd., et al., 1999, pp. 5-60, F-7; Attachment 2.)

In 1996, 1997, and 1998, bowhead whales were rarely seen within 20 km of an active seismic operation. <u>Near total avoidance extended to 15-20 km in two years, with substantial avoidance extending out to 30 km in the third year.</u> Significantly elevated sighting rates at 20-30 km during seismic activity the first year and 30-40 km during seismic activity in the third year are consistent with the interpretation that whales concentrated at those distances while avoiding the areas closer to the seismic operations.

BOWHEAD WHALE DISTURBANCE DUE TO VESSEL TRAFFIC (See Richardson, et al., 1995, p. 270). Bowheads react strongly and consistently to approaching vessels of a wide variety of types and sizes; interrupt normal behavior and swim rapidly away; surfacing, respiration, and diving cycles are affected. Research at BP’s Northstar Island, where oil production is occurring, also showed bowheads deflecting away from the island at very low levels of received sounds (Richardson 2008).

RESEARCH AND MITIGATION RELYING SOLELY ON MARINE MAMMAL OBSERVERS (MMOs) (See Richardson, et al., 1995, p. 268). <u>Some bowhead whales begin to avoid approaching diesel-powered vessels 4 km or more away -- too far away</u>

to be observed from the vessel. Therefore, MMOs are not an appropriate means of documenting disturbance.

ACTIVITIES MOST LIKELY TO AFFECT BOWHEAD WHALES. These include marine seismic exploration, exploratory drilling, ship and aircraft traffic, discharges into the water, dredging and island construction, and production drilling (NRC, 2003, p. 100).

Marine seismic exploration produces the loudest industrial noise in the bowhead whale habitat (NRC, 2003, p. 100). Aside from seismic vessels, the strongest noise sources known to occur near bowhead whales are icebreakers (Burns, et al., 1993, p. 639).

CONSEQUENCES OF DISTURBANCE._“The significance of short-term behavioral responses to the long-term well-being of individuals and populations is rarely known. Most brief interruptions of normal behavior may have little affect on overall energy balance and reproductive performance. However, physiological reactions may occur even if no overt behavioral response is evident (e.g., MacArthur, et al. 1979; Section 11.8.4). Uncertainties about physiological, long-term, and population consequences are common for all types of marine mammals and all sources of disturbance.” (Richardson, et al., 1995, p. 242, citing, MacArthur, R.A., V. Geist and R.H. Johnston. 1979. *Factors influencing heart rate in free-ranging bighorn sheep: A physiological approach to the study of wildlife harassment. Can. J. Zool.* 57(10):2010-2021).

In most studies, little or no information has been obtained about the duration or biological significance of altered behavior after disturbance (Richardson, et al., 1995, p. 242). This is a very serious base line research need in the Arctic. The AEWC has requested support for this research for more than 20 years.

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National Research Council (NRC). Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. 2003. National Academies Press. 288 pp.

Richardson, W.J. 2008. Montiroing of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 1999-2004. LGL Rep. P1004 from LGL Ltd. (King City, Ontario), Greeneridge Sciences Inc. (Santa Barbara, CA), WEST Inc. (Cheyenne, WY), and Applied Sociocultural Research (Anchorage, AK) for BP Exploration (Alaska) Inc. (Anchorage, AK).

Richardson, W. John, Charles R. Greene, Jr., Charles Malme, Denis H. Thomson. 1995. Marine Mammals and Noise. Academy Press. 575 pp.

Exhibit 3

Shell Offshore Inc.
3601 C Street, Suite 1334
Anchorage, AK 99503

March 30, 2007

United States Coast Guard, District 17
Attn: Lt. Matthew York
709 West 9th Street
Juneau, Alaska 99801

Subject: Revised Request for the Establishment of Safety Zones for the Frontier Discoverer Drill Ship and the Semi Submersible Drill Unit Kulluk in the Beaufort Sea, Alaska

Dear Lt. York:

On December 22, 2006 Shell Offshore Inc. (SOI) submitted two separate requests to the United States Coast Guard (USCG) to have Safety Zones established around drill site locations for two drilling units; the Frontier Discoverer Drill Ship (Discoverer) and the Semi Submersible Drill Unit Kulluk (Kulluk), in the Beaufort Sea Alaska. On January 17, 2007 the USCG notified SOI the information received by the USCG did not meet the threat threshold to establish a Safety Zone, as established in 33 CFR 147.10. SOI respectfully submits this additional information and asks the USCG to reconsider the Safety Zone requests.

During the 2007 drilling season (late July to the end of October) the Discoverer and the Kulluk will be managed by seven vessels (see the vessel inventory submitted with the original request). The vessels will be used for ice management, anchor handling, spill response, and servicing the drill units. In addition, SOI will also have a dedicated Oil Spill Response tanker in the general area. In all, SOI will have control of 10 marine vessels in support of drilling. Most of the vessels proposed for use by SOI have lengths greater than 30.5 meters (m) (100 feet [ft]) and draft at least 4 m (13.1 ft). Attachment A provides specifications for drilling equipment, ice management, and anchor handling vessels to be used during 2007.

The Discoverer and Kulluk are each secured utilizing a radial anchor array, with radii of 460 m (1,509 ft) and 640 m (3,000 ft) respectively. The anchors will be set in approximately 30 m (100 ft) of water and each will be marked using a crown buoy with a rig acoustical release for rapid departures if warranted. Much of the ice management will be within these anchor arrays and will be handled by the large, fixed-drive Kapitan Dranitsyn (Discoverer) and Vladimir Ignatyuk (Kulluk). These high horsepower ice management vessels are slow to react and each step of the ice management process must be examined well in advance. Attachment B provides centerpoint locations for the proposed safety zones.

Ice conditions during 2006 were such that the areas of drilling interest were ice covered the majority of the period between July and October. If ice conditions are similar during 2007, then each drill rig will be constantly ice managed within its anchor array. Should a vessel move into the 500 m (1640.2 ft) zone without authorization, there is a greatly increased risk that there could be a vessel-vessel collision or a vessel-ice collision. There is also a risk that the ice management vessels will create leads that other vessels in the area will attempt to exploit.

Although marine traffic historically has been relatively light in this portion of the Beaufort Sea, between May and October 2006, based on Shell Communication Center call logs, two large vessels were in the general vicinity of the area to be drilled; the Greta S. Akpik (official #1064872) out of Barrow and a tug and barge (Sinuk 180-1) operated by Crowley Maritime Corporation. It is anticipated that there will be much more traffic in the Beaufort Sea this year because of the increase in oil and gas exploration and an increase in scientific studies that are part of the International Polar Year research program (a two-year initiative that includes up to 50 studies in Alaska).

SOI believes it is imperative that the only way to ensure the safety of all persons and vessels in the area to be drilled is the creation of Safety Zones, into which are allowed only authorized vessels.

Support and detailed information regarding the Discoverer, Kulluk and attending vessels are attached. If additional support information is needed, please contact me at (907) 770-3700, or by e-mail at Susan.Childs@shell.com.

Sincerely,

Shell Offshore Inc.

Susan Childs

Susan Childs
Regulatory Affairs Coordinator, Alaska

cc: Mark Stone - Shell
Chandler Wilhelm – Shell
Travis Purvis - Shell
Greg Horner – ASRC Energy Services
Jeff Walker – MMS
Don Perrin - ADNR
Project File
Administrative File

15214-D-07-022/07-067

MARINE MAMMAL COMMISSION

24 May 2010

Mr. P. Michael Payne, Chief
Permits, Conservation, and Education Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, Maryland 20910-3226

Dear Mr. Payne:

The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the application from Shell Offshore, Inc., under section 101(a)(5)(D) of the Marine Mammal Protection Act. The applicant is seeking authorization to take small numbers of three cetacean species (beluga, bowhead, and gray whales) and three pinniped species (ringed, spotted, and bearded seals) by harassment incidental to open-water offshore exploratory drilling at the Torpedo and Sivulliq prospects in Camden Bay, Beaufort Sea, Alaska, during the 2010 Arctic open-water season. The Commission also has reviewed the National Marine Fisheries Service's 19 April 2010 *Federal Register* notice (75 Fed. Reg. 20481) announcing receipt of the application and proposing to issue the authorization, subject to certain conditions.

RECOMMENDATIONS

The Marine Mammal Commission recommends that the National Marine Fisheries Service—

- issue the requested incidental harassment authorization contingent upon the successful negotiation of a conflict avoidance agreement between Shell and the Alaska Eskimo Whaling Commission and affected whaling captains associations;
- facilitate development of more comprehensive conflict avoidance agreements that involve other potentially affected communities and take into account potential adverse effects on all species taken for subsistence purposes including, but not limited to, bowhead whales;
- require Shell to suspend operations immediately if a dead or seriously injured marine mammal is found in the vicinity of the operations and the death or injury could be attributable to the applicant's activities. Any suspension should remain in place until the Service has reviewed the situation and determined that further deaths or serious injuries are unlikely or has issued regulations authorizing such takes under section 101(a)(5)(A) of the Act;
- revise its assessment of expected takes associated with the proposed activity by evaluating all aspects of Shell's operations, whether directly involved in drilling or indirectly related to providing operational support;
- take a lead role pursuing the objectives set forth in the expert panel review associated with the open-water meeting to improving ecosystem assessments and assessments of the cumulative effects of oil and gas operations;

- develop and employ means for tracking and enforcing Shell's implementation of monitoring and mitigation measures to ensure that they are executed as expected; and
- include in its environmental assessment for this project a thorough analysis of (1) the potential for an oil spill, including a worse-case scenario, during the proposed exploratory drilling activities, and (2) the ability of Shell to respond to such a spill, including contingency plans in the event that the drillship, *Frontier Discoverer*, is disabled or sunk.

RATIONALE

Issuance of the requested authorization hinges largely on whether the operations (1) have an unmitigable adverse effect on the availability of marine mammals for subsistence purposes and (2) affect more than a small number of marine mammals or have more than a negligible effect on their populations. The Service states that the primary means of taking marine mammals during the proposed exploratory drilling operations would be by disturbance from drilling sounds and secondary sources of noise from drilling and support vessels, including ice management vessels, oil spill response vessels, and aircraft. As described in this letter, taking all these activities into account is necessary to provide a full assessment of the potential effects of exploratory drilling on the availability of marine mammals for subsistence and on the populations themselves.

Availability of Marine Mammals for Subsistence

With regard to the availability of marine mammals for subsistence purposes, Shell has developed a draft plan of cooperation for the 2010 Camden Bay exploratory drilling program to minimize effects on subsistence harvests. The plan establishes the time and location of drilling activities to avoid interference with the annual fall bowhead whale hunts from Kaktovik, Nuiqsut, and Barrow. It also establishes transit routes and times to avoid other subsistence use areas, and it calls for communication with other coastal communities before operating in or passing through those areas. In addition, Shell plans to hold consultation meetings with the affected communities and subsistence user groups to discuss the mitigation measures included in the plan.

Shell also is reviewing the draft 2010 conflict avoidance agreement with the Alaska Eskimo Whaling Commission and the various whaling captains associations and is expected to make a decision as to whether it will sign the agreement prior to commencing operations in 2010. Shell is not required to sign the agreement to obtain an incidental harassment authorization, but such agreements often contain measures that help the Service make determinations of no unmitigable adverse impact. In this particular case, the Service already has made a preliminary determination that the proposed operation will not have an unmitigable adverse impact on subsistence uses. It based this determination on the measures described in Shell's draft plan of cooperation, the proposed mitigation and monitoring measures, and the project design.

Shell should be acknowledged for taking the steps just described to avoid unacceptable effects on the availability of marine mammals for subsistence purposes. However, it is not yet clear that those steps are sufficient. For example, do Shell's consultations with Alaska Native communities resolve the hunters' concerns? Similarly, negotiating and reaching consensus on a conflict avoidance agreement related to bowhead whales is useful but also leads to the question as to why such agreements should not be prepared for subsistence hunters taking other species if Shell's activities might affect the availability of those species. Thus, the Commission believes that a determination of no unmitigable adverse impact on the availability of marine mammals for subsistence uses should be based, in part, on concurrence of those people who are the experts regarding the availability of marine mammals for subsistence harvests—the potentially affected Alaska Natives. With that in mind, the Marine Mammal Commission recommends that the National Marine Fisheries Service issue the requested incidental harassment authorization contingent upon the successful negotiation of a conflict avoidance agreement between Shell and the Alaska Eskimo Whaling Commission and affected whaling captains associations. Such an agreement should help promote cooperation and communication among the parties involved and minimize potential conflicts between industry activity and bowhead whale subsistence hunts. Similarly, the Marine Mammal Commission recommends that the National Marine Fisheries Service facilitate development of more comprehensive conflict avoidance agreements that involve other potentially affected communities and take into account potential adverse effects on all species taken for subsistence purposes including, but not limited to, bowhead whales.

Effects on Marine Mammal Populations

The potential effects on marine mammals from exploratory drilling and related support operations range from small changes in behavior (e.g., temporary modification of diving patterns) to larger shifts in distribution and habitat use and, under certain conditions, physical injury or death (e.g., from ship strikes). Because Shell has chosen to apply for an incidental authorization under section 101(a)(5)(D) of the Act, the authorization, if granted, cannot include allowances for serious injuries or deaths. With that limitation in mind, the Marine Mammal Commission recommends that the National Marine Fisheries Service require Shell to suspend operations immediately if a dead or seriously injured marine mammal is found in the vicinity of the operations and the death or injury could be attributable to the applicant's activities. Any suspension should remain in place until the Service has reviewed the situation and determined that further deaths or serious injuries are unlikely or has issued regulations authorizing such takes under section 101(a)(5)(A) of the Act.

The information in the *Federal Register* notice indicates that the Service may have limited its analysis to drilling-related noises and dismissed a number of effects that may arise from support activities. For example, on page 20484, the notice states that "crew change and resupply activities are considered part of normal vessel traffic and are not anticipated to impact marine mammals in a manner that would rise to the level of taking." The Commission disagrees with this conclusion. Once the drilling vessel and associated vessels (e.g., spill response vessels) are in place, most of the vessel activity in the region likely will involve crew change and resupply vessels. These vessels may make frequent trips and may travel at relatively high speeds in areas where bowheads and other marine mammals occur. The vessels may disturb those marine mammals, will introduce additional noise into the marine environment, and will pose a risk of ship strikes. To dismiss the operations of these vessels as normal vessel traffic unreasonably discounts such added risks. Similarly, the Service preliminarily concludes that "ice-management activities are not anticipated to impact marine mammals in a manner that would rise to the level of taking." Here, too, the Commission disagrees. Previous research in the Arctic provides ample evidence that ships, and especially icebreakers, introduce large amounts of sound into the ocean that may cause bowhead whales and other marine mammals to alter their behavior. Finally, the Service's preliminary determination does not appear to take into account the risks associated with the drilling process itself. For example, the drilling process discharges a variety of material into the marine environment (e.g., drilling muds and cuttings, cooling water), and the Service's analysis does not appear to have accounted for the potential effects of such discharges. If, in fact, the Service's preliminary decision is based almost entirely on the sounds from the drillship, then the full potential for taking marine mammals likely will be underestimated. To address this concern, the Marine Mammal Commission recommends that the National Marine Fisheries Service revise its assessment of expected takes associated with the proposed activity by evaluating all aspects of Shell's operations, whether directly involved in drilling or indirectly related to providing operational support.

Cumulative Effects on Marine Mammal Populations

Judging whether or not the effects of the proposed activities will be negligible requires taking into account the full range of factors that may already be affecting the species and stocks in this region. Wildlife populations do not consist just of healthy, resilient animals. They also include animals that are compromised by injuries, disease, or parasitism; females that are stressed physiologically by the energetic demands of carrying a fetus or nursing a calf; and calves that are in the most vulnerable stage of their life history, being at first entirely dependent on their mother for nutrition and protection and then making the transition to nutritional independence. For such individuals, the effects of one drilling operation might be tolerable if that were the only risk factor to which they were exposed. However, the populations under consideration are exposed to other human activities (e.g., seismic testing at various locations in the Beaufort and Chukchi Seas, seasonal barge and vessel traffic, hunting, and disturbances from several already established oil and gas operations). They also are experiencing the consequences of climate change, although it is too early to tell whether the effects of Arctic warming will be positive or negative for some species, including gray and bowhead whales.

As noted in the expert panel report completed in association with the open-water meeting, the Service needs to address, as fully as possible, the cumulative effects of multiple human-related activities on the marine mammals that may be affected by the proposed operations. The panel described a number of basic tasks that the industry, federal agencies, Alaska Native organizations, conservation organizations, and other interested parties could undertake to promote more comprehensive ecosystem assessments. These include, but are not limited to—

- Emphasizing multidisciplinary studies that integrate physical, chemical, and biological measurements to assess human influences throughout marine ecosystems;
- Incorporating data collected using all reliable methods and from all pertinent sources, including broad ecosystem studies, more narrowly targeted research, and other activities (e.g., commercial, military) that may have ecosystem effects. These data streams should be

integrated spatially and temporally to provide a more comprehensive assessment of the ecosystem;

- Archiving all collected data in standardized databases for sharing among scientific disciplines;
- Maintaining and making available detailed logs of all activities in the Beaufort and Chukchi area (e.g., oil and gas, shipping, fishing, scientific cruises, use of ice breakers);
- Developing and implementing policies and means for sharing data and ensuring that the research community has access to the information needed to conduct more integrated, comprehensive ecosystem assessments;
- Developing better and more timely methods for integrating and displaying combined datasets spatially and temporally;
- Including data on location and timing of subsistence hunts;
- Monitoring developments in other regions or scientific disciplines that may reveal better ways of integrating and analyzing multiple datasets or conducting cumulative effects or comprehensive ecosystem analyses; and
- Including pertinent biological information on the status, ecology, and behavior of the potentially affected species or stocks (e.g., contaminant load, body condition, reproduction, distribution, and relative abundance).

The Commission concurs that these tasks would promote better ecosystem assessment as well as assessment of the cumulative effects of oil and gas operations. Therefore, <u>the Marine Mammal Commission recommends</u> that the National Marine Fisheries take a lead role pursuing these tasks for the purpose of improving ecosystem assessments and assessments of the cumulative effects of oil and gas operations. Doing so will take cooperation with all involved parties and will require time to implement, but each of the listed actions should enhance the Service's ability to fulfill its regulatory role regarding such effects.

Monitoring, Mitigation, and Enforcement

The *Federal Register* notice states that Shell's marine mammal monitoring and mitigation plan incorporates both design features and operational procedures for minimizing potential impacts on marine mammals. Those include pre-season sound propagation modeling to establish the appropriate safety and behavioral radii; reducing vessel speed and/or changing course to avoid coming close to sighted marine mammals; resuming full activity only after marine mammals are confirmed to be outside the safety zone; and prohibiting aircraft from flying below an altitude of 1,500 feet. The Service states that it intends to require additional mitigation measures to "ensure the least practicable impact on the affected species or stocks." Measures under consideration include reducing vessel speed within 300 yards of whales; avoiding multiple changes in vessel direction and speed within 300 yards of whales; reducing speed and changing operating procedures in inclement weather; avoiding drilling operations during the bowhead migration and subsistence hunting periods; using vessel and aerial monitoring to look for concentrations of bowhead whales and migrating bowhead whale cow/calf pairs; and temporarily interrupting operations when such groups are sighted and appear to be responding to drilling operations. The Marine Mammal Commission fully supports the implementation of such measures.

With regard to monitoring and mitigation requirements, visual monitoring—whether from aircraft or vessels—can be woefully inadequate under certain conditions, and reliance on visual monitoring does not give confidence that potentially important effects on marine mammals will be detected. The Commission has written extensively about the need to better characterize the effectiveness of these measures, not necessarily for the purpose of discontinuing them if they provide some benefit, but more for giving managers and decision-makers a more realistic appraisal of the efficacy of such measures and the need to improve them. Because it is responsible for issuing incidental harassment authorizations under the Marine Mammal Protection Act, and because it often must do so on the basis of monitoring and mitigation measures of uncertain utility or efficacy, the Service is frequently in the position of having to decide whether to approve or disapprove a proposed activity based on incomplete information. Here, too, the expert panel report associated with the open-water meeting provided a number of suggestions for improving monitoring and mitigation during the course of Shell's exploratory drilling in Camden Bay. The Marine Mammal Commission concurs with those recommendations and also recommends that the National Marine Fisheries Service incorporate them into the authorization, if issued.

However, requirements for certain monitoring and mitigation measures will mean little if the parties involved fail to implement them. In this case, Shell likely will be working under a tight schedule determined in part by seasonal changes in weather and, particularly, ice conditions. Although the company may recognize monitoring and mitigation measures as important, it may not deem such measures to be the highest priority if they conflict with operations considered essential to drilling progress. Under such conditions, monitoring and mitigation measures may not be put into practice as intended and their value may be compromised. To avoid such situations, the Marine Mammal Commission recommends that the National Marine Fisheries Service develop and employ means for tracking and enforcing Shell's implementation of monitoring and mitigation measures to ensure that they are executed as expected.

Worst-case Scenario

Finally, the National Marine Fisheries Service's *Federal Register* notice, Shell's application, and the Minerals Management Service's environmental assessment of the proposed activities all discount the potential for a large oil spill occurring during the proposed exploratory drilling activities. In its environmental assessment regarding Shell's 2010 Outer Continental Shelf Lease Exploration Plan for Beaufort Sea Leases Camden Bay, Alaska, OCS-Y-1805 and 1941, the Minerals Management Service states that, "[f]or purposes of Shell's proposed exploration drilling program during the 2010 open-water season, OCS historical crude and condensate spill data demonstrates that a large spill is too remote and speculative an occurrence to be considered a reasonably foreseeable occurrence of Shell's proposed exploration project.... A very large oil spill [≥150,000 bbl] from a well-control incident during OCS exploratory drilling is a similarly unlikely occurrence.... A very large spill from a well-control incident is not a reasonably foreseeable event in connection with the exploration activities set forth in Shell's EP [Exploration Plan], and therefore, this EA does not analyze the impacts of such a worst-case scenario."

On 30 March 2009 the Marine Mammal Commission wrote to the Minerals Management Service (letter enclosed) regarding lease sales in the Beaufort and Chukchi Seas. Among other things, the Commission recommended that the Minerals Management Service revise its draft environmental impact statement by "expanding its tables of impact to include worst-case scenarios, the probability of their occurrence, and the potential consequences should they occur." This notion that unlikely events need not be considered because of the small probability that they will occur runs counter to standard risk analysis. Such analysis defines risk not simply as a function of probability of occurrence but also in terms of the consequences if a worst-case scenario occurs.

Considering the recent blowout of the *Deepwater Horizon* oil rig in the Gulf of Mexico and the potentially devastating ecological impacts from the associated oil spill, the Commission considers it essential that the Minerals Management Service and the National Marine Fisheries Service conduct a thorough analysis of not only the likelihood of a spill, but the potential consequences if a spill should occur. Such analysis is particularly important given the adverse weather conditions, presence of sea ice, and major logistics challenges to exploratory drilling and oil spill response efforts in the Arctic environment, and the potential for severe adverse impacts to the fragile Arctic ecosystem and Alaska native subsistence hunting. What is the risk that Shell will experience a failure similar to that in the Gulf? How long would it take to drill a relief well if the *Frontier Discoverer* were disabled? Would response efforts be brought to a halt by advancing winter conditions? These seem reasonable questions that warrant consideration by the National Marine Fisheries Service. The Service's *Federal Register* notice states that it is currently preparing an environmental assessment to determine whether or not this proposed activity may have a significant effect on the human environment. The purpose of that assessment is to inform decision-makers regarding such concerns. With that in mind, the Marine Mammal Commission recommends that, in preparing the environmental assessment, the National Marine Fisheries Service conduct a thorough analysis of (1) the potential for an oil spill, including a worse-case scenario, during the proposed exploratory drilling activities, and (2) the ability of Shell to respond to such a spill, including contingency plans in the event that the drillship, *Frontier Discoverer*, is disabled or sunk.

Please contact me if you have questions regarding these recommendations.

Sincerely,

Timothy J. Ragen

Timothy J. Ragen, Ph.D.
Executive Director

Enclosure

Cc: Liz Birnbaum, Minerals Management Service

Attachment

Marine Mammal Commission
4340 East-West Highway, Room 905
Bethesda, MD 20814

30 March 2009

Mr. John Goll
Regional Director
Alaska OCS Region
Minerals Management Service
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503–5820

Dear Mr. Goll:

The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the Minerals Management Service's draft environmental impact statement (DEIS) for Beaufort Sea and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 (73 Fed. Reg. 77835). The Commission commends the Service for its efforts to complete this complex document on Arctic lease sales and the activities that may flow from them. The Commission provides the following recommendations and rationale with the intent of improving the statement and thereby better informing decision-makers and the public about potential strategies for and risks associated with oil and gas development in the Beaufort and Chukchi Seas.

RECOMMENDATIONS

The Marine Mammal Commission recommends that the Minerals Management Service revise its DEIS by—

- adding an alternative that contrasts the potential costs and benefits of coastal and offshore development and deferral of the entire coastal region under consideration;
- providing a comprehensive description of the key risks associated with oil and gas development under Arctic marine conditions, the measures required to address those risks, the efficacy of existing measures, and means for improving those measures when they fall short of their objective;
- describing the frequency and proprietary nature of the seismic studies conducted over the continental shelf areas of the Beaufort and Chukchi Seas and evaluating whether the frequency and intensity of such studies could be reduced by making results available to all oil companies or developing other mechanisms to reduce their frequency and intensity while still meeting the companies' needs for seismic information;
- including a species-by-species review of the pertinent literature to ensure inclusion of all salient reports pertaining to the species or species groups that may be affected;
- providing a more comprehensive and quantitative assessment of cumulative effects taking into account the limitations of the proposed mitigation measures; and
- expanding its tables of impact to include worst-case scenarios, the probability of their occurrence, and the potential consequences, should they occur.

RATIONALE

Oil and gas lease sales in the Beaufort and Chukchi Seas provide one mechanism for helping to meet our nation's energy demands in the foreseeable future. They also pose a risk of significant adverse effects on (1) the marine living resources in or near the proposed lease areas and (2) the people that depend on those resources, particularly Alaska Natives who use them for subsistence purposes.

The primary risks associated with oil and gas production from these areas are (a) contamination (e.g., oil spills or leaks, fuel spills, disposal of drilling muds); (b) noise and disturbance from seismic surveys, construction, exploratory and development drilling, support operations, and spill responses; (c) habitat degradation from contamination, construction, and drilling; (d) marine mammal/ship collisions involving construction and support activities; (e) unmitigable effects on the distribution and abundance of marine mammals that can be taken by Alaska Natives for subsistence purposes; and (f) the cumulative effects of those and other risk factors arising from additional human activities in the action and adjacent areas (e.g., commercial shipping, commercial fishing, military exercises, tourism, coastal development, and oil and gas development in Alaska state waters and Canadian waters).

The companies that explore the Beaufort and Chukchi Seas for oil and gas will implement a considerable set of mitigation measures to avoid or minimize the effects of these risk factors. Those mitigation measures will include such things as the application of engineering and technology aimed at preventing and responding to adverse effects (e.g., spill prevention and response measures); the implementation of spatial and temporal constraints on seismic surveys, construction, and operations; and the use of equipment, training, and exercises to maximize response capabilities. The Commission also assumes that oil and gas companies will coordinate with other parties in the proposed lease areas to avoid significant adverse interactions or unnecessary duplication of activities.

Despite all these important efforts, oil and gas development in these regions still poses significant risks to the affected marine ecosystems. Viewed in a broad context, and based in part on the information in this DEIS, the Marine Mammal Commission believes that—

- development of oil and gas operations in the areas of concern will likely occur over many decades;
- the demand for oil during that period is difficult to predict and will be a function of many factors, including growing energy demands as well as shifting emphasis to alternative energy sources;
- the potential adverse effects of oil and gas production appear to be greater in coastal regions that exhibit greater biological diversity, where spilled oil is more likely to contact benthic substrates and cause greater ecological disruption, and where Alaska Natives must find the resources to satisfy their subsistence needs;

- oil and gas development strategies that minimize the probability of an accident are crucial because current response measures are either unproven or known to be only marginally effective (e.g., oil spill response in ice) in harsh Arctic conditions;
- the Beaufort and Chukchi ecosystems are particularly vulnerable because they are in what is expected to be a prolonged period of relative ecological instability as the Arctic climate changes;
- expanding human activities will add to climate-related risks to the Beaufort and Chukchi ecosystems;
- current baseline data to assess and mitigate the effects of climate change and human activities in the Arctic is limited; and
- approaches to oil and gas development that allow time to devise better prevention and mitigation measures should reduce the overall risk to these ecosystems during the period of exploitation.

These observations all point support the notion that is oil and gas are going to be extracted from the Chukchi and Beaufort Sea, then the Service should consider a strategy of deferring oil and gas development in those areas that are more vulnerable to potential adverse effects, including coastal regions that include areas where spring leads and polynyas tend to develop. As described in the DEIS, the costs of deferring activities in coastal areas in the Beaufort and Chukchi Seas would be an estimated reduction of 12 and 21 percent in oil and gas available for extraction, respectively. The benefits would be additional time to improve prevention, response, and mitigation measures in the more vulnerable coastal ecosystems and a reduction of risk to Alaska Native communities that depend on coastal ecosystems for subsistence.

A Coastal Versus Offshore Alternative

The alternatives put forward in the DEIS do not provide a sharp distinction between oil and gas development in offshore versus coastal areas, particularly in the Beaufort Sea where the area under consideration more closely approaches the coastline and where the continental shelf break divides the region under consideration into distinct coastal and offshore habitats. Although the existing alternatives allow for deferral of activities in some coastal areas, the parsing of the coastal area essentially minimizes the benefits that might accrue from deferring the entire coastal region. The end result is that deferral of any single parsed area does not provide significant benefits relative to alternative 2, which does not distinguish between offshore and coastal areas at all. This is clearly evident in the Executive Summary table of impact conclusions, which reveals virtually no distinction among the alternatives (i.e., conclusions for alternatives 3 through 6, whether in the Beaufort or Chukchi Sea, are virtually identical to conclusions for alternative 2). The approach taken is surprising because the relative costs and benefits of offshore versus coastal oil and gas exploitation have been debated at length in other regions of the United States. In fact, the DEIS dismisses a number of suggested alternatives that were aimed at this very distinction.

To provide a comprehensive assessment of the costs and benefits of a full coastal deferral, <u>the Marine Mammal Commission recommends</u> that the Minerals Management Service revise its

DEIS by adding an alternative that contrasts the potential costs and benefits of coastal and offshore development and deferral of the entire coastal region under consideration. Such an alternative should draw a clearer distinction for decision-makers and the public based on biological differences (e.g., species present); the potential consequences of contaminants, noise, disturbance, vessel activity, and habitat degradation in offshore versus coastal ecosystems; the utility of various mitigation measures; the difficulty of working in these two environments; and the implications for Alaska Native communities along Alaska's northern and northwestern coastline.

Mitigation Measures and Their Efficacy

The DEIS notes various statutes and regulations that establish a framework for mitigation and points to a number of Notices to Lessees and Operators. The DEIS also indicates that it imposes multiple requirements on lessees and operators to ensure adequate mitigation. Unfortunately, the description of mitigation measures—with its multiple references to other documents— is more confusing than enlightening, and the Commission cannot see how decision-makers or the public could possibly make informed judgments regarding these proposed lease sales based on the information provided. In particular, the DEIS fails to address some of the fundamental questions regarding mitigation measures for oil and gas operations in the Arctic marine environment. The most obvious are related to the challenge of responding to oil spills in or under the ice. Although efforts are underway to develop response strategies in icy conditions, existing response measures are unproven at best and, if response measures under other conditions are any indication, those used in ice are likely to be minimally effective. This information seems vital for decision-makers and the public, but the DEIS does not provide a direct and thorough discussion of such matters. In the end, decision-makers and the public are left in the position of having to assume that the existing statutes, regulations, notices to lessees and operators, and the ability of oil companies to implement these mitigation measures somehow will prove adequate. Absent a thorough description of the mitigation measures and their efficacy, the Marine Mammal Commission cannot concur that such is the case.

A description of the efficacy of mitigation measures is particularly important in a DEIS such as this. Agencies and industries whose activities pose threats to the marine ecosystem often rely on mitigation measures that are unproven or known to be marginally effective, at best. For example, Navy vessels and seismic survey vessels often carry observers to watch for marine mammals and use sightings within safety zones as a basis for curtailing or stopping operations. Although these observation efforts undoubtedly are helpful at preventing physical harm, only a portion of the marine mammals in the area are likely to be detected. Detection rates may be exceeding low under some conditions, such as during periods of inclement weather or darkness. Similarly, agencies and industries often rely on "ramp-up" procedures to give animals in an area an opportunity to leave before noise levels become intolerable, but they have not collected the data to determine if these procedures are effective or, alternatively, involve greater risk because curious animals approach the sound source instead of moving away from it. The underlying concern regarding mitigation measures is whether they work and, if not, how they can be improved, replaced, or supplemented. To inform decision-makers and the public, the Commission believes that the action agencies have an obligation to develop mitigation measures, assess and describe their efficacy, and undertake the research needed to improve them if they fall short of acceptable standards. For all these reasons, the Marine Mammal Commission recommends that the Minerals Management Service revise its DEIS by providing a comprehensive description of the key risks associated with oil and gas development under Arctic marine conditions, the measures required to address those risks, the efficacy of existing measures, and means for improving those measures when they fall short of their objective.

Finally on the topic of mitigation, the DEIS indicates that the Service will require industry to develop "Adaptive Management Mitigation Plans" to ensure there are no unmitigable adverse effects to subsistence resources or harvests. As a general principle, the Commission supports the notion of adaptive management. However, the value of this approach depends, in part, on whether the approach is applied in a precautionary or non-precautionary manner – that is, on whether it is like to make over-protection or under-protection errors. The Commission believes that the former is clearly preferable to ensure no unmitigable adverse effects on the marine environment or subsistence users. With that in mind, stakeholders should be an integral part of the process for developing mitigation measures.

Unnecessary Repetition of Seismic Studies

Figure 3.2.1-4 is one of the more remarkable graphics in the DEIS because it suggests intensely concentrated seismic studies in both regions, but particularly over the continental shelf area in the Beaufort Sea. The period of time over which the area was surveyed is not clear from the graphic, but it raises questions as to whether such intense surveying is needed and whether some surveys are unnecessarily redundant because the information from seismic studies is considered proprietary and not shared. Seismic studies are among the more controversial activities associated with oil and gas development as they may disturb or injure marine mammals or cause them to alter their habitat-use patterns in ways that are biologically significant or significant to Alaska Natives that harvest them for subsistence purposes. To clarify the need for such intense surveys, the Marine Mammal Commission recommends that the Minerals Management Service revise its DEIS by describing the frequency and proprietary nature of the seismic studies conducted over the continental shelf areas of the Beaufort and Chukchi Seas and evaluating whether the frequency and intensity of such studies could be reduced by making results available to all oil companies or developing other mechanisms to reduce their frequency and intensity while still meeting the companies' needs for seismic information.

Species-Specific Reviews

In reviewing the DEIS the Commission did not find reference to the following publication:

Amstrup, S.C., G.M. Durner, T.L. McDonald, and W.R. Johnson. 2006. Estimating potential effects of hypothetical oil spills on polar bears. Alaska Science Center, U.S. Geological Survey, Department of the Interior.

During the review period we were not able to go through the DEIS and compare the descriptions of potential effects to ensure that all the relevant literature was considered. But the absence of this particular report was disconcerting. A number of articles by Amstrup were cited regarding polar bears, some of which were published after this article. Given its relevance, and the possibility that other key literature might have been overlooked, the Marine Mammal Commission recommends that the Service revise its DEIS by including a species-by-species review of the pertinent literature to ensure inclusion of all salient reports pertaining to the species or species groups that may be affected. Such a review would inform decision-makers and the public about risks to specific species. It also might help identify biologically sensitive areas that the Service could protect with time/area closures or should avoid altogether in its oil and gas lease sales.

Assessment of Cumulative Effects

The cumulative effects of a proposed action, combined with the effects of other activities in the same area, often are the most difficult to characterize and mitigate. The DEIS recognizes their importance, stating that "without proposed mitigation in place, cumulative effects on subsistence resources and harvests from noise and disturbance would be major" (page 4-324). The DEIS concludes, however, alternatives would result in negligible to minor direct, indirect and cumulative effects to ESA listed bowhead and humpback whales" (page 4-446). The Commission has difficulty reconciling these statements because the efficacy of mitigation measures to protect bowhead whales is still a matter of legitimate debate and concern. For these reasons, the Marine Mammal Commission recommends that the Minerals Management Service revise its DEIS by providing a more comprehensive and quantitative assessment of cumulative effects taking into account the limitations of the proposed mitigation measures.

Describing Risk

Finally, the Commission believes that the manner in which the DEIS expresses conclusions about risks could inadvertently mislead decision-makers and the public. With respect to any particular adverse event (e.g., an oil spill), risk is generally defined as a function of two considerations, the probability of the event and the consequences if it occurs. The DEIS tends to describe risks in terms of anticipated outcomes (i.e., certain effects "are expected to be" or "should be"), but this approach is tantamount to describing the best possible outcome. Consider a DEIS statement regarding potential impact to bowhead whales: "Alternative 2 would result in negligible to minor direct, indirect, and cumulative effects to ESA-listed bowhead ... whales." What this statement does not convey is the possibility and consequence of a large spill in the migratory path of bowhead whales – a worst-case scenario that is a primary concern for both Alaska Natives and conservationists and that should be taken into account by decision-makers and the public as they consider these oil and gas lease sales. The manner in which risk-related data are presented may have considerable influence on decision-making and, for that reason, it is imperative that the DEIS provide clear, objective statements of the probability and consequences of major adverse events. Therefore, the Marine Mammal Commission recommends that the Minerals Management Service revise the DEIS by expanding its tables of impact to include worst-case scenarios, the probability of their occurrence, and the potential consequences, should they occur.

The Commission hopes that these recommendations and rationale are helpful. Please contact me if you have questions.

Sincerely,

Timothy J. Ragen

Timothy J. Ragen, Ph.D.
Executive Director

May 19, 2010

VIA EMAIL

P. Michael Payne, Chief
Permits, Conservation and Education Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway, Silver Spring, MD 20910
E: PR1.0648-XU80@noaa.gov

Re: National Marine Fisheries Service's Proposed Incidental Harassment Authorization for Takes of Marine Mammals Incidental to an Exploration Drilling Program Near Camden Bay, Beaufort Sea, AK

The Native Village of Point Hope submits the following comments on the National Marine Fisheries Service's (NMFS) April 19, 2010, proposed authorization pursuant to the Marine Mammal Protection Act (MMPA). NMFS has proposed issuing an Incidental Harassment Authorization (IHA) to Shell Offshore Inc. to take six species of marine mammals – the bowhead, gray, and beluga whales and the ringed, spotted, and bearded seals – during Shell's 2010 exploration drilling activities in the Beaufort Sea.

The Native Village of Point Hope is a federally recognized tribal government under the 1934 Indian Reorganization Act, as amended in 1936 for Alaska Natives, that is responsible for the well being of its 950 members. It is also the oldest continuously inhabited village in all of North America. For thousands of years, our members have harvested the sea. We preserve our traditional way of life, hunting bowhead whales, walrus, seals, polar bears, and beluga whales, as well as various fish and sea birds. Where we live, a half-gallon of milk costs nine dollars, and families depend on subsistence hunting as a source of healthy food. Subsistence resources are so vital to our well being that if the health of the ocean deteriorates, so will the physical health of our people. Yet, the importance of hunting, whaling, and fishing runs much deeper. They are central to our culture as a way to celebrate our heritage and maintain ties within the community. We view the ocean as our garden. It is what sustains us physically and spiritually as individuals and as community members.

We would like to describe briefly our subsistence traditions and concerns about the effects oil and gas development may have on those activities. The Agviq (the bowhead whale) hunt is at the center of our culture. Preparation for the hunt is a year long process. We normally start preparing in March for the hunt: sewing the skins; preparing the tools; and clearing out the underground freezers that were built generations ago. Our hunt is in the spring. In June, we share and celebrate the landing of our whale. We celebrate for three days, which is open to anyone who wants to come. The ladies have a special day during the three day celebration. We celebrate our firstborn sons and initiate them. We give gifts to the female elders. There are then two days of dancing, where we sing our traditional whaling songs that have been handed down through the generations. This is also the time we as a community acknowledge our responsibility to share with those less fortunate.

We hunt Uugruk (bearded seals) right after the whaling feast. We hunt for the skins and the food. It takes six skins to cover a whaling boat. When that is done, we prepare our food to last for the year. We save a little portion of whale for Thanksgiving, Christmas, and first slush ice. Throughout the year, ceremonial dances surround all of our celebrations of the whale and our subsistence harvest. This is not an individual endeavor or even just a family endeavor. The whole community is involved in every aspect of the whale hunt and celebration.

We are deeply concerned about the proposal by Shell Oil to conduct exploratory drilling in the Arctic in 2010 and beyond. These activities will interfere with our way of life, especially when added to the effects of climate change, which is already affecting our ability to engage in our traditional way of life. When oil and gas activities frighten or injure the animals we depend upon in the ocean, we spend time, money, and energy pursuing them and may still end up with nothing. We are forced to travel farther from shore in our attempt to get our whale, walrus or seal, causing safety problems and stress and worry to family and community members. This worry is not for nothing. These are not calm waters. We have always been taught to be very careful and constantly vigilant because of how quickly everything can change while on the ice or in the water. By going farther offshore to hunt, we increase the possibility of our equipment failing and worse still the risk that someone will be seriously injured or even killed. Neither are we prepared for this individually as subsistence users nor as a community in terms of our search and rescue capabilities. These are not issues that we should be forced to face.

There are indications that changes occurring in the Arctic are already having very real effects on our hunts. In recent years, our hunters have been out for many days without landing a whale. This is very unusual. Also, there were two times in recent memory that we did not land a whale. When that happens, even though Barrow and the other communities will share with us, the circle is not complete because we are not a part of the harvest. Something is just missing from our year round ceremony – it is as if we have lost a part of our identity. We are very fearful of the effects of adding oil and gas activities to these changes in our waters. The way we look at it is it's like a monopoly – only a few people will benefit from this development and we will suffer.

We are also haunted by the worry that an oil spill will occur in our waters. The ongoing spill in the Gulf of Mexico demonstrates that enormous spills can result from exploration activity like Shell's proposed operations. Our area is harsher than the Gulf of Mexico, and an Arctic oil spill could be impossible to stop for entire seasons if ice encroaches on the area before the spill is halted. This type of spill would be disastrous and could disrupt our culture for generations or even permanently. We worry that our land and water would forever be contaminated by oil. The animals would either disappear or be so tainted that our children or grandchildren would be forced to decide which is less harmful to them: contaminated whale meat or processed food shipped up from some place like Costco.

We join in the May 19, 2010, comments by conservation groups on the proposed IHA. The proposed drilling threatens the welfare of marine mammals on which our community's health depends and our culture. We urge NMFS to deny Shell's application. If NMFS does authorize Shell's drilling operations, NMFS must first correct the identified errors and omissions.

We will do everything in our power to protect our water, land, and way of life and hope that EPA will address our concerns.

Sincerely,

Caroline Cannon
President
Native Village of Point Hope

North Slope Borough

OFFICE OF THE MAYOR

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Edward S. Itta, Mayor

May 19, 2010

Via Electronic Mail

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Re: Shell Offshore Inc. Application for an Incidental Harassment Authorization (IHA) to Take Marine Mammals by Harassment, Incidental to Offshore Drilling in the Beaufort Sea.

Dear Mr. Payne,

Thank you for the opportunity to comment on the National Marine Fisheries Service's (NMFS) proposed authorization of incidental take of marine mammals from offshore drilling in the Beaufort Sea by Shell Offshore Inc. (Shell).

The North Slope Borough (NSB or Borough) has the largest territorial and coastal jurisdiction of any municipal government in the United States—an area larger than the State of Minnesota. We have multiple interests at stake in the Arctic Ocean Outer Continental Shelf (OCS).

Foremost are our interests in the health and welfare of our residents, who are rightfully concerned about potential health impacts associated with offshore oil and gas development on the North Slope. Activities allowed by the proposed authorization will have direct, indirect, and cumulative impacts on species that are critical to our subsistence harvest. North Slope residents continue to depend heavily on the subsistence harvest for maintaining both culture and health. Traditional foods are far more nutritious than many types of imported "store-bought" food, and their continued consumption has repeatedly been shown to be critical to the health of our residents.[1] Subsistence activities also provide spiritual and cultural affirmation, and are crucial for passing skills, knowledge and values from one generation to the next.

As evidenced by the ongoing disaster in the Gulf of Mexico, it is no longer debatable that our concerns are founded. The potentially significant impacts of industrial activities and environmental changes offshore—both individually and cumulatively—demand comprehensive environmental analysis and proven mitigation prior to the issuance of additional incidental take authorization. With this in mind, we submit to you the following:

I. Shell's Proposed Activities will Create Cumulative Impacts and Require an Environmental Impact Statement.

In the Federal Register Notice, NMFS generally states that it is "currently preparing an Environmental Assessment" to determine whether Shell's activities may have a significant impact on the environment.[2] But pursuant to the National Environmental Policy Act[3] and its accompanying regulations,[4] NMFS should prepare an environmental impact statement (EIS) to adequately consider the potentially significant impacts, including the cumulative impacts of Shell's proposed activities.

In particular, Shell's proposed drilling activities combined with all other past, present and reasonably foreseeable future activities will create mpotentially significant cumulative impacts.[5] NMFS should consider the cumulative impacts of Shell's Camden Bay proposal in combination with the following proposals, all of which may be planned for the 2010 open water season:

1) Shell's Chukchi Sea Exploration Plan
2) Shell's Chukchi and Beaufort seas Geophysical Work

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[1] The subsistence diet protects against obesity and diabetes, and associated problems such as hypertension and cardiovascular disease. Restricted access to subsistence foods therefore places the community at increased risk for these problems. If subsistence use in the region is reduced, very significant increases in obesity and diabetes in the impacted communities would predictably ensue. *See*

Ebbesson SO, Kennish J et al. Diabetes is Related to Fatty Acid Imbalance in Eskimos. *International Journal of Circumpolar Health.* 58: 108-119. 1999.

Shephard R and Rode A. The Health Consequences of Modernization: Evidence from Circumpolar Peoples. Cambridge University Press. 1996

Curtis T, Kvernmo S et al. Changing Living Conditions, Lifestyle, and Health. *International Journal of Circumpolar Health*. 64(5) 442-450

Jorgensen M, Bjerregaard P et al. Diabetes and impaired glucose tolerance among the Inuit of Greenland. *Diabetes Care*. 26: 1766-1771. 2002.

Ebesson S, Schraer C et al. Diabetes and impaired glucose tolerance in three Alaskan Eskimo Populations. *Diabetes Care*. 21: 563-569. 1998.

Hogan P et al. Economic Costs of Diabetes in the U.S. in 2002. *Diabetes Care.* 2003. 26: 917- 932.

[2] 75 Fed. Reg. at 20509.

[3] *See* 42 U.S.C. 4321-4347.

[4] For specific regulatory guidance on making a significance determination, *see* 40 C.F.R. § 1508.27.

[5] 40 C.F.R. § 1508.7

3) GX Technology's Beaufort Sea seismic surveys
4) Statoil's Chukchi Sea seismic surveys
5) Seismic surveys planned in the Canadian Arctic
6) U.S. Geological Survey's seismic surveys
7) BP's production operations at Northstar

If NMFS is in possession of applications and/or any other information regarding these activities, it should include it in the record for this action because that information is integral to a thorough, up-front analysis of cumulative impacts.

NMFS must also consider the reasonably foreseeable drilling activities in future years. Future drilling is foreseeable for a number of reasons. First, Shell has sought authorization to drill five total wells – three in the Chukchi and two in the Beaufort. Shell, however, informed the Minerals Management Service (MMS) that it has time to drill only three wells in a single season, because it plans to use the Discoverer and its support vessels to drill all the wells. Therefore, Shell, would need at least a second year to drill all the wells included in the two exploration plans. Also, Shell has applied for a multi-year Clean Air Act permit from the Environmental Protection Agency (EPA) and has therefore already sought coverage for future drilling operations. Finally, ConocoPhillips plans to drill in the Chukchi Sea in 2012 and has begun its EPA permitting process with EPA for that activity.

In conducting a cumulative impact analysis, NMFS should ascertain the significance of multiple exposures to underwater noise, ocean discharge, air pollution, and vessel traffic; all of which could impact bowhead whales and decrease survival rates or reproductive success.[6] NMFS should consider how many bowhead whales would be exposed to underwater noise, where those exposures could take place, what impact the noise could have on bowhead whale behavior, and the biological significance of these impacts. NMFS should also consider the cumulative impact of discharge and whether bioaccumulation of contaminants could have lethal or sub-lethal effects on bowhead whales and other marine mammals. NMFS should then synthesize that information into a health impact assessment looking at the overall combined effect to the health of the local residents.

NMFS is currently in the process of preparing such an EIS in partnership with MMS, assessing the potentially significant impacts of oil and gas exploration activities in the Arctic. In choosing this course, NMFS has recognized that these activities can have significant impacts on marine mammals and that a longer term, more comprehensive review needs to be taken of these activities. It would be a tremendous mistake for NMFS to allow Shell to proceed on a one-year IHA when the impact of those activities could have a catastrophic impact on Arctic resources and foreclose management options to be developed in the forthcoming EIS. NMFS should not allow exploration activities to proceed when it has the opportunity to develop a robust long-term plan for balancing the needs of industry with Congress' mandate in the Marine Mammal Protection Act to prioritize the protection of our subsistence resources.

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[6] Thorough comments regarding potential marine mammal impacts is contained in Department of Wildlife comments below, and in Attachment A, a Declaration from Wildlife Biologist Robert Suydam, PhD. of the NSB Wildlife Department.

II. NMFS and Shell Must Consider the Potential Impacts, including Site-Specific Impact Analysis, of a Blowout and/or Major Oil Spill.

Shell's application materials and NMFS's public notice appear to disregard the threat of an oil spill and the resulting takes of marine mammals and interference with subsistence activities that may consequently occur.[7] In light of the recent Gulf of Mexico disaster, the application should be returned to the applicant for inclusion of this necessary site-specific detail.

Shell's application lacks any information about potential take resulting from a release of oil in any amount. The federal register notice for this proposed action does not include any mention of a possible release of oil and the potential harm to marine mammals and subsistence activities. There is no rationale for ignoring these potential impacts in the face of abundant evidence that marine mammals are vulnerable to the effects of exposure to oil.

Given the project's proximity to Camden Bay, an area where thousands of bowhead whales congregate to feed and rest during their fall migration, the omission of oil spill analysis is a serious concern. This area is also near the subsistence hunting grounds for the villages of Nuiqsut and Kaktovik. A large oil spill in this habitat during the fall migration could expose thousands of whales and other marine mammals to oil, causing long-term interference with the subsistence activities of our residents and with the local culture, and long-term contamination of this relatively pristine Arctic environment.

Armed with the knowledge of the Deepwater Horizon blowout, we must no longer assume that offshore oil and gas activities are risk-free.

For these reasons, NSB strongly recommends that NMFS return the application to Shell. NSB also requests clarification from NMFS on whether and how the agency considers the risk of an oil spill when authorizing exploratory drilling activities pursuant to the Marine Mammal Protection Act, including a complete rationale for the agency's position. In regulating industrial activities pursuant to the Marine Mammal Protection Act, NMFS should consider the consequences of a major spill in Arctic waters.

III. NMFS and Shell Have Not Considered the Potential Impacts or Potential Mitigation of Large Volumes of Marine Discharge, Including Toxic and Bio-Accumulating Waste Associated with Exploratory Drilling Activities.

NMFS and Shell have similarly disregarded the potential threats to marine mammals and subsistence activities resulting from the daily intake, exchange and discharge of millions of gallons of biocide-treated cooling water, drilling fluids, muds, cuttings and other contaminants, including toxic and bio-accumulating waste, into Camden Bay and the Beaufort Sea.[8] The

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[7] NSB made similar but more extensive comments regarding the absence of a site and project specific impact analysis associated with a blowout to Minerals Management Service that were entirely disregarded in reaching its conditional approval of Shell's 2010 Camden Bay Exploration Plan. *See* p. 49-56 of NSB's 2010 Camden Bay EP Comments, separated into three Attachments and marked as B1, B2, and B3 respectively.

[8] For NMFS consideration of this issue, NSB incorporates Attachments B1, B2, and B3 and submits the following additional materials for the administrative record:

Borough has recommended alternative disposal mechanisms to the applicant and is working extensively with EPA to examine standards and technologies to control or abate much of the harmful discharge.[9] Because Shell's application does not contain any information regarding the possible discharge of pollution and its impacts on marine mammals or subsistence activities, it should be returned to the applicant as incomplete, and the IHA should not be issued.

Unlike sound, water pollution lasts longer and may continue to deflect and or otherwise injure marine mammals long after the original discharge takes place. Whereas Shell could "turn off" the source of underwater noise, Shell loses control of the water pollution once it is discharged. After discharge, the rate of dilution and/or dissipation is controlled not by Shell but by the conditions found in the vicinity of the site, including water column conditions, weather conditions, currents, seas and ice. The impacts of discharge may therefore last much longer than the impacts of underwater noise, which historically has been the main focus of NMFS's review of exploratory drilling proposals.

As evidence of the foregoing, the recent Trefry and Dunton studies commissioned by Shell and conducted at the Hammerhead drill site in the Beaufort Sea indicate ongoing heavy metal contamination more than twenty years since the well was drilled.[10] These studies negate conclusions that habitat impacts of water quality discharge from exploration drilling are negligible and temporary. In addition to identifying long term heavy metal contamination, Trefry, et al and Dunton identified polynuclear aromatic hydrocarbons (PAH) contamination at the site. The presence of bivalve shells of organisms destroyed at the time of drilling in 1985 suggests that immediate impacts may have occurred at the site due to this contamination.

The discharge of pollution could thus result in the harassment, injury or death to individual marine mammals. Exposure to contaminants could interfere with the whales' acute sense of smell and possibly other important life functions. Acute or chronic exposure to contaminants could lead to other negative health effects over time, and contaminants could bio-accumulate in the food web, leading to additional impacts and stressors on the whales.

- Attachment C, Shell's 2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska, Table 6.0-3A "Projected Ocean Discharges-Sivulliq Prospect Drill Site N," p. 25.
- Attachment D, NSB's Comments, Notices of Intent (NOI), NPDES General Permit AKG-28-0000 (Relating to the Chukchi Sea Exploration Plan but demonstrating identical contemplated discharges for comparative purposes).
- Attachment E, Fitzgerald, D. *Norwegian Environmental Regulation of Offshore Oil and Gas Activities*, prepared for Mayor Edward S. Itta, March 20, 2009.

[9] *See* Attachment F, Harvey, Susan, *Review of Shell Exploration and Production Company's August 2008 Analysis of the Pros and Cons of Zero Discharge of Muds and Cuttings During Exploration Drilling in the Alaskan Beaufort Sea Outer Continental Shelf,* and Shell's May, 2009 *Supplemental Information on Annular Injection and Barents Sea Exploration Permits,* June 16, 2009, written as a response to Shell Oil's *Analysis of the Pros and Cons of Zero Discharge of Muds and Cuttings During Exploration Drilling in the Alaskan Beaufort Sea Outer Continental Shelf,* August 2008 (also included as Attachment F1).

[10] *See* Attachment G: Trefry, J.H., and Trocine, R.P., *Chemical Assessment in Camden Bay (Sivulliq Prospect and Hammerhead Drill Site), Beaufort Sea, Alaska*, prepared for Shell Exploration and Production Co., Anchorage, Alaska, July 2009; *See also* Attachment H, Dunton, K., et al, *Characterization of Benthic Habitats in Camden Bay (Sivulliq Prospect and Hammerhead Drill Sites), Beaufort Sea, Alaska.* July 15, 2009.

On August 31, 2009, NSB provided MMS with extensive comments on Shell's exploration plan for Camden Bay, including detailed information on the associated water quality impacts resulting from the discharge of toxic and bio-accumulative contaminants.[11] NSB provided additional comments on October 5, 2009 to the Environmental Protection Agency regarding this marine discharge.[12] Based on information from Shell's Exploration Plan, the proposed activities involve the daily intake, exchange and discharge of millions of gallons of cooling water, drill cuttings, spent drilling fluids, excess cement, sanitary wastewater, ballast water, bilge water and other sources of pollution.[13] As we have indicated in our prior comments, this discharge includes biocides, chlorine, ammonia, PAHs, heavy metals (i.e. chromium, mercury and cadmium), benzene, ethylbenzene, thermal effluent and other pollutants. We also highlighted our concern about the stratified and estuarine conditions of Camden Bay that restrict the mixing and dilution of discharged contaminants.

Shell disregards these concerns in its IHA application. Nowhere does Shell disclose what contaminants will be discharged, the volume and concentration of discharged contaminants, the fate and transport of the contaminants, and the potential impacts to marine mammals, their prey, or habitat. Without having any of this information available in the IHA application, NMFS cannot make an informed decision.

Of additional concern is the omission of any discharge data regarding the seven or more support vessels. Shell's Exploration Plan and the instant IHA application exclude any reference to discharges associated with the fleet. Given the number of vessels, and the size of the crews and engines associated with each vessel, it is difficult to imagine that there are no discharges associated with any of the vessels. Shell should provide this information.

Comments from the NSB Department of Wildlife Management[14]

General Comments:

[11] *See* Attachment B1-B3 starting at p. 21.

[12] *See* Attachment D.

[13] As described in the attached excerpt from Shell's Camden Bay Exploration Plan (*see* Attachment C), Shell's exploratory drilling includes a high volume discharge of several regulated effluents, including toxic and bio-accumulating waste associated with muds and cuttings as well as the daily discharge of approximately 45,000 bbl of biocide laden thermal effluents. While the Federal Register Notice at p. 20493 generally considers impacts from the "possibility of some seafloor disturbances or temporary increased turbidity in the seabed sediments during anchoring and excavation of the mudline cellar (MLCs)," it does not consider any impacts from effluent discharge at all.

[14] The following references are included as Attachments I and J for your consideration and were relied upon in the formation of the Wildlife's comments:

Moore, S.E. , D.P. DeMaster, and P.K. Dayton. 2000. *Cetacean Habitat Selection in the Alaskan Arctic During Summer and Autumn*. Arctic 53:432-447.

Suydam, R.S., K.J. Frost, and L. Lowry. 2005. Distribution and movements of beluga whales from the eastern Chukchi Sea stock during summer and early autumn. Final Report OCS Study MMS 2005-035. University of Alaska, Coastal Marine Institute, Fairbanks. 48 pp.

Shell's application does not provide enough information for the public and decision makers to fully assess impacts. Shell assesses noise impacts from the drill ship but not the numerous support vessels—all of which can cause impacts to bowheads. This has been demonstrated in several studies, most notably those measuring impacts from industrial activities at BP's Northstar Island in the Beaufort Sea. Analyzing the impact from all vessels is important because some of Shell's support vessels are very large—more than 275' long. Even if not operating at full power, these vessels will propagate substantial amounts of sounds into the water.

Shell proposed to have marine mammal observers (MMOs) on the drill ship and support vessels. The Open Water Peer Review Panel highlighted some of the many limitations of MMOs. One of the limitations is that the MMOs are not independent. The MMOs work directly for Shell or for a company contracted by Shell. The MMOs should be independent.

Shell is exploring for a resource that belongs to the people of the United States, in an ocean managed by the federal government. Data collected during monitoring and mitigation for Shell's drilling program should be made publically available so that other entities can conduct independent analyses.

As with many previous documents, Shell appears to make conclusions that are not supported by science. Opinions are framed as facts. For example, Shell claims that impacts will be short-term and not have population level effects. There are no data to support these contentions. NMFS should insist that decisions be made on science and not supposition. If decisions are made on supposition, then Shell should be required to pursue the appropriate science to answer the question, and a precautionary approach should be used in the event that the supposition is false.

Throughout Shell's IHA application, numbers are biased low. The result of the biases implies that fewer marine mammals will be exposed to sounds than would be in reality. For example, not including support vessels and aircraft artificially reduces Shell's footprint of operation. That footprint is directly related to the estimated takes of marine mammals. There are also other biases in the application (see comments below).

Specific Comments:

Pg. 1, Shell IHA application, 3rd paragraph: Shell has "determined that any takes …would not be of biological significance to marine mammal populations." What data and analyses did Shell use to reach this conclusion? We are not aware of any data collected on the biological significance of taking (i.e., deflection of whales away from industrial sounds) marine mammals during industrial activities in the Beaufort Sea. Shell's conclusions are not supported by data. Data are needed for the Beaufort and Chukchi Sea to assess the types of suppositions made by Shell.

Pg. 1, Shell IHA application, 4th paragraph: NMFS must consider all activities associated with Shell's activities and not just sounds produced by the drillship. The large number of support vessels for the drilling operation is not routine for the Beaufort Sea and are a direct result of Shell's proposed drilling activities. NMFS must include the sound footprint from all support vessels and aircraft to estimate takes of marine mammals. Otherwise, the estimate will be biased low and will not provide the appropriate information for the public or decision makers when assessing Shell's proposal. The Peer Review Panel (PRP) also strongly recommended that all vessels should be considered as part of Shell's operation and not just the drill ship.

Pg. 2, Shell's IHA application, last paragraph: What is the maximum number of vessels associated with Shell's proposed activities? Shell does not provide adequate information for fully evaluating impacts to marine mammals.

Pg. 3, Shell's IHA application, 2nd paragraph, 1st sentence: Shell should not move its vessels through the Chukchi Sea until the beluga hunt is completed in Point Lay and Wainwright, which are along the Chukchi Sea coast. The best available data suggest that belugas occupy offshore habitats in the Chukchi Sea before moving to coastal areas where they are hunted.[15] Moving a large number of vessels through the Chukchi could disrupt beluga migration and cause impacts to the harvests. If Shell moves through the Chukchi prior to the harvest, they should be required to obtain written approval from the villages. Another option would be the use of adaptive management. Once the hunts have been completed, then Shell could transit through the Chukchi Sea.

Pg. 3, Shell's IHA application, Table 1-1: Aircraft—Shell states they will have "three trips between the shorebase and offshore vessels per day throughout the 2010 drilling season." It is not clear whether this is three trips per helicopter or a total of three trips. Additional information is needed.

Pg. 4, Shell's IHA application, 1st paragraph: Shell "will operate in accordance with the provisions of a Plan of Cooperation (POC)." A POC is not a negotiated agreement with subsistence users, but is simply a document that Shell drafts. Therefore, it is not clear

[15] R. Suydam, unpublished data.

how operating with a POC will prevent unmitigable adverse impacts to the availability of marine mammals for subsistence hunting.

Pg. 6, Shell's IHA application, 2nd paragraph, 1st sentence: Shell plans to cease drilling on or before October 31st. However, it plans to remove its acoustic arrays by October 15th. This is not appropriate. NMFS should require a monitoring program to be in place and functioning throughout the drilling operation. This is especially important because many bowhead whales will be passing through Camden Bay during the final two weeks of October. Information is needed to inform future decisions about mitigating impacts from oil and gas activities to marine mammals in the Beaufort Sea.

Pg. 8, Shell's IHA application, Beluga: The best available data show that belugas from the Eastern Chukchi Sea stock use the shelf break of the Beaufort Sea during the summer.[16] Shell's application implies that only the Beaufort Sea stock of belugas would be exposed to sounds from the drilling operation. NMFS must consider impacts all marine mammal stocks that could be impacted by Shell's operations.

Pg. 18, Shell's IHA application, Section 5, 1st paragraph: Shell suggests that the "only type of incidental taking sought in this application is that of takes by noise harassment." Further, Shell expects that the takes will only be associated with sounds from their drillship. The entire operation must be considered. The support ships and helicopters produce sounds that could cause deflections of marine mammals. Additionally, marine mammals could be impacted by the large amount of discharge associated with Shell's activities. Shell goes on to contradict itself on page 19 (section 6, 2nd paragraph) when it says that impacts could come from "noise propagation" from "associated support vessels." The later statement is most accurate and is reflective of the best available science that shows that bowheads are deflected away from vessels, most likely due to the sounds produced by those vessels.

Pg. 19, Shell's IHA application, Basis for Estimating "Take by Harassment": The approach Shell has outlined is not appropriate. Estimates are biased low, implying that marine mammals are mostly stationary throughout the season. But tagging studies have shown that marine mammals move considerably throughout the season. Shell's assumption of a constant density means that the movement of animals into and out of the project area is not accounted for. The estimated takes should be much higher than proposed by Shell. Shell has acknowledged this aspect of marine mammal biology in their estimates of takes for bowheads—this approach should also be used for the other species of marine mammals. Shell states that limited information does not allow for it to account for movement of marine mammals in their estimates of exposure. Shell should be required to collect the data needed to revise its estimate, or use a more precautionary estimate.

Pg. 21, Shell's IHA application, Beluga, 2nd sentence: Shell incorrectly states that belugas are "most likely to be encountered in the eastern Alaskan Beaufort Sea" during the summer. While this is true for the eastern Beaufort Sea stock of belugas, the eastern Chukchi Sea

[16] Suydam et al. 2005.

stock occurs across the Alaskan Beaufort Sea during the summer. The eastern Chukchi Sea stock of belugas needs to be considered by NMFS in their evaluation of Shell's application.

Pg. 22, Shell's IHA application, 1st paragraph, penultimate sentence: Shell provides three density estimates for bowheads in the Beaufort Sea in July. It uses the median estimate as an average, even though the actual average of the three estimates (0.0334 whales/km^2) is almost twice as large as what is used by Shell. This is another example where Shell provides numbers that are biased low. Using the true average density would provide higher estimates of take.

Pg. 22, Shell's IHA application, 1st paragraph, last sentence: Shell references Moore et al. (2000) as having reported that "bowhead whales in the Alaskan Beaufort Sea were distributed uniformly relative to sea ice." Shell has left out some important words. Moore et al. (2000; page 439) actually stated that "neither bowhead nor white whales were distributed uniformly with regard to ice cover." Analyses based on Shell's misreading of Moore et al. (2000) should be revised.

Pg. 25, Shell's IHA application, Estimates Area Exposed to Sounds ≥120 dB: Shell proposes to use a 7.4 km radius circle around the drill rig to represent the area where marine mammals would be exposed to ≥120 dB. While this measurement may fit Shell's calculation, it does not fit with the best available science for the zone of influence of drilling in the Beaufort Sea. When drilling occurred in Camden Bay in 1986 (with little ice management), the "zone of avoidance" by fall migrating bowhead whales appeared to extend 15-25 km (9-15 mi) from the drill ship. No whales were detected closer than 9.5 km (6 mi) from the drillship (received sound at 15 km was 105-130 dB) and few were seen closer than 15 km (9 mi).[17] When there was drilling in Camden Bay in 1992 (with daily ice management), whales began to deflect at about 32 km (19 mi) away from the drill rig (Brewer et al. 1993) and in 1993, whales were nearly excluded from an area within 20 km (12 mi) of the drilling platform.[18] Thus, the area where bowheads will likely be impacted during drilling is much larger than predicted by Shell. NMFS should use the best available science to estimate numbers of takes of bowheads associated with Shell's proposed activities.

Pg. 26, Shell's IHA application, Table 6-5: The estimated number of belugas that would be exposed to sounds levels ≥120 dB is too small. Shell provides the minimal population sizes for the Beaufort and Chukchi sea stocks of belugas. The actual number of animals in each stock is much larger than the minimal estimates. For example, the minimal estimate for the Beaufort Sea stock is based on a survey of only a small area of the entire distribution. It is likely that the stock is twice (or more) as large as the minimal estimate. It is not credible that only a few belugas would be exposed to sound levels ≥120 dB. This is especially notable when looking at Table 6-7. Shell predicts that more narwhals

[17] LGL and Greeneridge 1987.

[18] Davies 1997, Hall et al. 1994.

and harbor porpoises will be exposed than belugas. But the estimated take of belugas is biased low. It is likely that the estimated takes of pinnipeds is also biased low.

Pg. 29, Shell's IHA application, Conclusions, 2^{nd} sentence: The vessel traffic associated with Shell's drilling activities is not "routine." If Shell's drilling operation proceeds in 2010, the number of vessels in the Beaufort Sea will be abnormally large. NMFS should consider the full range of activities associated with the drilling operation and not just the drillship.

Pgs. 45 and 46, Sections 9 and 10: There will be considerable amounts of discharged material from the drillship and associated support vessels. The discharges include large amounts of heated water, drilling muds and cuttings, and other types of discharge. These discharges will affect habitat in a variety of ways. NMFS must consider discharge as an impact on marine mammal habitat in Camden Bay. This is especially important for Camden Bay because the area is an important feeding area for bowheads. Discharges could impact those prey in the relatively small area of Shell's proposed project.

NSB has been, and continues to be, prepared to assist NMFS, other regulatory agencies and interested stakeholders in reassessing offshore activities in the Arctic to determine how those activities can safely co-exist with our residents' subsistence practices. We welcome the opportunity to work with you and other leaders over the coming months to seek answers to those questions. We cannot do so in a meaningful way, however, while you are simultaneously permitting the very activities that we are trying to consider.

Thank you for your consideration of these comments.

Sincerely,

Edward S. Itta

Edward S. Itta
Mayor

Attachments

cc:

Bessie O'Rourke, NSB Attorney
Dan Forster, Director, Planning
Taqulik Hepa, Director, NSB Department of Wildlife
Andy Mack, NSB Mayor's Office
Karla Kolash, NSB Mayor's Office

I, Robert Suydam, hereby declare as follows:

1. I am a Wildlife Biologist. I obtained my undergraduate degree in environmental biology at California State University Fresno in 1986. I obtained a Master's of Science degree in biology from the University of Alaska Fairbanks in 1995 and I completed a Doctoral degree in aquatic and fishery sciences from the University of Washington in April 2009. My doctoral thesis focused on the age, growth, reproduction and movements of beluga whales from the eastern Chukchi Sea.

2. I work for the North Slope Borough Department of Wildlife Management. One aspect of my job entails conducting studies on wildlife species that are important for subsistence on the North Slope of Alaska. Much of my work focuses on bowhead and beluga whales but I have also published papers on other marine mammals, sea ducks and caribou. My CV is attached to this declaration as Exhibit 1.

3. As part of my job, I am responsible for reviewing documents related to oil and gas exploration, development, and production for projects on shore and offshore. Since 2000, I have been very involved in reviewing and evaluating impacts to bowhead whales and other marine mammals from industrial activities, particularly industrial

sounds, in the Beaufort and Chukchi seas off northern Alaska. Throughout this time, I have worked and continue to work very closely with the Alaska Eskimo Whaling Commission to provide scientific advice on the status of the bowhead whale and potential impacts from oil and gas operations.

4. I reviewed Shell Offshore Inc.'s (Shell's) Exploration Plan for both Camden Ban and the Chukchi Sea for 2010, and I participated in writing comments on those plans on behalf of the North Slope Borough. I have also reviewed the Environmental Assessments for both Camden Bay and the Chukchi Sea, which were prepared by the Minerals Management Service. I have also reviewed the IHA application materials submitted by Shell. In addition, I have reviewed all the other documents cited or referenced in this declaration. I make this declaration based upon my own personal knowledge.

Bowhead Whale Biology and Migration

5. Bowhead whales are slow-moving, late-maturing, long-lived animals. The whales may live well over 100 years and perhaps up to 200 years. They reach sexual maturity around 20 years of age. Bowhead whales migrate through the Chukchi and the Alaskan Beaufort seas semiannually between wintering areas in the Bering Sea and the

primary summer feeding area in the eastern Canadian Beaufort Sea. Some bowheads remain in the western Beaufort and Chukchi seas in summer.

6. Bowheads rely primarily on hearing for orientation and communication. They use sound to communicate, find mates, to navigate, to detect predators, and to gain other information about their environment. It is likely that bowheads use cues from echoes from their calls to navigate under ice and to distinguish thin ice from multiyear flows (thick ice).

7. Bowhead whale breeding likely starts in January or February, while much of the population remains in the Bering Sea. Gestation lasts for an estimated 13-14 months, and females give birth to a single calf about every three to four years. Most calving occurs during the spring north and eastward migration in the Chukchi Sea. Peak calving time likely occurs in May. There is a high energetic cost of reproduction for these whales, especially during lactation. Because of these factors, the ability of a female to provide adequate care to her offspring is critical to the long-term viability of the species. Females must find adequate food in order to provide adequate care.

8. The spring migration north and eastward through the Chukchi coincides with the ice breakup and typically lasts from late March through mid-June. The whales tend to migrate through leads, or openings, in the sea ice. In some areas, the leads that form between shorefast ice and the labile offshore pack ice are especially important.

9. Most whales continue to travel eastward through the Beaufort and spend the summer in the eastern Canadian Beaufort. In recent years, however, more whales are being detected in the northeastern Chukchi and western Beaufort during summer months (Funk et al. 2009; John C. George, pers. comm.). Whaling captains have told us for years that whales can be seen regularly in summers north of Point Barrow, and in recent years we have begun to document increased numbers of whales in these areas during the summer (Harry Brower, pers. comm.).

10. Bowheads begin leaving the Canadian Beaufort in the autumn and begin moving westward into Alaska waters in August and September. The migration across the Alaskan Beaufort varies somewhat from year to year but primarily occurs from late August to late October. The timing may vary from year to year as environmental and anthropogenic factors can influence the location of the migration.

11. Cow/calf pairs are typically at the tail end of the spring migration. In the autumn there is no clear pattern of when cow/calf pairs arrive. They appear to occur throughout the migration. They have been seen early (i.e., early September) in the migration at Kaktovik, in the eastern Alaskan Beaufort Sea or may be present late (i.e., October) in the migration at Barrow in the western Beaufort. Cow/calf pairs also tend to migrate in waters between 20-40 m deep.

12. During the westward migration through the Alaskan Beaufort, bowhead whales feed regularly in nearshore waters. The Borough's Department of Wildlife collected and assisted in analyzing stomach samples from whales harvested during the fall from 1969-2000 and found that 78% of subadults and 73% of adults had been feeding during the fall migration. (Lowry et al. 2004).

13. Recent information highlights the critical importance of the Sivulliq area, where Shell plans to drill in Camden Bay, as feeding habitat for bowhead whales during their migration. In 2007, Shell conducted seismic surveys in the same vicinity as the proposed 2010 exploration wells. During those operations, Shell monitored for the presence of marine mammals. The results of that monitoring are summarized in a January 2008 report, which was submitted by Shell to the National

Marine Fisheries Service and the U.S. Fish and Wildlife Service. (LGL 2008).

14. As a part of the study, LGL estimated the number of bowhead whales present in the Sivulliq area during the open water period in September and October (the same time that Shell plans to drill in 2010). LGL estimated that on 11 September a large number of whales (4,826 [95% confidence interval: 1,513 to 15,397) was in the prospect areas (Table 5.53, page 5-100). Throughout much of September and possibly into October thousands of whales were in the Sivulliq area at any one time, demonstrating that this area provides important habitat for the bowhead population during their annual fall migration.

15. Furthermore, the LGL Study concluded that many of the whales that used the Sivulliq area in 2007 were feeding. The monitoring results demonstrated that "a high proportion of sighted whales appeared to be feeding . . . near and west of Sivulliq" and that "[f]eeding was the most commonly recorded activity." LGL also identified feeding as the most common activity recorded during 2008 monitoring activities.

16. Most of the bowhead whale population summers in the eastern Beaufort Sea and must migrate west through the Camden Bay area during fall migration. The population numbers approximately 12,600

individuals (95% confidence interval of ~7,900 to 19,700; Koski et al in press. Journal of Cetacean Research and Management). Based on the summer distribution of bowheads, their fall migration route, and the number of animals observed by LGL, almost the entire population of the Bering-Chukchi-Beaufort Stock of bowhead whales may use the Sivulliq area during its westward migration. Many of the whales would use the Sivulliq area at the same time that Shell proposes to drill in 2010.

17. Bowhead whale food is not uniformly distributed, but is aggregated. Their food occurs in patches. This information is important, because if bowhead whales miss feeding opportunities because they are excluded or deflected from certain habitat, they may not be able to find other areas along the migration route to feed.

18. Moreover, bowhead whales that are feeding appear to be less sensitive to anthropogenic sounds. Ljungblad et al. (1988) observed the response of bowheads in the Canadian Beaufort to approaching seismic vessels with airguns operating. This is the area where bowheads spend much of the summer feeding. There were some limitations in the data, but during the experiment, bowheads responded when the seismic vessel was <10 km away, with received

sound levels at about 140 to 160 dB. This is an example where whales did not flee from areas ensonified by industrial sounds. This is most likely because of the biological importance of the feeding activity. At first glance this would appear positive; however, feeding animals could be exposed to high levels of sound that could cause temporary or possibly permanent hearing damage, which may impact their ability to communicate and navigate. In 2007, for instance, during Shell's seismic operations in the Sivulliq area many whales were present in the area, as mentioned above. In this case, some whales were not deflected away from a feeding opportunity but may have been exposed to high levels of sounds from seismic operations.

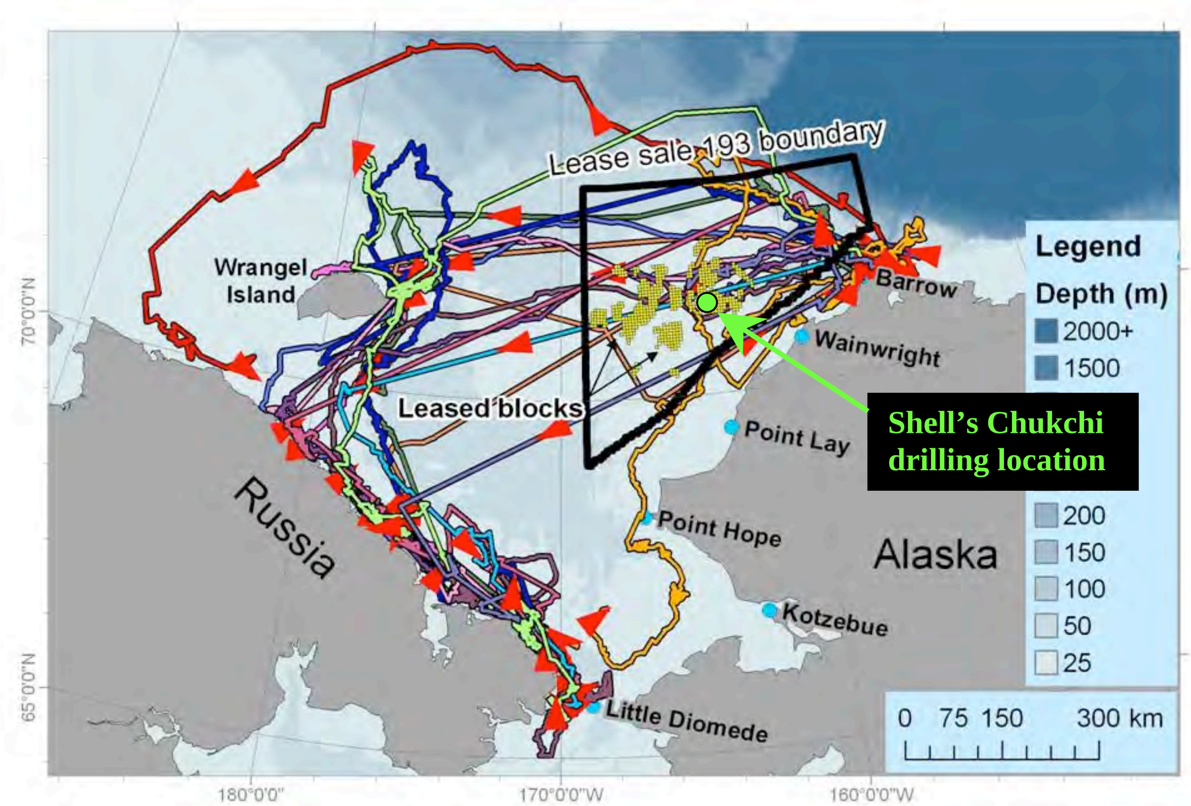
19. Traditional knowledge also provides insights into the importance of Camden Bay for bowheads. Nuiqsut hunters have told us that Camden Bay is an important feeding and resting area. The migration between wintering and summering areas is hundreds of kilometers in length; therefore, safe resting areas are important along the way.

20. Data on bowhead migration and feeding in the Chukchi is more limited, but more data has been gathered in recent years. Recently, the Alaska Eskimo Whaling Commission (AEWC) and the North Slope Borough's Department of Wildlife Management have been

working with a team of scientists led by Lori Quackenbush at the Alaska Department of Fish and Game to tag bowhead whales and track their movements with satellite transmitters. The study required a high degree of collaboration, between the scientists and whaling captains to tag the whales. The scientists provided regular updates to the AEWC as a main partner in the research project. The Minerals Management Service (MMS) is the primary funder of this project.

21. The information developed by the study is the best available current information on fall distribution and movements of bowhead whales in the Chukchi Sea. The preliminary results of the study are attached to my declaration as Exhibit 2. The team has been collecting data on the migration routes and track lines of bowhead whales through the Chukchi Sea, including the Lease Sale 193 area, and then estimating bowhead whale distribution or "kernel densities."

22. Almost all of the tagged bowhead whales (n =32) used the Lease Sale 193 area during the autumn migration across the Chukchi Sea, primarily in October.



Many of the tagged whales also traveled near Shell's proposed drill site (green dot on map). Moreover, some of the whales traveled west through the Lease Sale area to Russia, returned east through the Lease Sale area back to near Barrow, and then again swam west moving through the Lease Sale area a third time in the same season. From this information, we can conclude that a large majority, if not all of the bowhead whale population uses the lease area during the fall migration in October, and that a portion of the population uses the lease area more than once each season.

23. MMS has also been funding a study conducting aerial surveys of marine mammals in the Chukchi Sea – the Chukchi Offshore Monitoring in Drilling Areas ("COMIDA") program. MMS funded aerial surveys are also providing us with recent information on bowhead whale migration through the Chukchi Sea. A recent update from that program (Clarke et al. 2009) is attached as Exhibit 3 and is available at ftp://ftp.afsc.noaa.gov/posters/pClarke03_aerial-survey-mar-mammals.pdf. The aerial surveys have also identified bowhead whales in the Lease Sale 193 area and the vicinity of the proposed well sites.

24. We are learning that the lease area is important to bowheads but we still know little about how bowheads use the lease area. Sightings from marine mammal observers aboard ships and planes and satellite tracking data indicate that bowheads feed extensively off the north coast of the Chukotka Peninsula in the southern Chukchi Sea and possibly near Wrangel Island, Russia, in the western Chukchi Sea.

Bowhead Whale Reactions to Underwater Noise

25. Scientific studies have documented the impacts to migrating bowhead whales caused by oil and gas activities on the North Slope. We know based on past offshore drilling operations that bowhead whales can be

and often are deflected from their normal migratory route by the underwater sounds produced by drilling and icebreaking activities.

26. As described in more detail later, studies show that fall migrating bowhead whales almost completely avoided a single drillship operation by 9-15 miles (15 to 25 km). At this distance, the received sound levels are relatively low – as low as 120-135 dB. A National Research Council (2003) review of the information concluded that the distances at which many whales began to move away from the drillship was likely greater than 9-15 miles and the received sound levels lower.

27. Studies of the 1992 and 1993 Kuvlum and 1986 Hammerhead drilling projects in Camden Bay are particularly helpful for assessing the potential impacts of Shell's proposed exploration. Those drilling operations occurred in the roughly the same area where Shell plans to drill in 2010. At the 1992 Kuvlum drilling site, the drilling was done from a floating platform, the Kulluk. That year, aerial surveys showed that the approaching fall migrating whales began to deflect north away from the drill rig at a distance of about 32 km (19 miles) east of the drillship (Brewer *et al.* 1993). The authors noted that many whales did not return to their migratory path but maintained a

dispersed pattern at least until they reached Point Barrow (about 200 miles west of Camden Bay) area (page 67 of Brewer *et al.* 1993).

28. Schick and Urban (2000) statistically analyzed the aerial survey data from near Kuvlum. In 1993, they found that the distribution of bowhead whales was "highly correlated with distance from the drilling rig, indicating that the presence of the drilling rig resulted in a significant temporary loss in available habitat".

29. The 1993 Kuvlum data showed that bowheads avoided an area within 20 km (12 miles) of the drilling platform (Hall *et al.* 1994 and Davies 1997) and that it was unlikely that a factor other than the drilling unit might explain this absence (Davies 1997).

30. In 1986, open water drilling operations at the Hammerhead site was well monitored and produced important data regarding displacement of fall migrating bowhead whales. The studies showed that no whales were detected closer than 9.5 km (6 miles) from the drillship and few were seen closer than 15 km (9 miles) One whale was observed for 6.8 hours swimming in an arc around the drillship, keeping about 25 km (15 miles) away (LGL and Greeneridge 1987, see page 47 of Integration and Summary section). The zone of influence therefore seemed to extend about 15-25 km (9-15 miles) from the drillship (see

Integration and Summary, LGL and Greeneridge 1987), but the zone may have been larger as whales likely begun deflecting at farther distances.

31. In addition to studying bowhead whale avoidance of exploratory drill sites, it is also important to examine the influence of industrial noise upon the calling rate of fall migrating bowhead whales. This provides another clue about how whales respond to industrial sounds. Bowheads are a highly vocal marine mammal which indicates that acoustic communication is important to this species. A change in calling rate may indicate behavioral changes.

32. During the fall 1992 drilling activities at Kuvlum, scientists studied the call rates of bowheads (Brewer *et al.* 1993). Due to ice conditions, several ice-breakers assisted the Kulluk. Scientists used sonobuoys (floating hydrophones deployed from ships or airplanes) to detect the calls of the whales. These sonobuoys showed that bowhead calling rates were greater 32 km (19 miles) northeast of the Kuvlum drill site than near the drill site (page 67 of Brewer *et al.* 1993). The change in calling behavior also shows that bowheads are distressed by sounds produced by industrial activities.

33. Although observations of avoidance behavior are useful in assessing the impacts of drilling sounds on the fall migration of bowheads, it is also useful to study information about the level of received sounds that bowheads experience when they are being impacted. This information is vital for understanding impacts and developing monitoring and mitigation plans.

34. One study examined received levels and whale distribution around the Corona-Hammerhead drilling sites in 1986 (LGL and Greeneridge 1987). At 15 km (9 miles) from the drillship at Corona (east of Shell's 2010 planned drilling site), industrial sound levels were generally 105-125[1] dB re: 1 μPa (Figure 12, page 30 of Integration and Summary section of 1987 report). As another example, at 11 km (6.6 miles) from Hammerhead, received levels were generally 105-130 dB (Figure 13, page 31 of Integration and Summary section of 1987 report). Industrial sounds were even higher during periods when ice-breakers were moving or breaking ice.

35. Another study examined received levels and whale reactions to a seismic vessel during 1996-1998 (Richardson 1997, 1998, 1999). This study showed that nearly all whales (even the most noise

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[1] The dB values in this document are referenced to 1 μ Pa unless otherwise specified.

tolerant) stayed ~20 km (12 miles) away. The 1998 data give strong evidence that the deflection is well underway at 35 km (21 miles) to the east of the active seismic vessel (see pages 5-59, 5-60, 5-78, 5-101 of Richardson 1999). It therefore seems reasonable to look at received levels (RL) at these distances. At 20 km (12 miles) bowheads received pulses of seismic sounds of about 117 dB re: 1µPa to 135 dB. RL at 30 km were about 107 to 126 dB (page 5-101). The authors noted "[t]he received levels at 20-30 km are considerably lower levels than have previously been shown to elicit avoidance in bowheads or other baleen whales exposed to seismic pulses."

36. The behavior or activities that bowheads are engaged in plays an important role in how they respond to industrial sounds. Because feeding is such an important behavior, whales appear to be much more tolerant of industrial sounds when they are feeding. Feeding whales move away from operating seismic airguns at much closer distances (Ljungblad et al. 1988) then when bowheads are migrating (Richardson and Greeneridge Sciences 1999).

37. While there are instances of whales seen close to drillships or operating seismic vessels, primarily when feeding, there is (as cited above) almost complete avoidance by fall migrating bowhead whales

of drillship operations or seismic airguns where received levels are 105-125 dB (distance from noise source of 15-25 km or 9-15 miles).

38. Recent research on the effects of low-level industrial noise from British Petroleum's Northstar Island on migrating bowhead whales have produced very large acoustic datasets with the "statistical power" to detect very small (1-2 km) deflections of whales away from industrial sounds (Richardson 2008). They confirm earlier findings that migrating bowhead whales show behavioral reactions to low received sound levels, which are often near or perhaps even below ambient noise levels.

39. Ship movements also have the potential to physically impact bowhead whales. As slow moving animals, bowhead whales are susceptible to vessel strikes, which can injure or kill animals, particularly calves. A closely related species, the North Atlantic Right Whale, with similar behavioral characteristics is at risk of extinction from ship strikes and other anthropogenic impacts. In recent years, several bowhead carcasses have been found in the Beaufort and Chukchi, and some of those have evidence of being struck by a ship. Sightings of bowhead carcasses in the Beaufort and Chukchi seas are rare, unless they are directly related to subsistence harvests, such as animals that were

struck and lost. A bowhead carcass found in 2008 had evidence of a ship strike. There was a large gash on its side, although case of death was not confirmed. Vessel movement through the migration route during the migration could therefore cause bowhead whale disturbance, injury or death. Furthermore feeding whales may be especially susceptible to being struck by ships because the animals are preoccupied with feeding.

Potential Impacts of Shell's Proposed Operations

40. Because many of the results I discussed above were collected in the same location or general vicinity of Shell's proposed 2010 activities, we can reasonably predict that Shell's proposed operations are likely to cause reactions of migrating bowhead whales. A drilling operation involving a single ship, icebreakers and support vessels at Shell's lease area in Camden Bay is likely to result in deflection of thousands of whales from their migratory corridor, and the zone of deflection is likely to extend out at least 9-15 miles and perhaps further.

41. In the Beaufort Exploration Plan and application for Incidental Harassment Authorization, Shell made an attempt to estimate the number of bowhead whales that would be exposed to sound levels in excess of 120 dB, but the analysis and conclusions are flawed. In

conducting its analysis, Shell makes the unjustified assumption that no icebreaking activities will occur during the fall migration. They suggest that icebreakers will only manage ice and then only with the ships operating at low power. Icebreakers are known to be one of the most pervasive sources of underwater sound, even when not breaking ice, associated with drilling activities, and the zone of received sound in excess of 120 dB from an active icebreaker can extend a large distance from the ship. By not including icebreakers or other support vessels in their assessment of impacts to marine mammals. Shell has artificially shrunk, by a large margin, the potential area that would be ensonified to 120 dB or larger. This approach results in an unrealistically low estimate, a biased estimate, of the number of bowhead whales exposed to these sound levels and potentially excluded from Camden Bay as a resting area or at risk from high levels of sound or ship strikes if feeding opportunities arise there. Ice is often found or formed in the Beaufort Sea during September and October, and it is reasonable to expect that Shell will have to break or move ice during these times to protect its vessels and drill rig. That ice management or breaking will very likely impact bowheads and other marine mammals in the Camden Bay area.

42. Shell and NMFS appear to distinguish between icebreaking and ice-management (i.e. pushing ice). NMFS claims that Shell's proposed ice management activities would involve only 15-20 percent of the propeller's rotation capacity. It appears that NMFS then concludes that relatively little noise would be produced by ice management or ice breaking, thus that activity would not be included in take estimates. It is not clear what data NMFS used to reach this conclusion. Ice breaking or management is not a routine oil and gas activity in the Beaufort Sea and those activities are directly related to Shell's drilling plans. Therefore, NMFS must include all activities, both vessel and aircraft, when assessing possible marine mammal takes associated with Shell's planned exploration activities in Camden Bay. That assessment must include impacts from sounds produced by icebreakers, even if they are only pushing ice.

43. Shell has stated they would stop operations, move the drill ship off site, instead of breaking ice. NMFS should include that requirement as a mitigation measure to protect marine mammals from the potential impacts of sounds of icebreaking.

44. Impacts from industrial sounds on bowhead whales will affect habitat use. This includes: (a) deflection of migrating whales from the

"normal" migratory path into deeper waters further offshore, and therefore (b) potentially reduced feeding opportunities in the typical fall migratory corridor (Lowry et al., 2004) or (c) an increased expenditure of energy to avoid drilling activities.

45. One cannot accurately assess the potential biological impacts to bowhead whales without considering the harm that could result from excluding whales from important feeding area. Because the food of bowheads is not uniformly distributed, but is aggregated, deflection of animals from their normal migratory route could cause whales to miss patches of food and thus feeding opportunities. Shell's application suggests that whales could find other feeding opportunities if they are excluded from Camden Bay. This statement is not supported by data. If bowheads miss feeding opportunities, the resulting energetic loss, either by missing feeding opportunities or expending more energy to swim farther, could impair their reproductive fitness or survival of certain individuals in the population. Mothers with calves have heightened nutritional needs and are therefore uniquely susceptible to harm resulting from deflection from feeding areas along the migration route.

46. NMFS's analysis of this issue in the public notice is not supported by science. In particular, NMFS appears to conclude that drilling operations are not expected to preclude bowhead whales from finding sufficient feeding opportunities during the fall migration. To the best of my knowledge, there have been no empirical or modeling studies that conclude that Camden Bay is unnecessary as feeding habitat and that whales have sufficient alternatives during the migration. Given the lack of information, NMFS should use a precautionary approach in protecting feeding habitats for bowhead whales.

47. Disturbance of bowhead whales could also result in the separation of calves from their mothers. Such separation of calves from their mothers could lead to increased predation on calves by killer whales, which could result in long-term impacts to the bowhead whale population. Separation could also interfere with the calves' ability to complete the fall migration and/or find feeding and resting opportunities along the migration route.

48. Shell's operations in the Beaufort Sea also have potential to interfere with the fall subsistence hunt of bowhead whales at Barrow. Shell has not clarified when it intends to transit it vessels back and forth between the Beaufort and Chukchi Seas, however, we do know that

Shell intends to move the vessel north of 71.25°N and 146.4°W before the Nuiqsut and Kaktovik hunts and then possibly to return to Camden Bay after those hunts conclude. By October 31 they plan to transit the Beaufort again en route to the Bering Strait. Within those general limitations to activities, Shell could easily be transiting the western Beaufort Sea either to or from Camden Bay during the fall bowhead whale hunt at Barrow, which occurs from late September into October. The transiting of vessels could easily deflect bowhead whales from their normal migration route or render the whales more skittish and therefore more difficult to locate and hunt. In my opinion, NMFS discounts this potential entirely in its notice related to the Camden Bay IHA. NMFS should implement mitigation measures that are adequate to protect against adverse impacts from Shell's activities to the Barrow fall bowhead whale hunt.

49. I am also very concerned that NMFS has not considered the potential impacts of an oil spill on bowhead whales and other marine mammals. As the Gulf of Mexico incident dramatically demonstrates, accidents will happen, and we should be considering ahead of time what impact those accidents will have on the resources of the Arctic before approving those activities. Numerous studies have documented that spilled oil can cause injury or mortality to marine mammals. Moreover, chronic exposure to oil and possibly dispersants, even at sublethal levels, can have long-term effects on wildlife and marine mammals. Response activities, including the potential for burning oil, use of dispersants, increased icebreaker activity and increased vessel traffic could also all result in death, injury or harassment of marine mammals. Even though the chance of a large oil spill is relatively small, a spill must be included in an assessment for an IHA for exploratory drilling because the impacts could be large.

50. I am also very concerned that NMFS has not considered the potential impacts from discharges related to Shell's planned activities. Cooling water, biocides, drilling muds, cuttings, and other types of discharge associated with exploratory drilling will likely have impacts to marine mammal habitat, both in the water column and in the benthos. Some of the discharges may contain contaminants that could contribute to acute or chronic harm to the health of bowhead whales or other marine mammals or to their prey. Also, discharges could cause bowheads to deflect away from the drilling area. Additional studies are needed to ascertain the impacts of discharges. In the meantime, NMFS should consider impacts from discharges to marine mammals and proceed with a precautionary approach until more information is available to make an information-based decision.

51. Given the flaws discussed above, I have great concern with NMFS conclusion that Shell's operations will have a negligible impact on bowhead whales. Shell and NMFS have ignored the impact of oils spills and discharge altogether, improperly discounted the impacts of icebreakers, other support vessels, and aircraft, and discounted the impacts on a unique feeding habitat in Camden Bay. Shell's application provides misleading and biased information about Shell's operations. Without conducting a reasonable scientific analysis of all the activities associated with Shell's exploration and without taking into account the uncertainty in the available information, NMFS's cannot reasonably conclude negligible impacts to bowheads and other marine mammals without substantially more mitigation measures or monitoring requirements.

Mitigation Measures

52. For many years, I have worked with the North Slope Borough's Department of Wildlife Management and AEWC to provide input on the design of mitigation measures for industry operations that would provide adequate protections for bowhead whales during the fall

migration to minimize the potential impacts associated with industrial sounds. The minimal mitigation measures proposed by Shell and required by NMFS are inadequate to protect whales and disregard years of scientific work.

53. As detailed above, the best scientific information shows that migrating whales react to received sound levels as low as 100-120dB. In order to prevent potential impacts from deflection, we have long advocated for shut down procedures if aggregation of whales, particularly mothers and calves, approach an area ensonified to 120dB or more. This type of mitigation measures is particularly important in an area like Camden Bay, where mothers and calves are known to feed and rest during the migration. Our efforts on this front have included multiple project-specific comments to federal agencies including MMS and NMFS, as well as comments made during our participation in the annual open water scientific meetings held by NMFS.

54. In 2006, MMS prepared a programmatic environmental assessment for seismic surveys and adopted specific mitigation measures for aggregations of bowhead whales. MMS required that no seismic surveying be conducted "nearer the 120-dB radius of where" 4 or more cow/calf pairs were observed.

55. MMS also adopted a mitigation measure for the 160-dB isopleth, prohibiting seismic activity from beginning and requiring a shut down when 12 or more bowhead or gray whales were observed engaged in a non-migratory behavior such as feeding.

56. Although we had concerns with how these mitigation measures would be implemented and enforced, we strongly supported the determination that aggregations of feeding whales and cow/calf pairs should be protected from the effects of deflection resulting from received sound levels of 160 dB or 120dB, respectively. As discussed above, when whales are feeding, they may subject themselves to louder sounds then they otherwise would, which could result in temporary or permanent hearing damage.

57. In 2007, NMFS required these same mitigation measures in the Incidental Harassment Authorization issued to Shell for its prior exploration plan. At that time, NMFS stated that the 160dB was designed "to ensure that feeding bowhead and gray whales are not prohibited from accessing food resources in the vicinity of" the drilling rigs. NMFS also carried forward the mitigation measure related 4 or more cow/calf pairs within the 120-dB zone.

58. I have reviewed correspondence involving NMFS and MMS in August of 2009 related to the single whale in the Canadian Beaufort and whether observations of this whale support the decision to impose the 120-dB monitoring and mitigation zone. In particular, Deborah Cranswick of MMS concluded in the email exchange that the 120 dB monitoring and mitigation measures are no longer warranted.

59. MMS appears to have based its conclusions on the behavior of a single tagged bowhead whale in the Canadian Beaufort Sea. The tracks of the whale clearly indicate that the whale deflected away from the seismic vessel. It is unclear what the received sound levels were, but it would be entirely consistent with existing information that a feeding bowhead in the Canadian Beaufort Sea was more tolerant of industrial sounds than a migrating whale in the Alaskan Beaufort. MMS use of one tagged whale from the Canadian Beaufort to justify removing monitoring or mitigation requirements is inappropriate and inadequate. This is especially the case when put into the context of the available scientific data for the Alaska Beaufort Sea. As shown above, there are compelling data that show migrating bowheads are very sensitive to low levels of industrial sounds, including sounds near 120 dB or even lower. We know from many years of scientific

studies that industrial operations in Camden Bay and other areas of the Alaskan Beaufort have deflected bowhead whales from their migration route at received sound levels of 105-120 dB. We also strongly suspect that deflection can harass and harm bowhead whales by excluding them from feeding opportunities and possibly separating mothers and calves.

60. In the proposed IHA, NMFS does not discuss at any point in the document its position on mitigation measures designed to protect bowhead whales from sounds at 120 dB or louder. I do not know why NMFS has changed its position from 2007, and therefore I cannot comment on the scientific basis of NMFS's change in position. I am concerned that NMFS may be basing its change in position for similar reasons as MMS, namely on the observations of a single tagged bowhead whale. The large scientific information base of high sensitivity of bowheads to low levels of industrial sounds should form the basis for establishing mitigation measures and monitoring requirements.

61. NMFS also failed to carry forward the 160-dB exclusion zone for non-migrating (i.e. feeding) whales. Again, this exclusion zone should not just include the drill ship, but should include the support

vessels. Given that Shell and NMFS did not provide the size of the zone that would be ensonified to 160 dB from all of Shell's activities, it is difficult to assess how large that zone might be and how many whales may be exposed to sounds ≥160 dB. NMFS should require Shell to provide information about the size of the 160 dB zone and require mitigation measures for feeding or resting whales. There is no justification for not protecting feeding or resting whales. This concern is especially relevant given Shell's monitoring data from Camden Bay in 2007 and 2008, when thousands of bowheads were estimated to be using the area.

62. With respect to the subsistence hunt of bowhead whales, Shell has agreed to remove its equipment from Camden Bay until the end of the Nuiqsut and Kaktovik subsistence whale hunts. Although this measure should provide protections for the hunt, it does not provide adequate protections for the whales themselves. The hunt only lasts for a limited portion of the migration, in some years only a week or two. Bowheads will continue migrating through Camden Bay well after the hunts are completed.

63. In sum, the mitigation measures proposed by Shell and NMFS may not be adequate for protecting bowhead whales. The limited

information about the effectiveness of the mitigation measures, the duration of the impacts, or the biological significance of impacts requires that a precautionary approach be used by NMFS. Until additional conclusive information is available, NMFS should protect bowhead whales from industrial sounds of 120dB or greater. We have years of science and traditional knowledge supporting the need to do so.

Potential Cumulative Impacts of Shell's Operations

64. The information I presented above about whales deflecting away from exploratory drilling and seismic surveys was an assessment of the impacts from one operation on migrating and feeding whales. While there was clear evidence of deflection away from industrial sounds, there was no evidence that the migration was blocked. If future drilling and seismic operations are conducted in a similar manner, such that only one operation occurs in a season, it is likely that future results will be similar to those seen in the past. If, however, there are two or more operations (i.e., from drilling, seismic, ice-breaking, etc.) occurring at the same time or in the same general area, it is reasonable to expect that the impact will be greater.

65. A situation incurring higher conservation risk would be where the disturbing influences could be cumulative within the same season or over multiple years. Serious concerns arise when: (1) there are multiple operations taking place along the migratory path in the Beaufort and/or Chukchi Seas in the same season (i.e. drilling structures, seismic operations, ship traffic, ice management, or all of these), (2) two or more operations occur "in line" (adjacent) along the axis of the migration, and (3) two or more operations perpendicular to the migration with one just offshore of the other.

66. A National Research Council (2003) summary report entitled "Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope" suggested that multiple operations set offshore of each other by approximately 30 km could present a "barrier" to migrating whales. They suggest a disturbing influence set across (perpendicular to) the migratory path could: (1) displace whales seaward into heavier sea ice conditions, (2) affect the animals' behavior and/or distribution so as to interfere with the subsistence hunt, (3) reduce use of the area as feeding habitat, and (4) prevent some whales from passing.

67. Given the available data on reactions of bowhead whales to a single industrial operation, it is reasonable to assume an increased conservation risk to bowheads from multiple operations set along the Beaufort Sea coast operating at the same time, over many years. The cumulative impact of industrialization of the magnitude and density, common in many areas of the Gulf of Mexico, would likely cause: (a) significant reduction in the success of the Eskimo subsistence whale hunt, and (b) significant changes in bowhead whale distribution, habitat use, and possibly population size and health status.

68. As discussed earlier, Northstar is located to the west of Camden Bay, and recent data have confirmed that operations at Northstar result in the deflection of whales away from the artificial island, even when received noise levels are very low, near or possibly even below ambient background levels. Because of the location of Northstar, operations there are likely to combine to have a cumulative impact to bowhead whales, potentially deflecting them farther north or excluding them from a larger portion of nearshore habitat than would be caused by operations Camden Bay alone.

69. In addition to Northstar, we know that there are other projects planned in 2010. Shell itself is planning strudel scour and ice gouge surveys in

the central Beaufort and Chukchi seas (Exhibit 4). This activity was not identified in Shell's cumulative impacts section of their Environmental Impact Analysis in their exploration plan. Also attached to this declaration as Exhibit 5 is a draft Environmental Assessment prepared for ION (formerly GX Technology), which is planning seismic surveys in the Beaufort and northeastern Chukchi during October and November of 2010. In addition, we know that the United States Geological Service is planning for seismic testing in 2010 in the Beaufort Sea related to the Law of the Sea. Other scientific cruises are also planned for the Beaufort and Chukchi seas during the autumn in 2010 aborad Coast Guard vessels. There will also likely be seismic surveys in the Canadian Beaufort in 2010.

70. We also know that there are multiple seismic operations planned for the Chukchi Sea in 2010. Statoil is planning on 2D and 3D seismic surveys to the north of Shell's planned drilling operations in the Chukchi in 2010 (Exhibit 6).

71. The numerous industrial activities planned for the Beaufort and Chukchi seas in 2010 have the potential for substantial cumulative impacts to bowhead whales. These other activities were not considered in Shell's or MMS's cumulative impacts assessments.

72. Even without the numerous other activities, Shell's Beaufort and Chukchi drilling operations have the potential to have a combined impact on bowhead whales. Neither Shell nor MMS has provided adequate information on how the Beaufort and Chukchi drilling operations will be coordinated. Without this information, it is difficult, if not impossible, to assess the combined cumulative impacts of the drilling operations. For instance, without that information, we do not know how many times nor precisely when Shell will be transiting vessels through the migration corridor. If, for instance, Shell starts operations in Camden Bay, then moves to the Chukchi during the Cross Island hunt, and then returns to Camden Bay, Shell would possibly be transiting vessels through the migration three times, increasing the chances of a ship striking a whale. Based on the lack of information, we are left to speculate at the timing of the multiple operations and the transit between the two sites.

73. Even without the necessary information, it is clear that the multiple drilling operations carried out in the same year have a likelihood of combining to have a cumulative impact on bowhead whales. Swim speeds and migration times vary widely and likely depend on a host of factors including oceanographic conditions and feeding opportunities.

Studies have documented that average swim speeds can vary from 1.1-5.8 km per hour (Wartzog et al., 1990; Mate et al., 2000). Moreover, recent satellite tagging data demonstrates that bowheads do not simply swim in a straight line during their fall migration across the Beaufort and Chukchi seas. Some whales will remain in the same area for weeks or more to rest and feed, such as in Camden Bay. Some whales double back on their migration routes. Based on what we know about bowhead whale behavior, individual whales could easily be exposed to two or three disturbing events during their fall migration that are created only by Shell's operations in Camden Bay and the Chukchi Sea. Factoring in the numerous other industrial and scientific activities, bowheads will likely be exposed to multiple industrial operations in 2010.

74. For instance, if Shell begins operations in Camden Bay, resulting in the deflection of whales from a key feeding area, those whales may find it more important to feed in the western Beaufort Sea near Barrow. The western Beaufort is a well-known feeding area during the fall migration. Whales may stop to feed and/or rest in this area, as opposed to simply swimming straight through a constant speed. MMS's Bowhead Whale Aerial Survey Program and feeding studies

have provided the best available information about how whales use the Beaufort Sea. If whales remain to feed in the Beaufort, Shell's transiting of vessels through this area could result in additional disturbances to the animals. Once the drilling commenced in the Chukchi, that operation could potentially result in a third disturbance once the whales continue their westward migration. Again, this could all happen in combination with the impacts at Northstar, the GX Technology and Statoil seismic surveys and the other industrial and scientific activity planned for 2010.

75. Moreover, even if individual whales did not experience multiple disturbances, the operations could have a combined impact on the bowhead whale stock, as taken together they would disturb or harass a larger number of whales during the summer and fall migration.

76. In the end, however, Shell has not provided adequate information to assess the potential for cumulative impacts. Without knowing when Shell will be moving its vessels through the Beaufort and Chukchi and when Shell will be drilling wells in each location, we cannot determine or predict the cumulative impact of the two operations.

77. An analysis of impacts to bowhead whales should also consider the cumulative impacts over multiple years. If whales are excluded from

important feeding areas for more than one year, the impacts to the species could become magnified over time as reproductive fitness decreases over several years or whales perhaps become habituated to avoiding particular areas. We know, for instance, that Shell plans on drilling in Camden Bay for multiple years, because in 2007 they submitted a three-year exploration plan. We also know that ConocoPhilips plans to conduct drilling in the Chukchi starting as early as 2012. Any conclusion that impacts to whales are short-term or temporary must be reconciled with the fact that Shell and other companies plan on future years of industrial operations in Camden Bay and the Chukchi Sea.

Beluga Whale Biology and Migration

78. Beluga whales also inhabit seasonally ice-covered water and are closely associated with open leads and polynyas in ice-covered regions. Two of Alaska's five stocks are present in the Beaufort and Chukchi Seas – the Beaufort Sea and eastern Chukchi Sea stocks.

79. Beluga whales of both stocks winter in the Bering Sea and summer in the Beaufort and Chukchi Seas. The spring-migration routes for the Beaufort Sea stock is through same ice leads used by bowhead whales. Eastern Chukchi belugas move into coastal areas of the

Chukchi Sea especially near Kasegaluk Lagoon, near the village of Pt. Lay, from mid-June and often are found there until mid July. Animals from the Beaufort stock remain in the eastern Beaufort Sea and adjacent waters, in Canada through the summer. Whales from the eastern Chukchi stock move northeastward and spend the summer in the northern Chukchi and Beaufort seas. Some of these animals move far north into the Arctic Ocean, up to ~80°N. During the autumn migration, most belugas migrate far offshore near the shelf break of the Beaufort Sea, though some individuals may travel close to shore and then south through the Chukchi Sea.

80. Belugas also rely on hearing for feeding, orientation and communication. These whales are sensitive to industrial sounds, although there is relatively little scientific information about their sensitivity. It is commonly known among hunters in Northwest Alaska and is a widespread and very old part of traditional knowledge.

81. Belugas in some parts of the world seem to habituate to boat traffic and other human activities. For stocks in the far north, animals seem to be more sensitive to anthropogenic sounds; however, there is no information, to my knowledge, about how beluga respond to exploratory drilling. It is reasonable to assume, based on traditional

knowledge that belugas would deflect away from vessel sounds, drilling sounds and seismic surveys.

82. Erbe and Farmer (2000) demonstrated that icebreaker noise was likely audible to beluga whales in the Beaufort Sea over very long ranges (35-78 km) and could interfere with beluga communications at ranges of 11-54 km. Belugas changed their swimming behavior when an icebreaker was operating at distances of 40-60 km away (Cosens and Dueck, 1988; Finley et al., 1990).

83. Beluga whales from both stocks are an important subsistence resource for Alaskan Natives. In particular, beluga whales from the eastern Chukchi Sea stock are a vitally important resource for residents of the village of Point Lay, adjacent to Kasegaluk Lagoon, and Wainwright to the north of Point Lay. In Point Lay, the beluga whale harvest is an integral component of the annual subsistence activities of the community and typically occurs in late June or early July. In Wainwright (and sometimes Barrow) the beluga hunt typically occurs in late July or early August. Belugas are also harvested in the spring leads (April and May) from hunters at Point Hope and Barrow.

84. The transit of the drillship, support vessels and icebreakers during June and early July in the Chukchi could therefore have significant

impacts on a large number of beluga whales. This is especially a concern because belugas have their calves at this time. Even if the ships are far offshore, sounds from the vessels or drilling could cause belugas to alter their distribution and movements. Further, there is some recent information from a satellite tagged beluga, that the eastern Chukchi Sea stock may approach the area near Kasegaluk Lagoon from far offshore to the north from within the lease area. The sample size is small but this one animal provides the only data about early summer movements of Chukchi Sea belugas. The transit of ships or initiation of drilling in June or early July in offshore areas of the Chukchi Sea could impact belugas.

85. In addition, beluga whales could to be displaced from traditional harvest areas due to sounds from the icebreakers. The disturbance response, even briefly, might temporarily interrupt the movements of belugas, temporarily displace some animals when the vessels pass through an area, or make the animals skittish and hard to hunt. Such events could especially interfere with beluga movement to and from the lagoon areas, particularly Kasegaluk Lagoon where Point Lay hunts belugas.

86. Kasegaluk Lagoon is also biologically important habitat for beluga whales. We do not know exactly why they occur in the area but they have been doing so for hundreds, if not thousands of years. It is likely they concentrate in the area to rub off old skin on gravel beaches during their annual molt or perhaps they take advantage of warm and brackish coastal waters for molting or for improved energetic conditions for newly born calves.

87. In 2008, an oil company barge passed close to Wainwright during their hunt in early August. The barge caused the belugas to scatter while hunters were trying to drive the belugas into a lagoon where they would have hunted them. The village lost that opportunity to hunt belugas.

88. Because of belugas' high sensitivity to anthropogenic sounds, cumulative impacts from sounds produced by multiple industrial activities that occur over long periods of time and over large areas, could have profound impacts to the belugas. Animals might either be displaced from biologically important areas for long periods of time or adversely affected in other ways (Erbe and Farmer, 2000).

Summary

89. In sum, it is well known that bowhead and beluga whales are very sensitive to anthropogenic sounds during their migration along the northern coast of Alaska. Traditional ecological knowledge of Inupiat elders and hunters and scientific knowledge have shown that bowheads deflect from sounds created by humans. However, significant data gaps regarding the effects of industry activity remain, particularly in the Chukchi Sea and at the levels of planned industry activity. The International Whaling Commission's Scientific Committee recommended the need to: (a) investigate cumulative effects on bowhead whales from multiple seismic operations and other industrial activities, especially in light of reductions in sea ice associated with climate change in the Arctic Ocean; (b) determine the biological significance of the high sensitivity of bowhead whales to low levels of anthropogenic sound; and (c) document the sensitive areas needed by bowhead whales for breeding, calving or feeding, especially in the Chukchi Sea.[2]

90. Shell's exploration activities have great potential to impact bowhead and beluga whales, and possibly other marine mammals, because (a)

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[2] The report from the IWC can be found at http://www.iwcoffice.org/_documents/sci_com/SCRepFiles2006/ under Annex K.

bowheads and belugas have a high sensitivity to anthropogenic sounds, (b) the drilling activities will occur in the migratory path of the whales, and (c) the drilling vessels, icebreakers, and other support vessels make considerable amounts of noise. Thus, the zone of influence around the exploratory drilling vessels is large. Without considering the entire area of influence of Shell's planned drilling activities, NMFS cannot reasonably conclude that the activities will have no more then a negligible impact on bowhead and beluga whales or that significant effects are unlikely. Nor can NMFS reasonably conclude that the operations will not have an unmitigable adverse impact on the fall subsistence hunt of bowhead whales in Barrow or the summer subsistence hunt of beluga whales in the Chukchi Sea. Because the proposed exploration drilling will occur within the migratory path of the whales and in important feeding and resting habitat, there is a potential for the activities to significantly impact whales and have population level effects, particularly when considered in conjunction with the cumulative impacts of other industrial activities in the Beaufort and Chukchi seas over the next three years.

______________________________ 19 May 2010 _

Robert Suydam, Ph.D. Date

Aerial Surveys for Marine Mammals in the Northeastern Chukchi Sea: 2009

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ABSTRACT

COMIDA (Chukchi Offshore Monitoring in Drilling Area) aerial surveys for marine mammals were conducted in the northeastern Chukchi Sea from mid-June through the end of October 2009, providing survey coverage of the Chukchi Sea Planning Area during the ice-free season. COMIDA aerial survey objectives include determining the distribution of cetaceans, pinnipeds and polar bears and documenting areas of importance for specific behaviors such as calving/pupping, feeding, migrating and hauling out. The 122,500 km^2 study area, encompassing the region from 68°N to 72°N and from shore to 169°W, was subdivided into 10 survey blocks. A revised survey design was adopted in 2009, with offshore transect lines oriented perpendicular to the coastline instead of oriented north-south. In addition, there was a coastal transect (one km offshore) from Pt. Barrow to Pt. Hope. Surveys were flown in de Havilland Twin Otters and an Aero Commander. A total of 240 hours were flown in 2009, with 175 hours actively surveying in good conditions and 59% of that time spent on transect effort. Good survey coverage of the study area was achieved despite frequent time periods of inclement weather which prevented flying. Marine mammals recorded included bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*), belugas (*Delphinapterus leucas*), one humpback whale (*Megaptera novaeangliae*), polar bears (*Ursus maritimus*), walruses (*Odobenus rosmarus*), and several smaller pinnipeds. Bowheads were seen feeding near Pt. Franklin from 30 June through 11 July, and southwest of Pt. Barrow on 19 September. Gray whales were documented feeding in the nearshore area between Pt. Barrow and Wainwright from mid-June through early September; after mid-September, few gray whales were seen. The lone humpback whale was spotted feeding among four gray whales in mid-July near Wainwright. Belugas were seen in the study area in summer and late fall. Walrus distribution was closely associated with ice when ice was present in the study area, after which walruses were seen close to and on shore. Four polar bears were seen.

METHODS

Aerial surveys were flown in a de Havilland Twin Otter or Aero Commander 690A with 6-8 hours endurance. Each aircraft was outfitted with bubble windows to allow downward visibility and improve visual observations. Surveys were based out of Barrow (June-September) and Kotzebue (October). Two dedicated primary observers were positioned at bubble windows on each side of the aircraft and a data recorder/secondary observer entered all sighting and location information into a laptop computer interfaced with a GPS unit, which allowed for rapid data summarization on a daily basis. Daily summaries for each flight were made available on an Alaska Fisheries Science Center, NMFS-maintained website (http://www.afsc.noaa.gov/nmml/cetacean/bwasp/index.php) to expedite dissemination of information to interested parties. Surveys were flown every day, weather permitting; conditions required for surveying included a minimum ceiling of ≥305 m (1000'), good visibility and Beaufort sea conditions of ≤5. Surveys were flown along transect lines perpendicular to the coastline; a coastal transect was flown one km offshore between Pt. Hope and Pt. Barrow. Survey effort was designated as on effort (transect), off effort (search and circling) or deadhead; effort on deadhead was not included in summary statistics as it indicates time periods when surveying was not possible.

Bowhead Whales near Pt. Franklin
11 July 2009
Photo by Cynthia Christman
NOAA Fisheries
Permit No. 782-1719-05

COMIDA Study Area

RESULTS

A total of 240 hours of aerial surveys were flown in the COMIDA study area between mid-June and the end of October 2009. Months of best coverage were July and September, when weather and aircraft logistics were most favorable. Highlights:

- **Bowhead whales** were seen in every month in the Chukchi Sea. Bowheads were seen in offshore survey blocks in September and October, indicating migration across active oil and gas lease areas. This supports data collected from 1982-1991 during MMS-sponsored aerial surveys.
- **Gray whales** were seen nearshore between Pt. Barrow and Pt. Lay, with few sightings offshore. Few gray whales were seen in the study area in September and October. This contradicts information collected for gray whales from 1989-1991.
- **Belugas** were notably absent from the study area in August and September, and polar bears were seen infrequently.
- **Walruses** were the most commonly observed pinniped; more information on walrus sightings is available on a companion poster by Cynthia Christman et al.

COMIDA 2009 Total Flight Effort

COMIDA 2009 Bowhead Sightings

COMIDA 2009 Other Cetacean Sightings*

* Does not include sightings of unidentified cetaceans

COMIDA 2009 Pinniped Sightings

Does not include walruses; see poster "Pacific Walrus Sightings Documented by COMIDA Aerial Surveys of the Northeastern Chukchi Sea in 2009" by Cynthia Christman et al.

Summary of COMIDA 2009 Marine Mammal Sightings

(# of sightings/# of animals)

Month	Bowhead Whale	Gray Whale	Humpback Whale	Unid. Cetacean*	Beluga	Walrus	Unid. Pinniped**	Bearded Seal	Polar Bear
June	6/17	18/28	0/0	1/1	1/1	54/1,390	50/60	6/17	0/0
July	13/27	114/176	1/1	35/47	8/311	226/7,817	135/180	13/27	1/1
August	2/2	83/129	0/0	28/33	0/0	231/1,913	33/45	2/2	1/1
September	11/23	37/37	0/0	4/4	0/0	148/10,860†	90/178	11/23	2/2
October	20/37	14/20	0/0	8/11	13/113	5/9	92/240	20/37	0/0
Total	52/106	266/390	1/1	76/96	22/425	664/21,989†	404/703	52/106	4/4

* Includes any cetacean that could not be identified to species, regardless of size
** Includes any pinniped that could not be identified to species, regardless of size

Summary of COMIDA 2009 Flight Effort

(h = hours, km = kilometers)

Month	Total Time (h)	Transect Time (h)	Surveyable Time (h)	Deadhead Time (h)	Total Distance (km)	Transect Distance (km)
June	16.5	5.6	11.3	5.3	3,366	1,202
July	53.7	24.3	44.4	9.3	11,326	5,163
August	38.0	18.0	36.0	2.0	8,006	3,753
September	63.6	34.0	51.8	11.8	13,713	6,985
October	68.4	21.1	31.6	36.8	15,608	4,329
Total 2009	240.2	103.0	175.1	65.2	52,019	21,432

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North Slope Borough
OFFICE OF THE MAYOR

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Edward S. Itta, Mayor

August 31, 2009

John Goll
Director
Alaska OCS Region
Minerals Management Service
3801 Centerpoint Drive, Suite 50
Anchorage, Alaska 99503

RE: Shell Offshore 2010 Outer Continental Shelf Lease Exploration Plan and Environmental Impact Assessment

Dear Director Goll:

Thank you for the opportunity to comment on Shell Offshore, Inc.'s (Shell's) 2010 OCS Exploration Plan (EP) for proposed operations in the Beaufort Sea.

Shell plans to drill two deep offshore oil exploration wells on two separate prospects near Camden Bay, a feeding and migratory corridor for the bowhead whale, home to an abundance of other marine mammal species and fish, and an area important to the subsistence harvest success of the Inupiat. To accommodate this proposed drilling operation, a fleet, with a minimum of six large support vessels, including ice management vessels, will accompany the drilling rig. The operation is proposed to enter Arctic waters on July 1, 2010 with the fleet transiting through the Bering Strait into the Chukchi Sea, and arriving on location near Camden Bay to commence drilling on approximately July 10, 2010. On August 25, 2010, the exploration drilling is proposed to temporarily cease and withdraw into the deeper waters of the Beaufort Sea during the Nuiqsut and Kaktovik fall subsistence bowhead whale hunt. When the hunt ends, the drilling is proposed to recommence and may then continue through October 31, depending on ice and weather.

In recent years, Shell proposed same-season operations in both the Beaufort and Chukchi Seas together as a package. While we have been reviewing this Beaufort Sea EP, a separate Chukchi Sea EP has been submitted to Minerals Management Service (MMS). The likelihood that the Chukchi EP will be deemed complete and submitted by your agency in its current form, and the possible timing of such action, are unknown to us and to other concerned stakeholders. If the proposed Beaufort Sea and Chukchi Sea EPs are separately considered, certain potential impacts common to both proposals may not be appropriately analyzed in combination. Of particular concern are potential cumulative effects to migrating and feeding bowhead whales, and to the subsistence harvest of that species and other migratory species that may be exposed to multiple industrial noise sources during a single season. We are also concerned that the capacity of your staff, that of other agencies, the North Slope Borough (NSB), the Alaska Eskimo Whaling Commission (AEWC), North Slope tribes, and other most affected stakeholders to conduct meaningful and credible reviews may be compromised when multiple projects of this complexity are simultaneously proposed. When the system is overloaded, poor decisions are made. That is a reality that MMS, NMFS, Shell and other stakeholders must come to grips with.

The NSB has multiple interests to consider in reviewing this exploration plan. Most critical are those related to the health and welfare of our people, who are legitimately concerned with the significant risks posed by this action. Although we are engaged in wage employment, we continue to depend heavily on subsistence harvests for food. Traditional foods are far more nutritious than many types of imported "store-bought" food.[1] Subsistence activities also provide spiritual and cultural affirmation, and are crucial for passing skills, knowledge and values from one generation to the next, thus ensuring cultural continuity and vibrancy.

We acknowledge and appreciate that Shell has agreed to leave the Camden Bay area, beginning August 25, 2010, for the Nuiqsut and Kaktovik bowhead whale hunts and has improved its oil spill contingency planning. However, Shell has still not fully considered or acknowledged the significant risks associated with its activities, which may extend into winter months, and has not incorporated meaningful mitigation measures that will protect our subsistence way of life and the marine mammals and ecosystem upon which we depend.

We have conducted our review of the EP with reference to the National Environmental Policy Act, 42 U.S.C. 4321 *et seq*, the Outer Continental Shelf Lands Act, 43 U.S.C. § 1331 *et seq* and

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[1] The subsistence diet protects against obesity and diabetes, and associated problems such as hypertension and cardiovascular disease. Restricted access to subsistence foods therefore places the community at increased risk for these problems. If the fundamental role of subsistence is displaced, very significant increases in obesity and diabetes in the impacted communities would predictably ensue. *See*

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43 U.S.C. § 1801 *et seq*, Council for Environmental Quality Regulations, 40 C.F.R. 1508.27, and other applicable federal laws. We stand by our assertion to Secretary of the Interior Salazar that MMS must prepare a detailed Environmental Impact Statement (EIS) for this exploration plan, including robust public involvement.[2] The proposed action and the combined effects of this drilling operation may significantly alter the quality of the environment in the Beaufort Sea—an environment that is already stressed by the increasingly pronounced impacts of climate change.

At this time, MMS must not approve the 2010 Camden Bay exploration plan. Shell has not provided the necessary information or has submitted incomplete data for review of its plan. Across the board our conclusions are that this proposed exploratory program has changed, but that the impacts of the action remain strikingly comparable to the 2007-2009 exploration plan. Shell has also not demonstrated that its mitigation measures will alleviate the significant risks of its activities. The importance of the resources in the area, potential conflicts with subsistence uses, and the lack of certainty surrounding potential impacts associated with the proposed action should compel MMS to prepare and consider a full EIS before rendering a decision on this EP. Given our interest in the action, we look forward to participating in an EIS process. If MMS decides first to prepare an EA, we urge MMS to publicly release the EA and subject it to a formal 30-day comment period before completing the EA and before any decision to approve the Shell exploration plan.

The comments below are for MMS to consider in reviewing the adequacy of information provided by Shell and in determining the significance of the proposed action. Included as attachments are additional comments from NSB staff followed by declarations and reference documents to be incorporated fully and reviewed in support of citations made in these comments.[3]

Air Quality

Shell does not adequately assess and disclose the air quality impacts that could occur as a result of the actions authorized under the 2010 Exploration Plan for Camden Bay, Alaska (EP), therefore, failing to comply with the National Environmental Policy Act (NEPA) and the Outer Continental Shelf Lands Act (OCSLA). The EP must include a completed comprehensive assessment of the environmental and public health impacts of the proposed exploration activities. Without such an analysis, MMS cannot say what direct, indirect and cumulative impacts the activities analyzed in the EP will have on air quality and human health. Likewise, without a more complete analysis, MMS will be unable to assert that it has taken the necessary steps to prevent significant deterioration of air quality, as required by the Clean Air Act (CAA). The EP relies on a future EPA permitting process to satisfy MMS's air quality assessment obligations.[4] MMS cannot make a determination on the impacts of the planned activities absent a completed air quality assessment. If MMS will be relying, in part, on EPA's permitting process then MMS

[2] *See* Attachment A, 5/29/2009 Letter from NSB Mayor Edward S. Itta to Interior Secretary Salazar.

[3] *See* Attachment B for NSB Department of Wildlife and additional staff technical comments. Attachment C is a declaration from Dr. Robert Suydam.

[4] *See* EP at 75 and 91: "A PSD air permit application is currently being drafted and will be sent to the MMS upon completion." "Details concerning the source, composition, frequency and duration of air emissions for the *Discoverer* and support vessels are summarized in Section 7.0. Full details will be included in the PSD Air Permit application (Appendix D) that will be sent to MMS upon its completion."

must incorporate the final EPA PSD permit requirements into the MMS process. The commitments and assurances made by Shell in the EP must be made federally enforceable if MMS will be relying on them to demonstrate that there will be no significant impacts to air quality from the proposed exploration.

MMS Must Complete a Comprehensive Assessment of Air Quality Impacts as Part of this EP Review Process.

Shell's EP does not fully evaluate and disclose the air quality impacts to coastal and human environments from the proposed exploration activities, instead relying primarily on the EPA's OCS permitting process to fulfill MMS requirements under 30 CFR 250 for Exploration Plans. As previously noted in NSB's comments on Shell's 2007 – 2009 EP for the Beaufort Sea, MMS regulations at 30 CFR 250.218 require different analyses and technical data than required by the EPA; therefore, relying on the permit process under 40 CFR 55 is insufficient for this EP.[5] This EP must include the technical data and analyses specified in 30 CFR 250.

The first pages of the EP include a cross-reference table specifying the relevant regulatory requirements under 30 CFR 250 and the corresponding section in the EP where that particular requirement is addressed. Specifically, the air emissions information required for Exploration Plans under 30 CFR 250.218(a) through (f) is cross-referenced to Section 7.0 of the EP and Appendix D, which is reserved for future use, but does not contain the air quality permit authorization or modeling information required by 30 CFR 250. In fact, Section 7.0 of the EP contains sub-sections for each of the required elements of 30 CFR 250.218(a) through (f) but the information contained in these subsections is incomplete. For example, there is no indication of peak hourly emissions as required by 30 CFR 250.218(a)(1)(i) and, more importantly, the basis for the emissions information provided in Section 7.0 (as required under 30 CFR 250.218(a)(2)) is not included as part of the final EP. The EP indicates that "[f]ull details [of the air emissions calculations for the *Discoverer* and support vessels] will be included in the PSD Air permit application (Appendix D) that will be sent to the MMS upon its completion."[6] The EP does not base projected emissions on the maximum rated capacity of the equipment but rather reports emissions based on numerous emissions reduction measures. Per the requirements of 30 CFR 250.218(a)(3), the EP must disclose the projected maximum potential emissions in the EP. Emissions reduction measures included in Section 7.0(b) do not include the associated compliance demonstration techniques that will ensure these reductions are implemented, as required under 30 CFR 250.218(b). And finally, there is no modeling report, as required under 30 CFR 250.218(f). The EP indicates, under the Modeling Report subsection of Section 7.0 that "[a]n impact evaluation will be provided upon completion of the PSD permit application." Basically, the EP does not include enough substantive information for MMS to be able to make a proper evaluation of the significance of air quality impacts of the proposed exploration activities, as required under OCSLA, NEPA and the CAA.

Under the authority of the Secretary of the Interior, the MMS must ensure that all mineral

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[5] *See* Attachment D, May 11, 2007 letter from Johnny Aiken, North Slope Borough, to Natasha Greaves and Dan Meyer, EPA Region 10, see discussion on p. 2 of 8.

[6] EP at 91.

resource operations are conducted according to OCSLA and other federal laws.[7] OCSLA specifies that "[m]anagement of the outer Continental Shelf shall be conducted in a manner which considers economic, social, and environmental values of the renewable and nonrenewable resources contained in the outer Continental Shelf, and the potential impact of oil and gas exploration on other resource values of the outer Continental Shelf and the marine, coastal, and human environments,"[8] where the "human environment" is defined as "the physical, social, and economic components, conditions, and factors which interactively determine the state, condition, and quality of living conditions, employment, and health of those affected, directly or indirectly, by activities occurring on the outer Continental Shelf."[9] Clearly, MMS has an obligation to ensure that human health is not adversely impacted by exploration of the proposed areas in the Beaufort Sea. MMS must also ensure adequate protection of the human environment in the sense that it must consider factors that impact the "quality of living conditions" in affected areas and therefore must fully consider the cumulative impacts of this development in conjunction with all other past, present and foreseeable development in the region on significant deterioration of air quality and on adverse impacts to air quality related values on the North Slope of Alaska.

Federal agencies must conduct environmental review at each phase of the OCSLA process (i.e., for a five-year lease plan in the OCS, for individual lease sales, for exploration, and for development and production). For this EP, MMS must use the NEPA process to "identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment" and must "[u]se all practicable means, consistent with the requirements of the Act and other essential considerations of national policy, to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects of their actions upon the quality of the human environment."[10] MMS must, at a minimum, complete an environmental assessment of the proposed exploration activities and provide an opportunity for the public to comment on the Agency's assessment and subsequent action (i.e., on the FONSI or EIS).

The applicable leases for the drill site locations were acquired during the Beaufort Sea Oil and Gas Lease Sales 195 (March 2005) and 202 (April 2007). The Multiple-Sale EIS (for lease sales 186, 195 and 202) and the supplemental EA for lease sale 202 do not include an assessment of air quality impacts, as required under NEPA and OCSLA. Specifically, the Beaufort Sea Multiple-Sale EIS concludes the following about the effects of proposed Sale 202 on air quality:

> "Effects on onshore air quality from air emissions ***likely*** would be only a very small percent of the maximum allowable Prevention of Significant Deterioration Class II increments. The concentrations of criteria pollutants in the onshore ambient air would remain well within the air-quality standards. Consequently, there ***likely*** would be only a minimal effect on air quality with respect to standards. Principally, because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration and development and production activities or accidental emissions would not be sufficient to harm

[7] 30 CFR 250.101(a) and 30 CFR 250.202(a).
[8] 43 U.S.C. 1344(a)(1).
[9] 43 U.S.C. 1331(i)).
[10] *See* 40 CFR 1500.2(e) and (f).

vegetation. A light, short-term coating of soot over a localized area could result from oil fires."[11] (Emphasis added).

With regard to cumulative impacts to air quality, the Multiple-Sale EIS concluded in Section V.C.15 that "all projects affecting the North Slope of Alaska in the past and occurring now have caused generally little deterioration in air quality, which remains better than required by national standards." However, no real assessment of the direct, indirect or cumulative impacts to air quality from these proposed lease sales was included in the Multiple-Sale EIS or subsequent EA for lease 202 to support the general, qualitative statements about air quality that are included in the underlying lease sale assessments.

The underlying 5-year lease plan also does not include a comprehensive assessment of air quality impacts. The final EIS concludes the following about the air quality impacts from the proposed 5-year program:

> "In Alaska, the concentrations of NOx, SOx and PM10 and CO would remain well within the NAAQS. The impacts from the proposed 5-year program on pollutant levels would be minor. Ambient ozone levels are within the Federal standard in all areas of Alaska, so the impacts from the proposed 5-year program activities would be negligible. Air quality impacts from oil spills and in-situ burning could be localized and of short duration and could cause minor impacts on air quality."[12]

MMS cannot continue to avoid fully assessing the air quality impacts at each phase of the OCSLA process. In order to meet its obligations under NEPA, OCSLA and the CAA (30 CFR 250.202(a) requires that the exploration plan conform to federal laws), the EP must include the appropriate air emissions and modeling assessment required under 30 CFR 250.218 and propose action on Shell's EP based on an assessment of the air quality impacts of the exploration activities on the affected coastal and human environment. In doing so, MMS must ensure the public that allowable levels of emissions from the proposed activities will not cause or contribute to violations of health-based air quality standards, will not cause significant deterioration of air quality and will not have any adverse impacts on air quality related values, such as visibility. MMS must then identify necessary mitigation measures capable of preventing any such adverse impacts to human health and the environment.

Unfortunately, MMS has failed to accomplish this. In relying on the EPA's OCS permitting process as the only means to assess the proposed exploration activity impacts, MMS is failing to fully consider the direct, indirect and cumulative impacts of the proposed exploration along with all other existing and reasonably foreseeable emissions sources as part of this regulatory action. Reliance on the EPA's OCS permitting process cannot be a substitute for the MMS's own regulatory obligations. The fact that Shell must obtain a PSD permit from EPA prior to conducting the proposed exploratory activities does not mean that MMS is relieved of its

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[11] USDOI, MMS, 2003:Sec. IV.C.15.b(5)).
[12] OCS EIS/EA MMS 2002-006, April 2002, FEIS at 2-4.

responsibilities under NEPA and OCSLA to fully assess and disclose the air quality impacts from the proposed exploration.

Specifically, MMS must identify its specific regulatory obligations and, if it will be relying on EPA's permitting process to meet certain obligations, must show how EPA's process satisfies that obligation. If MMS will be relying on EPA's permit to satisfy its regulatory obligations then MMS must review EPA's final PSD permit. It is not acceptable for MMS to rely on a draft permit or permit application to meet its regulatory requirements. As of the date that MMS deemed the EP complete, MMS has no final EPA decision (or even draft permit or modeling) to rely on. Therefore, it is impossible for MMS to ensure that EPA's PSD permit process will satisfy and resolve MMS's regulatory obligations. In addition, there may be MMS requirements that are not met by solely relying on EPA's permit process. These additional requirements must be identified and fully assessed as part of this review. For example, MMS must consider the cumulative impacts, as defined under NEPA. As such, MMS must consider "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions."[13]

MMS Must Present a Consistent and Thorough Technical Basis for the Required Air Quality Impacts Assessment

Emissions Inventory

The Environmental Impact Assessment (EIA) in Appendix H of the EP addresses, in some detail, the potential air quality impacts from the proposed exploration but does not include the underlying details of the assessment and therefore also does not meet the requirements of 30 CFR 250.218(a)(2). In fact, the emissions inventory data presented in Appendix H conflict with what is presented in Section 7.0 of the EP. The huge discrepancy in these two reported emissions estimates is presented below:

Annual Potential-to-Emit (PTE) Estimates for the *Discoverer* plus Support Vessels

	EIA Appendix H Table 2.3.3-1, p. 35	EP Section 7.0 Table 7.0-1, p. 29	% increase in estimated PTE ($\Delta/PTE_{EIA}*100$)
NO_x	883	2,044	130%
$PM_{2.5}$	34	187	450%
PM_{10}	34	213	520%
SO_2	53	186	250%
CO	233	769	230%
VOC	27	168	520%
Pb	0.011	0.134	1,110%
HAPs	1.2	3.6	200%

The EIA presents screening model estimates, presumably based on the inventory presented in Appendix H. These results are labeled "preliminary" and, therefore, potentially subject to

[13] *See* 40 CFR 1508.7.

change.[14] MMS must require a finalized modeling assessment that fully satisfies the requirements of 30 CFR 250.218(f) in order to be able to properly assess the environmental impacts of the planned exploration activities.

The "preliminary" modeling results presented in the EIA indicate that maximum predicted $PM_{2.5}$ concentrations are at almost 90% of the 24-hour $PM_{2.5}$ NAAQS. PM_{10} concentrations are predicted to consume over 90% of the available 24-hour PM_{10} increment and almost 70% of the available annual NO_2 increment. Considering these model results appear to be based on the significantly lower emissions estimates in Table 2.2.3-1 of Appendix H, predicted concentrations could be significantly higher than what is presented in the EIA in Appendix H. MMS must clarify which emissions inventory is correct and must assess potential air impacts based on modeling of the correct emissions inventory.

It's unclear if the inventory includes all sources associated with potential oil spills. MMS must fully evaluate the potential emissions from an oil spill scenario, including VOC and HAP emissions from evaporation, $PM_{2.5}$ and PM_{10} emissions from in-situ burning during cleanup operations and combustion emissions (NO_x and PM) from response vessels. MMS must then determine what mitigation measures may be needed to ensure that no significant impacts to human health and the environment will occur from such an event.

All data used to prepare the emissions inventory, including stack testing data, vendor data and emissions estimating methods (*e.g.*, EPA AP-42 emission factors) must be fully disclosed in the EP before MMS can move forward with its decision-making process. These data, especially calculations based on stack tests or vendor data, must be accompanied by supporting evidence that the data provide an accurate inventory over the range of operating loads for the various sources.

Sulfur Content in Diesel Fuels

New regulations were adopted by the U.S. EPA in 2006 requiring industry to transition toward using ultra low sulfur diesel (ULSD) with less than 15 parts per million (ppm), or 0.0015 percent, sulfur in all diesel combustion sources in 2010 in rural Alaska. [15] For the lower 48, this involved a two part transition, first, EPA required diesel powered vehicles operating on the U.S. road system to transition to low sulfur fuel containing 500 parts per million (0.05%) sulfur in 2007 and then to fully convert to the use of 15 parts per million ULSD by 2010. EPA recognized unique issues in Alaska, and granted rural Alaska (those areas off the road and ferry system) an exemption from the first requirement to switch to low sulfur diesel in 2007. But industry still has to comply with EPA's requirement to use ULSD in all diesel combustion sources in rural Alaska in 2010. MMS needs clarification from EPA as to the requirements they uphold for Alaska's OCS. On page 87 of Shell's EP, and reiterated on page 208 of Shell's EIA (Appendix H) it states: "Low sulfur diesel fuel will be used for the ice management, oil spill response and support vessels, with a maximum sulfur content limit of 0.19 percent by weight, while the Discoverer drilling vessel will use ultra-low sulfur diesel with a maximum sulfur content limit of 0.0015

[14] EIA Appendix H at 207.
[15] 71 FR 32450, effective July 6, 2006.

percent by weight." In other words, the *Discoverer* will be complying with EPA's ULSD requirement, but the other vessels are significantly out of compliance with this requirement. In fact, what Shell is euphemistically referring to as "low-sulfur" diesel has 126 times the amount of sulfur compared to ULSD, and nearly four times the sulfur content of EPA's "low sulfur" fuel. As indicated in the emissions inventory presented in Table 7.0-1 on page 29 of the EP, estimated SO_2 emissions from the *Discoverer* and its support vessels are over 475 times higher than SO_2 emissions from the *Discoverer* alone with a large portion of this increase due to the use of fuel with substantially higher sulfur content. MMS must ensure the support vessels will comply with EPA's new ULSD standard in rural Alaska.

Ice Breaker Emissions Estimates

NSB is concerned that ice management activities may be underestimated in Shell's analysis, as presented in the EP. This is important since the ice breaker activities represent a large portion of the overall emissions from the exploration activities. Specifically, the EIA (Appendix H) indicates that "[i]ce management vessel activity account for more than 90 percent of support vessels' emissions, thus total emissions will be lower in favorable ice conditions." EIA Appendix H at 205. Heavier ice conditions result in heavier engine load factors and higher emissions. The EIA states that ice breaker estimates are based on 2003-2005 data. EIA Appendix H at 206. The reference for this statement is a recent (2009) conversation between the air quality consultant preparing the PSD permit application materials (Air Sciences Inc) and the "Arctic Wells Advisor" for Shell International Exploration and Production, Inc. Based on these data and this reference, it was assumed that there would be a 38% frequency of ice within 30 miles of the drillship. However, in its revised application to the US Coast Guard for safety zone designation, Shell characterized the ice conditions more recently than 2003-2005 as follows:

> "Ice conditions during 2006 were such that the areas of drilling interest were ice covered the majority of the period between July and October. If ice conditions are similar during 2007, then each drill rig will be constantly ice managed within its anchor array."[16]

This indicates that there is a strong possibility that the 38% frequency of ice may grossly underestimate emissions from the ice breaker. MMS must present an unbiased source of data for this important source's emissions – something other than an estimate from Shell of ice conditions. If the operator's estimate is based on a scientific analysis of ice flow data from 2003-2005 then that analysis should be made available and more recent data, if possible, should be incorporated into the analysis. The ice breaker emissions must be modeled to account for the maximum potential operation scenario and any restrictions in operation for the source must be specified as enforceable mitigation measures by MMS.

Emissions Reduction Measures

The EP presents several emissions reduction measures that Shell will implement. The EIA

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[16] *See* Attachment E, March 30, 2007 letter from Susan Childs, Regulatory Affairs Coordinator – Alaska, Shell Offshore Inc. to United States Coast Guard, District 17, regarding the establishment of safety zones for the Frontier Discoverer drill ship and the semi-submersible drill unit Kulluk in the Beaufort Sea, Alaska, p. 2.

indicates that the measures are considered "preliminary" and that "EPA will establish permit limitations and enforceable standards incorporating BACT control technology, owner requested operating restrictions, and low-sulfur content diesel fuel."[17] The modeling results presented in the EP, however, are based on implementation of these emissions reduction measures. In fact, there are no estimates or model predictions for maximum (uncontrolled) potential operating scenarios. Therefore, it is essential that MMS establish clear and enforceable requirements for any assumed control technology. This includes Best Available Control Technology (BACT) control efficiencies, fuel restrictions, operating restrictions, pollutant limits, etc. MMS must also include very specific details on the monitoring and compliance demonstration techniques that will be required in order to ensure emissions remain consistent with modeled scenarios. It is not clear, based on a lack of information regarding Shell's monitoring and reporting requirements in the EP, how compliance will be verified. The proposed operator requested limits must have associated rigorous monitoring and reporting systems to ensure compliance. MMS must make clear its plan for ensuring compliance with these assumed limits.

The EP includes a list of emissions reduction measures "offered" by Shell as a means to limit emissions and air quality impacts.[18] There is, however, no underlying information regarding the technical basis for the application of these particular measures and whether or not these measures constitute the best available technologies. In fact, it does not appear that the support vessels will employ Best Available Control Technologies (BACT), as required by the Clean Air Act.[19] MMS must ensure that BACT is employed for all OCS sources, as defined by the CAA in Section 328(a)(4)(C). 30 CFR 250.202(a) requires that the exploration plan conform to Federal laws.

OCS sources include, but are not limited to:

> "....platform and drill ship exploration, construction, development, production, processing, and transportation. For purposes of this subsection, emissions from any vessel servicing or associated with an OCS source, including emissions while at the OCS source or en route to or from the OCS source within 25 miles of the OCS source, shall be considered direct emissions from the OCS source." CAA Sec. 328(a)(4)(C).

MMS must include an analysis of the underlying technical basis for the emissions reductions measures suggested by Shell and must ensure that the required controls are made federally enforceable with comprehensive compliance demonstration measures.

Cumulative Impacts Analysis

The proposed exploration activities are predicted to result in substantial pollutant concentrations within approximately 60 and 100 miles from the North Slope communities of Kaktovik and Nuiqsut, respectively. According to the EP, "[t]he preliminary air quality impact analysis shows that Shell will exceed the Significant Impact Levels (SILs) at the Beaufort Sea shoreline."[20]

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[17] EIA Appendix H at 207.
[18] *See*, for example, EP at 29.
[19] *See*, for example, previous comment on the failure to ensure the use of ULSD fuel in support vessels.
[20] EP at 207.

Therefore, a full impact analysis is needed in order to adequately determine the cumulative impacts of the proposed emissions along with all other emissions that impact the same areas impacted by the exploration activities. In the presence of the strong temperature inversions that persist in this Arctic Region and the associated arctic haze, the air pollutants from the exploration activities may result in cumulative impacts to the region that are of concern.

Based on the limited underlying information presented in the EP for the screening model assessment it also appears that the predicted concentrations potentially underestimate impacts to air quality in the affected areas. In particular, the cumulative impact analysis is grossly deficient. The EIA (Appendix H) concludes that "[t]he anticipated cumulative impacts are expected to be well below NAAQS and AAAQS at the shoreline as a result of dispersion. Thus, the cumulative impacts to air quality from the EP activities are not significant."[21] It does not appear, however, that Shell modeled the cumulative impacts in the nearby onshore areas. MMS must fully consider the cumulative impacts from the proposed exploration activities along with all other past, present and reasonably foreseeable emissions that impact the same area as is impacted by the *Discoverer* and all other support activities. This would include, for example, the sources described earlier in the EIA:

> "The major local sources of industrial emissions are from the North Slope existing oil production complex including Prudhoe Bay, Kuparuk, Alpine, and other North Slope oil production facilities. Additional emissions from the North Slope come from generators in villages such as Kaktovik, Nuiqsut, and Barrow. Small amounts of pollutants are also emitted from vehicles such as cars, trucks, and ATVs, drill rigs, and heavy construction equipment such as dozers and graders."[22]

This would also include any reasonably foreseeable development in the area associated with other lease sales or with the potential production and transport that would result from the exploration activities in this plan. The cumulative impacts from regional sources along with Shell exploration activities addressed in this plan must be thoroughly addressed. Even though maximum concentrations from the Shell exploration activities will likely be highest near to the drill site, MMS must ensure that concentrations in all affected areas do not contribute to significant impacts when considered along with all other regional sources. The cumulative impact of these regional sources must be fully integrated into the modeling analysis and not just assessed at the point of greatest impact from the Shell sources (e.g., at the hull). Also, maximum potential emissions from these regional sources must be considered when determining cumulative impacts.

Baseline data gaps

The need to identify gaps in baseline air quality data has been an issue identified in previous NEPA reviews and continues to be of concern for the North Slope region. MMS must acknowledge these existing air quality concerns in its assessment and recognize that unknown

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[21] EIA Appendix H at 343.
[22] EIA Appendix H at 44.

and in some cases high background levels of air pollutants can mean that even if the proposed exploration activities will result in relatively minor increases in certain pollutant concentrations onshore, the aggregate level of pollution that could result might have significant detrimental effects on human health and the environment.

The recent draft OCS Multi-Sale EIS (OCS EIS/EA MMS 2008-0055) points out that, "[b]ecause of the current data gaps, it is not possible to determine with confidence the potential contribution of existing oil and gas emissions to baseline levels of respiratory illness in the NSB region, although it is certain that air pollution would be only one of several important contributors."[23] And, in fact, EPA commented on the need to identify these data gaps in its comments on the recent draft Multi-Sale EIS.[24] MMS must clearly identify the additional data needs. EPA committed to working with MMS, as appropriate, to identify these data needs and NSB encourages an evaluation of baseline data needs as part of this EP process as well.

Other Elements that Must be Included in the Exploration Plan Review Process

Impacts to Climate Change

As noted in the EP, "[t]he Council on Environmental Quality (CEQ) has issued guidance under NEPA indicating that climate change is a reasonably foreseeable impact of GHG emissions." EIA Appendix H at 42. Therefore, MMS must consider the potential impacts to the coastal and human environment from increased greenhouse gas emissions under this EP.

Recent research on the effects of black carbon on climate change indicate that the pollutant - a product of fossil fuel combustion - may have significant impacts on climate change, especially in the Arctic region. A portion of the $PM_{2.5}$ emissions from the proposed exploration activities are made up of black carbon emissions (from diesel fuel combustion), although it is uncertain what the exact percentage is. According to the EPA, there is sufficient evidence to support the reduction of black carbon emissions as a means to slow the rate of warming in the Arctic over the next few decades.[25]

The EP estimates that CO_2 emissions from the *Discoverer* and support vessels could approach 60,000 tons per year.[26] In addition to quantifying potential CO_2 emissions, MMS should implement reasonable measures for minimizing CO_2 and $PM_{2.5}$ emissions so as to minimize the associated climate impacts.

In the EIA, MMS compares the projected CO_2 emissions from the proposed exploration activities to state-wide estimates for CO_2 in order to make the argument that the exploration emissions are

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[23] OCS EIS/EA MMS 2008-0055, p. 3-233.

[24] *See* Attachment F, August 27, 2009 letter from Christine B. Reichgott, Manager, Environmental Review and Sediment Management Unit, EPA Region 10, ETPA-088, to John Goll, Regional Director, Mineral Management Service, Ref: 07-047-MMS, p. 3.

[25] M. Sarofim et al. Current Policies, Emission Trends and Mitigation Options for Black Carbon in the Arctic Region, Draft White Paper, U.S. EPA and others, April 28, 2009, available at http://iiasa.ac.at/rains/reports/DRAFTWhitePaper-BCArcticMitigation-280909.pdf

[26] EIA Appendix H at 203.

relatively "insignificant".[27] In this comparison, MMS makes mathematical errors that result in a gross misrepresentation of the significance of the exploration activities on climate change. Specifically, the EP states that:

> "In 2005, the total GHG emission from all state-wide Alaska sources was estimated to be 53 million metric tons CO2 equivalent (MMtCO2e)... The Alaska oil & gas industry accounted for 15.3 MMtCO2e of the industrial source total... Preliminary estimates of GHG emissions for the Shell operations are 20,000 tons CO2 from the Discoverer itself and about 55,000 tons CO2 from the combined fleet (Discoverer and its support vessels). The Discoverer and its support vessels combined projected CO2 emissions will account for approximately 0.001 percent of the Alaska 2005 total statewide estimated greenhouse gases of 53 million tons and 0.004 percent of the Alaska 2005 statewide oil & gas industry estimated greenhouse gases of 15 million tons."[28]

In fact, 55,000 tons of CO_2 is 0.1%, (or 1/10 of 1%, not 0.001% or 1/1000 of 1%) of 53 million; Similarly 55,000 tons of CO_2 constitutes roughly 0.4% of the 2005 statewide oil and gas industry emissions, not 0.004% as stated in the EP. And if the higher estimate of 60,000 tons CO_2 is used (as identified on p. 203 of the EIA) these percentages are even higher. This misrepresentation of the relevant significance of Shell's proposed exploration activities by a factor of 100 is unacceptable and NSB does not support the concluding statement that the "projected CO2 emissions from the proposed Shell exploration activities will be insignificant in relationship to the Alaska 2005 total statewide and Alaska oil & gas industry GHG/CO2 emissions."

Hazardous Air Pollutant Impacts

The EP quantifies total hazardous air pollutants (HAP) emissions from the proposed exploration (EP at 29) but does not include any further analysis of ambient concentrations of HAPs or the associated health impacts from exposure to HAPs at the levels indicated. Furthermore, without the underlying details of the emissions inventory it is unclear what assumptions have been used to calculate HAP emissions. In particular, there is no discussion in the EP of the emissions from raw venting from tanks or well venting, a potentially significant source of HAPs. There is also no mention of a flare. Based on the total estimated emissions presented in the EP, the VOC and HAP inventory does not appear to include these potential emissions. MMS must specify the VOC and HAP emissions associated with venting (or flaring, if applicable) and include these emissions in the air quality impact analysis.

Under NEPA, MMS must fully analyze and disclose the cumulative hazardous air pollutant impacts to the exposed population.[29] There is no mention of the impacts of background HAP emissions, in conjunction with projected emissions from the exploration, on human health in the affected areas. MMS's HAP assessment must be a cumulative one, not just an analysis of the

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[27] "The projected CO2 emissions from the proposed Shell exploration activities will be insignificant in relationship to the Alaska 2005 total statewide and Alaska oil & gas industry GHG/CO2 emissions." EIA at 42.

[28] EIA Appendix H at 42.

[29] NEPA regulations require an analysis to determine significant impacts to the environment including impacts to public health and safety (40 CFR 1508.27(b)(2)).

incremental risk associated with the development, which would be imposed on top of existing health risks in the area. It should, at a minimum, include an analysis of the health impacts of the following potential HAPs associated with offshore exploration: benzene, toluene, ethylbenzene and xylene (BTEX), n-hexane and 1,3-butadiene,[30] formaldehyde and secondary formaldehyde[31], polycyclic aromatic hydrocarbons (PAH) as well as diesel particulate matter. In particular, the cancer risk associated with diesel exhaust emissions may be significant. EPA's health assessment for diesel exhaust found that long-term exposure to diesel exhaust poses lung cancer risks while short-term exposures can cause lung irritation and inflammation.[32] Diesel combustion will be required in many aspects of the proposed offshore exploration, including emissions from drilling units/ships, icebreakers, and support vessels traveling to and from shore. Each of these HAPs comes with its own suite of concerns to human health and it is imperative that these pollutants be considered in the air quality analysis for this EP.

MMS must prepare a more comprehensive inventory and include estimates for individual HAPs and an assessment of how those emission levels, in conjunction with other emissions sources in the area, will impact human health. Of particular concern is the potential for significant HAP exposure from oil spills. MMS must fully evaluate the impacts to human health from all sources of HAP exposure in this EP.

Secondary $PM_{2.5}$ Analysis

An important consideration in determining $PM_{2.5}$ impacts, which is not accounted for in this EP, is the assessment of secondary $PM_{2.5}$ formation in the atmosphere. In addition to primary $PM_{2.5}$ emissions (directly emitted from combustion point sources and from fugitive sources), emissions of NO_x, VOCs, SO_2 and ammonia can form, after emitted into the atmosphere, into $PM_{2.5}$ and this can potentially be a significant component of ambient $PM_{2.5}$ concentrations. And while primary $PM_{2.5}$ emissions are generally a localized issue, secondary $PM_{2.5}$ emissions can be more regional in scale. Estimates of $PM_{2.5}$ formation from these precursors should be included in the EP's assessment of $PM_{2.5}$ impacts. This could be especially important considering the fact that the screening modeling results presented in the EIA predict $PM_{2.5}$ concentrations at almost 90% of the 24-hour NAAQS.[33]

The fraction of $PM_{2.5}$ concentrations in the ambient air that is due to the secondary formation of $PM_{2.5}$ (e.g., sulfates and nitrates), as opposed to directly emitted [primary] $PM_{2.5}$ (e.g., as a product of combustion) is dependent on many factors. However, the presence of strong temperature inversions that limit dispersion and provide conditions (e.g., high relative humidity) that contribute to the formation of secondary $PM_{2.5}$ in the atmosphere can increase secondary $PM_{2.5}$ formation. $PM_{2.5}$ concentrations, therefore, can be due to gaseous pollutants that form fine particles after reacting with other compounds in the air during meteorological inversions and it is

[30] *See* EPA's *Locating and Estimating Air Toxic Emissions* documents at http://www.epa.gov/ttnchie1/le/ for more info on 1,3-butadiene and other HAPs listed here.

[31] This would include the contribution of other VOCs emitted from development and production sources to the formation of secondary formaldehyde in the atmosphere downwind from the points of emission.

[32] U.S. Environmental Protection Agency (U.S. EPA), *Health Assessment Document for Diesel Engine Exhaust*, May 2002, 1-3, available at http://www.epa.gov/ttn/atw/dieselfinal.pdf. *See also*, http://www.catf.us/projects/diesel/dieselhealth/.

[33] EIA Appendix H Table 4.1.6-1 at 206.

important for the MMS to consider these $PM_{2.5}$ precursor sources (e.g., NO_x from diesel combustion) in its air quality impact assessment. Because of the presence of strong temperature inversions on the North Slope, MMS must seriously consider the contribution from secondary $PM_{2.5}$ to total $PM_{2.5}$ concentrations in the area. All of the sources of the primary pollutants that contribute to secondary $PM_{2.5}$ formation – e.g., NO_x, SO_x, VOC and ammonia - from sources in the area should be accounted for in an assessment of $PM_{2.5}$ impacts.

While the discipline of secondary $PM_{2.5}$ modeling is still evolving there are tools available to support such an analysis. The EPA provides access to certain photochemical modeling applications, including modeling of secondary PM, for regulatory applications. Specifically, the EPA recently developed a model based on the Community Multi-scale Air Quality (CMAQ) model to support the development of the $PM_{2.5}$ NAAQS. According to the EPA, the model has been shown to "reproduce the results from an individual modeling simulation with little bias or error" and "provides a wide breadth of model outputs, which can be used to develop emissions control scenarios".[34] The Comprehensive Air quality Model with extensions (CAMx) is another tool available to assess secondary $PM_{2.5}$ formation. CAMx has source apportionment capabilities and can assess a wide variety of inert and chemically reactive pollutants, including inorganic and organic $PM_{2.5}$ and PM_{10}. The Regional Modeling System for Aerosols and Deposition (REMSAD) can also model concentrations of both inert and chemically reactive pollutants on a regional scale, "including those processes relevant to regional haze and particulate matter."[35] These are just some examples of current models with the capability to assess secondary $PM_{2.5}$ impacts. Depending on the capabilities of these models they may either have to be adapted for use over water or used in combination with the Offshore and Coastal Dispersion (OCD) Model (to determine onshore concentrations of precursor emissions). The MMS's "next generation" OCD model (an adaptation of the CALPUFF model for use over water) might be another available tool if evaluations of the model indicate it is effective at predicting these types of impacts.[36] An Alaska Department of Environmental Conservation (ADEC) statement highlights the importance of this issue:

> "While North Slope air quality data has not shown violations of the National Ambient Air Quality Standards (NAAQS) near the facilities, concerns exist about the ability of older air quality models to predict deposition given the North Slope's strong atmospheric stability, complex high latitude atmospheric chemistry, the secondary formation of pollutants trapped in mid to long distance transport, and deposition of air pollutants which can accumulate in the soil and vegetation."[37]

It is important that MMS use the best available tools to assess the impact of emissions in the area that contribute to secondary $PM_{2.5}$ formation. The secondary $PM_{2.5}$ impacts could be critical to understanding the best way to mitigate any potential health impacts from fine particle pollution on the North Slope.

Regional Ozone Impacts

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[34] *See* http://www.epa.gov/scram001/reports/pmnaaqs_tsd_rsm_all_021606.pdf
[35] *See* http://remsad.saintl.com/
[36] *See* project summary at http://www.src.com/calpuff/download/MMS_Files/MMS2006_ProjectSummary.pdf
[37] *See* OCS EIS/EA MMS 2008-0055, p. 3-233.

The EP does not include an analysis of ozone. The EIA (Appendix H) does, however, include a discussion of EPA's concerns with respect to ozone:

> "The *Discoverer* and support vessel VOCs are not high enough to trigger EPA significance on their own, but coupled with the project's NO2 emissions may raise a potential ozone concern with EPA. The preliminary air quality impact analysis shows that Shell will meet all applicable NAAQS, AAAQS, and PSD increment standards at the edge of the *Discoverer*, the immediate vicinity of its support vessels, and at the Beaufort Sea shoreline. However, EPA is still reviewing the emissions inventory used by Shell's compliance demonstration. Until that review is complete, our modeling results must be considered preliminary.
>
> The preliminary air quality impact analysis shows that Shell will not have a significant adverse impact at the nearest villages along the Beaufort Sea coast, Nuiqsut and Kaktovik by demonstrating compliance with the applicable NAAQS, AAAQS, and PSD Increment standards."[38]

The EIA goes on to state that "[t]he proposed project should not have a significant impact on the contribution to ozone formation."[39] Yet the EP presents no evidence to support such a statement.

The importance of protecting the air quality for those people who live in the region, most importantly for sensitive populations, including children, the elderly and those with respiratory conditions is huge. Exposure to ground-level ozone is a serious concern as it can cause or exacerbate respiratory health problems, including shortness of breath, asthma, chest pain and coughing, decreased lung function and even long-term lung damage.[40] According to a recent report by the National Research Council "short-term exposure to current levels of ozone in many areas is likely to contribute to premature deaths".[41] The EPA recently revised the 8-hour ozone standard from 80 ppb to 75 ppb.[42] The Clean Air Scientific Advisory Committee (CASAC) - appointed by the Administrator to recommend revisions to the existing standards, per section 109(d)(2) of the Clean Air Act - recommended substantially lowering the 8-hour standard and the EPA did not abide by the committee's recommendations. Specifically, the CASAC put forth a unanimous recommendation to lower the 8-hour standard from 80 parts per billion (ppb) to somewhere between 60-70 ppb.[43] The committee concluded that there is no scientific justification for retaining the current 8-hour standard and that the EPA needs to substantially reduce the primary 8-hour standard to protect human health, especially in sensitive populations. Since ozone concentrations at levels as low as 60 ppb can be considered harmful to human health, the MMS must consider this when evaluating the air impacts in the EP.

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[38] EIA Appendix H at 207.
[39] EIA Appendix H at 207.
[40] *See* EPA's National Ambient Air Quality Standards for Particulates and Ozone, 62 FR 38,856 (July 18, 1997).
[41] *See* http://www.nationalacademies.org/morenews/20080422.html
[42] 73 FR 16436, Effective May 27, 2008.
[43] *See* Attachment G, EPA-CASAC-LTR-07-001, Clean Air Scientific Advisory Committee's (CASAC) Peer Review of the Agency's 2nd Draft Ozone Staff Paper, October 24, 2006.

The atmospheric chemistry leading to ozone formation is complex and is highly sensitive to a wide range of factors, including the intensity of sunlight, air temperature and the quantity and chemical composition of the volatile organic compounds (VOC) and nitrogen oxide (NO_x) pollutants that combine in the presence of sunlight to form ozone. Traditionally, elevated ozone levels are thought to be a summertime problem that plagues large urban areas. But recent events that have occurred in rural southwest Wyoming in wintertime demonstrate this is not always the case. This raises a concern with respect to potential ozone formation on the North Slope of Alaska during the non-summer months.

According to a recent study by the National Oceanic and Atmospheric Administration, ozone rapidly formed in southwest Wyoming "when three factors converged: ozone-forming chemicals from the natural gas field, a strong temperature inversion that trapped the chemicals close to the ground, and extensive snow cover, which provided enough reflected sunlight to jump-start the needed chemical reactions."[44] The North Slope of Alaska also exhibits these three factors needed for ozone formation. First, industrial sources in the North Slope region have the potential to contribute tens of thousands of tons of NO_x emissions (80,000 TPY) and several thousand tons of VOC emissions (2,500 TPY) to the area each year.[45] In comparison, the NO_x inventory for the counties that include the Wyoming development field totals just over 60,000 TPY and VOC emissions total just over 10,000 TPY.[46] Second, the EP references the strong temperature inversions that frequently occur in Alaska's North Slope region.[47] Finally, extensive snow cover is persistent in the region from as early as September through June.[48] The exploration activities in the EP will occur as late as October 31. While there may not be available sunlight in the dead of winter there is certainly abundant sunlight in the fall and spring in conjunction with snowcover and strong temperature inversions. The fact that the pollution sources and photochemical mechanisms for producing ozone are available and the possibility of elevated background concentrations from global transport of pollution is real means that MMS must thoroughly investigate the effects of NO_x and VOC sources from the proposed exploration and from existing and reasonably foreseeable NO_x and VOC sources in the region on ozone formation on the North Slope.

Even though background levels of ozone in and near Prudhoe Bay do not threaten compliance with the NAAQS, background concentrations as high as 50 ppb (based on daily average data from NOAA/GMD monitoring in Barrow[49]) have been observed. This level is equivalent to

[44] *See* NOAA's press release at http://www.noaanews.noaa.gov/stories2009/20090118_ozone.html, January 18, 2009 for Schnell, R.C., et al. 2009. Rapid photochemical production of ozone at high concentrations in a rural site during winter. *Nature Geoscience* 1-3 (January 18, 2009), http://www.nature.com/naturegeoscience.

[45] *See* the North Slope Borough Region Emission Summary in Table 3.4.5-8 of the Beaufort Sea and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 Draft Environmental Impact Statement, OCS EIS/EA MMS 2008-0055. Total permitted NOx emissions exceed 83,000 TPY and total permitted VOC emissions exceed 2,500 TPY.

[46] Based on 2005 emissions data presented in meeting notes from Greater Yellowstone Area Clean Air Partnership Annual Meeting, Pocatello, ID, October 17-18, 2007, available online at http://www.fs.fed.us/r1/gallatin/resources/air/gyacap/docs/GYACAP-Pocatello_2007_Meeting_Notes.doc

[47] *See*, for example, EIA Appendix H at 44.

[48] *See*, for example, the Barrow Snowmelt Date study performed by NOAA's Earth System Research Lab at http://www.esrl.noaa.gov/gmd/grad/snomelt.html

[49] *See* http://gaw.kishou.go.jp/cgi-bin/wdcgg/accessdata.cgi?index=BRW471N00-NOAA&select=inventory

background concentrations currently observed in the active oil and gas development areas in the Uinta Basin in northeast Utah.[50] MMS has an obligation to ensure that the emissions from the proposed exploration activities along with emissions from other existing and reasonably foreseeable sources in the region will not cause harm to human health or the environment. Table 7.0-1 of the EP estimates NO_x and VOC emissions at over 2,000 TPY and 168 TPY, respectively. Emissions will dilute as they transport away from their source of origin, but spreading of plumes is not always rapid and is highly dependent on the atmospheric stability at the time. These emissions could certainly contribute to ozone formation in the region under the right conditions, as described above.

A study looking at future ozone concentrations in the Arctic from increased shipping traffic in the Arctic northern passages determined that ships' combustion engines could increase ozone concentrations in the region by 2-3 times in the decades ahead (with predicted peak concentrations reaching more than 60 ppb_v in July and August).[51] According to the same study, "the photochemical lifetime of ozone [in the Arctic] is rather long, and its deposition velocity on ice and water is small." Furthermore, "[i]n most regions of the troposphere, including the remote Arctic areas where background concentrations of pollutants are particularly low, the formation rate of ozone is limited by the amount of nitrogen oxides that are present in the atmosphere." Thus, it is conceivable that NO_x (and VOC) emissions from Shell exploration activities could contribute to elevated ozone concentrations in the region, even during the summer months.

In order to ensure protection of human health and to fulfill its legal responsibility under NEPA and OCSLA, MMS must include a more thorough and convincing evaluation of potential ozone impacts in the region.

Additional Air Quality Impacts

The well-documented Arctic Haze that is observed in the winter and spring on the North Slope of Alaska is discussed in the EP but there is no analysis of the contribution from the proposed exploration activities to this resident haze. It is well known that Arctic Haze is a common phenomenon in polar climates. It is not well understood, however, how much of the Arctic Haze observed in the region can be attributed to localized sources. It is true that any increases in air pollutants that contribute to the formation of haze will exacerbate the existing haze in the area. MMS has an obligation under NEPA to meet Clean Air Act Requirements and under OCSLA to ensure adequate protection of the human environment and, therefore, must ensure that the proposed development would not adversely impact visibility in the region and in particular in nearby areas set-aside as wilderness and refuge lands, such as the Arctic National Wildlife Refuge, located 25 miles from the project area.[52]

It is not out of the question to see visibility impacts from similar sources with even lower levels

[50] Background ozone concentrations in the Uinta Basin, Utah from recent (2008) EAs = 50 ppb (draft Big Pack EA UT-080-06-488, draft River Bend EA UT-080-07-772, draft Southam Canyon EA UT-080-08-342). See http://www.blm.gov/ut/st/en/fo/vernal/planning/nepa_.html

[51] *See* Attachment H, Granier, C., U. Niemeier, J. H. Jungclaus, L. Emmons, P. Hess, J.-F. Lamarque, S. Walters, and G. P. Brasseur (2006), Ozone pollution from future ship traffic in the Arctic northern passages, *Geophys. Res. Lett.*, *33*, L13807, doi:10.1029/2006GL026180.

[52] EP at 146.

of emissions at distances further than Shell's activities will be from ANWR. For example, the modeling prepared for the Shell oil shale research, development and demonstration (RD&D) Environmental Assessments (EAs) in northwest Colorado, predicted that on 8-14 days per year, the visibility "limit of acceptable change" would be exceeded as a direct result of the Shell oil shale projects (i.e., not considering cumulative sources) at Flat Tops Wilderness Area, which is roughly 50 miles from the proposed source (almost twice the distance as the Arctic National Wildlife Refuge is from the proposed lease areas).[53] This particular project predicted emissions of all pollutants at levels quite a bit lower than what is predicted from the Shell exploration activities.[54] Further, the maximum direct total (wet and dry) nitrogen and sulfur deposition during operation were predicted to be nearly 0.265 and 0.033 kilograms per hectare per year (kg/ha-yr), respectively.[55] These predicted impacts are greater than the National Park Service's thresholds of 0.005 kg/ha/yr for both sulfur and nitrogen deposition used in determining whether an adverse environmental impact may occur due to sulfur or nitrogen deposition. Too much sulfur or nitrogen deposition in an area could affect soil fertility and nutrient cycling and could result in acidification of bodies of water. MMS should consider impacts to visibility and other air quality related values as part of its EP review.

The Arctic National Wildlife Refuge was originally established as the Arctic National Wildlife *Range* in 1960 (under Public Land Order 2214).[56] The Arctic Range was set aside for its "unique wildlife, wilderness and recreational values." In 1980, the Range was redesignated as a unit of the National Wildlife Refuge System and was established, along with an additional nine million acres to the south and west of the original Range, as the Arctic National Wildlife Refuge. The purposes for which the Arctic National Wildlife Refuge were established included conservation of fish and wildlife species and their habitats and opportunity for continued subsistence uses by local inhabitants as well as protection of water quality and quantity within the refuge.[57] Section 702(3) of ANILCA designated much of the original Refuge as a wilderness area, but not the coastal plain. In keeping with the intent for setting aside this refuge and wilderness area, MMS has a responsibility under NEPA to ensure there are no significant impacts to areas with unique characteristics (i.e., a responsibility to preserve the area's wilderness, wildlife and recreational values as well as to preserve its wildlife species and their habitats).[58]

The purpose of the Clean Air Act's Prevention of Significant Deterioration (PSD) program includes the need to "preserve, protect and enhance the air quality in national parks, wilderness areas and other areas of natural, recreational, scenic or historic value" and to "insure economic growth will occur in a manner consistent with the preservation of existing clean air resources."[59]

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[53] Shell Oil Shale Research, Development and Demonstration Projects EA, CO-110-2006-117-EA, August 2006, p. 18. See http://www.blm.gov/wo/st/en/prog/energy/oilshale_2/research_development.html

[54] Emissions from the oil shale RD&D project (compared with Shell's EP estimates): 500 TPY (2,000 TPY) NO_x, 75 TPY (168 TPY) VOC, 55 TPY (213 TPY) PM_{10}, 40 TPY (187 TPY) $PM_{2.5}$, 12 TPY (186 TPY) SO_2. Air Sciences Engineering Calculations, Oil Shale RD&D EA – Shell, May 24, 2006.

[55] Shell Oil Shale Research, Development and Demonstration Projects EA, CO-110-2006-117-EA, August 2006, p. 150. See http://www.blm.gov/wo/st/en/prog/energy/oilshale_2/research_development.html

[56] *See* http://arctic.fws.gov/plo2214.htm

[57] Alaska National Interest Lands Conservation Act (ANILCA), Title III § 303(2)(B). ANILCA, P. L. 96-487, 94 Stat. 2371.

[58] 40 CFR 1508.27(b)(3).

[59] CAA, Section 160(2) and 42 U.S.C. 7470.

In other words, the basic intent of the PSD program is to manage growth in the context of protecting the environment. For this EP, environmental protection would include, among other things, consideration of impacts on the Arctic National Wildlife Refuge, including the designated Wilderness Area within the refuge boundary. In addition to the basic PSD provisions of the CAA, there are provisions under other authorities (e.g., the Wilderness Act) to protect air quality related values (AQRVs) in areas designated as Class II air sheds under the CAA.[60] The Fish and Wildlife Service (FWS) is the Federal Land Manager (FLM) of the Arctic National Wildlife Refuge and the designated wilderness area within. FWS policy specifies the following with regard to Class II wilderness areas:

> "The planning, research and monitoring outlined above for Class I areas can also be applied in Class II areas. Information on air quality and AQRVs of a Class II area is important for comprehensive management of these refuge resources. Although the EPA or delegated state authority is not required to notify the FLM of proposed projects that may affect Class II areas, the EPA or state is required to evaluate whether such projects may cause an exceedance of the NAAQS or PSD Class II increments in these areas. Wilderness areas that are Class II air quality areas receive additional protection from the Wilderness Act, which requires the Service to minimize the effect of human use or influence on natural ecological processes and preserve "untrammeled" natural conditions within wilderness."[61]

One of the Fish and Wildlife Service's broadly stated Wildlife Habitat Goals is to "[i]dentify and recommend solutions for external threats to refuge habitats, such as air and water quality."[62] The information and procedures outlined in the Federal Land Manager's FLAG[63] document should be considered as generally applicable to evaluating effects on the AQRVs of Class II areas. In particular, MMS should fully consider the effects of the proposed exploration activities on the Arctic National Wildlife Refuge, along with all other sources that impact the Refuge and Wilderness Area, on visibility and other air quality related values that impact the ecosystem (for example, mercury and other toxics deposition, nitrogen deposition, acid deposition, etc.). The impacts to ecosystems from these various pollutant depositions include direct impacts to flora and fauna as well as indirect impacts to water quality. For example, atmospheric deposition of nitrogen and sulfur has the potential to acidify sensitive aquatic ecosystems, which can then impact fish and other wildlife resources. Protection of these resource values will ensure preservation of the wilderness values and the wildlife and habitat in the area (including water quality), as was intended when the land was set-aside as the Arctic National Wildlife Refuge.

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[60] The CAA establishes Class I, II and III areas with varying degrees of air quality protection. Class I areas are afforded the highest level of protection and include national parks greater than 6,000 acres, wilderness areas and national memorial parks greater than 5,000 acres and international parks that existed in 1977. There are no Class I areas on the North Slope.

[61] Fish and Wildlife Service Manual, 563 FW 2, 2.8B.

[62] "Fulfilling the Promise, The National Wildlife Refuge System, Visions for Wildlife, Habitat, People, and Leadership", The National Wildlife Refuge System, U.S. Fish and Wildlife Service, Department of the Interior, March 22,1999, p. 24.

[63] *See* http://www2.nature.nps.gov/air/permits/flag/index.cfm

The fact that the project area is close to the Arctic National Wildlife Refuge underscores the importance of taking a hard look at the potential cumulative impacts from existing and reasonably foreseeable sources of pollutants in the area in conjunction with the proposed exploration sources on the Arctic National Wildlife Refuge.

MMS should evaluate the tools available for conducting an analysis of visibility and AQRV impacts and if it determines that the existing models do not have the capability to adequately assess far-field cumulative impacts from a combination of over-water sources and onshore sources on receptors in the Arctic National Wildlife Refuge or other Class II areas of concern then the MMS should consider adapting the available models to include algorithms that can achieve this. The Offshore and Coastal Dispersion (OCD) Model would be one available tool for use in conjunction with a modeling analysis of the predicted onshore concentrations on visibility and AQRV impacts downwind. The MMS's "next generation" OCD model (an adaptation of the CALPUFF model for use over water) would be another available tool if evaluations of the model indicate it is effective at predicting these types of impacts.[64] As mentioned earlier, in the context of secondary pollutant formation, the ADEC has stated that "[w]hile North Slope air quality data has not shown violations of the National Ambient Air Quality Standards (NAAQS) near the facilities, concerns exist about the ability of older air quality models to predict deposition given the North Slope's strong atmospheric stability, complex high latitude atmospheric chemistry, the secondary formation of pollutants trapped in mid to long distance transport, and deposition of air pollutants which can accumulate in the soil and vegetation."[65] MMS must make an effort to address the significance of these impacts as part of this EP.

Water Quality

Exploration Plan Comments:

Page x, 30 CFR 250.216 – Biological environment reports referred to in the Table of Regulation Section:

Comments in the following section investigate the EP's failure to assess the key restrictive water quality effects of the proposed exploration activities on Beaufort Sea organisms and subsistence resources. The biological effects of the proposed discharge combined with actual Beaufort Sea ambient conditions went unexamined in the EP, the IHA, and the EIA.[66] Moreover, the large magnitude discharges and varying chemical types proposed in the EP were unanticipated in the NPDES permit. The actual chronic, toxic and bio-accumulating effects of the proposed discharges are fundamentally ignored in the biological reports.

The EP disregards the reduced mixing associated with the strongly stratified layer conditions in the Beaufort Sea in the summer and in the vicinity of the proposed exploration sites. The resulting two-layer system is acknowledged in the EIA yet nowhere in the EP, EIA or the

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[64] *See* project summary at http://www.src.com/calpuff/download/MMS_Files/MMS2006_ProjectSummary.pdf
[65] *See* OCS EIS/EA MMS 2008-0055, p. 3-233.
[66] *See* Attachment I, EP Environmental Impact Assessment (EIA) Pages 56-58. Also, IHA is the Incidental Harassment Authorization that is in EP Appendix E. The EIA is in EP Appendix H.

NPDES permit does it evaluate the restricted mixing of pollutants due to these stratified conditions. Surface discharges that constitute the majority of proposed discharges from the drillship are trapped in the upper surface layer and allowed to accumulate in the Beaufort Sea. Other restrictive dilution effects related to estuarine and slack tide conditions are also unacknowledged in the EP and related biological environment documents. Stratified, estuarine and slack tide conditions known to exist at the exploration sites were unanticipated and unexamined in the attached Arctic NPDES permit,[67] and the associated Arctic ODCE.[68]

The comments in this section rely upon the following documents, which are included in their entirety in attachments to these comments: The *Technical Support Document for Water Quality-based Toxics Control*, (EPA TSD, 1991) describing the restrictive mixing under stratified and estuarine conditions (see TSD Page 74);[69] and *Dilution Models for Effluent Discharges* (EPA 1994), which describes analysis procedures for assessing pollutant concentrations released into ambient waters.[70]

The National Environmental Policy Act (NEPA) requires that all federal government agencies prepare Environmental Assessments (EAs) and Environmental Impact Statements (EISs) that contain statements of the environmental effects of proposed federal agency actions. MMS must provide an environmental assessment of the actual ambient Beaufort Sea conditions including stratification and other identified estuarine conditions- Shell's EIA does not do so.

Page x, 30 CFR 250.217 – Solid and liquid waste information referred to in the Table of Regulation Section:

Comments in the following section also examine the EP's failure to fundamentally provide key information for assessing the effects of the wastes discharged as proposed in the EP. Discussion of actual chronic, toxic and bioaccumulating chemical effects is ignored in the EP, the IHA and the EIA. The reports offer little information on the actual chronic, toxic and bioaccumulating effects of the proposed discharges. This is despite the EP adversely exceeding the discharge magnitudes and chemicals types anticipated in, and forming the basis of, the NPDES permit AKG 280000.

The proposed discharges for non-contact cooling water, the toxic and bioaccumulating effects of the aggregate discharges (there are at least 11 discharge types), and drilling fluids and cuttings are especially problematic because these discharges and volumes were not analyzed in the EP or EIA.

Non-contact cooling water will be discharged in volumes that exceed by 9 times those anticipated in the NPDES permit and violate the ODCE mixing zone restriction of 100-meters.[71]

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[67] *See* Attachment J, NPDES General Permit and Fact Sheet *For Oil And Gas Exploration Facilities On The Outer Continental Shelf And Contiguous State Waters* (AKG280000) also know as Arctic OGGP, 2006.

[68] *See* Attachment K, *Final Ocean Discharge Criteria Evaluation of the Arctic NPDES General Permit for Oil and Gas Exploration* (AKG280000) also know as Arctic ODCE, EPA, 2006.

[69] *See* Attachment L, *Technical Support Document for Water Quality-based Toxics Control* (EPA TSD, 1991).

[70] *See* Attachment M, *Dilution Models for Effluent Discharges* (EPA 1994).

[71] 100-meter MZ restriction as stated in 40 CFR 125.121(c) and 40 CFR 125.122 – Determination of unreasonable degradation of the marine environment.

Moreover, EPA's *Quality Criteria for Water*[72] identifies a maximum acceptable increase of 1° C to protect marine aquatic life while the EP reports a discharge of at least 1.4° C in Shell's Offshore Exploration Drilling Discharge Program – Cooling Water.[73]

Under the EP, drilling fluids and cuttings will be discharged separately to the surface layer and seafloor of the Beaufort Sea. These discharges will be allowed to contain toxic and bioaccumulating chemicals including at least chromium and PAHs (fluorene and acenaphthene) unidentified and/or unexamined for biological effects in the EIA, or the NPDES permit development documents.

NEPA requires environmental assessments to contain statements of the environmental effects of proposed federal agency actions. MMS must require the applicant to provide an environmental assessment of actual toxic and bioaccumulating discharges to be released into the Beaufort Sea under known ambient conditions.

Page xii, 31[sic] CFR 250.227 - Environmental impact analysis information referred to in the Table of Regulation Section:

Comments in the following section also examine the EP's failure to perform environmental impact assessment for the most significant discharges including: proposed large thermal discharges as NPDES Discharge Number 009 – Non-contact Cooling Water; the whole effluent composition, toxicity, and bioaccumulation characteristics[74] of the discharge from the drillship's disposal caisson into the surface layer of the Beaufort Sea.

The whole effluent discharged from the disposal caisson is a chemical mixture of numerous discharge types including Drilling Mud and Cuttings (001), Deck Drainage (002), Sanitary Waste (003), Domestic Waste (004), Desalination Unit Waste (005), Blowout Preventer Fluid (006), Uncontaminated Ballast Water (010), and Bilge Water (011). This comprises a whole effluent mixture permitted to at least include chlorine, ammonia, fecal coliform bacteria, biocides, polymers, benzene, ethylbenzene, toluene, xylene, polynuclear aromatic hydrocarbons (PAH), metals including chromium and mercury and cadmium, BOD, TSS and other chemical compounds. Many of these chemicals are toxic and bioaccumulating[75] and the EP and the EIA ignore the effect of whole effluent composition, for all discharge types and combined discharges, in violation of the Ocean Discharge Criteria.[5] Moreover, the Arctic ODCE and NPDES permit (AKG280000) fail to anticipate whole effluent toxicity and provide no basis for combined discharges despite there being well established Whole Effluent Toxicity testing requirements and procedures.

In developing the NPDES permit AKG28000 for the Arctic the EPA stated:

[72] Page 275, under Temperature – Marine Aquatic Life, *Quality Criteria for Water*, 1986.
[73] Page 446 of 1260 pages (unnumbered), Shell's Offshore Exploration Drilling Discharge Program – Cooling Water.
[74] *See* Ocean Discharge Criteria – particularly 40 CFR 125.122(a)(1), (2) and (3).
[75] EPA *Criteria for Water*, 1986.

> In determining whether water quality-based limits are needed and developing those limits when necessary, EPA follows guidance in the *Technical Support Document for Water Quality-based Toxics Control* (TSD; EPA, 1991). The water quality-based analysis consists of four steps: (1) determine the appropriate water quality criteria that apply to each discharge, (2) determine if there is "reasonable potential" for the discharge to exceed the criteria in the receiving water, (3) develop a WLA if there is reasonable potential, and (4) develop effluent limitations based on the WLA.[76]

However, the EPA did not acknowledge the potential for aggregate toxic effects from single or multiple discharge types, and created no allowance for whole effluent toxicity in the NPDES permit. The EP and the EIA have perpetuated this omission while proposing to rely on the NPDES permit, and have accordingly failed to address the environmental impact of all the various discharge chemicals and discharge types acting together.

The EPA's own guidance from the TSD states the following requirements for biological testing of whole effluents:

> 1.3 Whole Effluent Approach for Aquatic Life Protection
> The whole effluent approach to toxics control for the protection of aquatic life involves the use of acute and chronic toxicity tests to measure the toxicity of wastewaters. Whole effluent toxicity is a useful parameter for assessing and protecting against impacts upon water quality and designated uses caused by the aggregate toxic effect of the discharge of pollutants [16]. Whole effluent toxicity tests employ the use of standardized, surrogate freshwater or marine (depending upon the mixture of effluent and receiving water) plants, invertebrates, and vertebrates. EPA has published extensive written protocols listing numerous marine and freshwater species for toxicity testing [17, 18, 19].[77]

The TSD provides additional information for implementing whole effluent toxicity WET testing and is attached in its entirety as Attachment M.

Also attached is *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*[78] that states:

> 1.1 This manual describes acute toxicity tests for use in the National Pollutant Discharge Elimination System (NPDES) Permits Program to identify effluents and receiving waters containing toxic materials in acutely toxic concentrations. With the exception of the *Holmesimysis costata* Acute Test (Table 19), the methods included in this manual are referenced in Table IA, 40 CFR Part 136 regulations and, therefore, constitute approved methods for acute toxicity tests. They are also suitable for determining the toxicity of specific compounds contained in discharges. The tests may be conducted in a central laboratory or on-site, by the regulatory

[76] Page 12, last paragraph, EPA *Fact Sheet* for the NPDES permit AKG280000.
[77] Page 4 of EPA *Technical Support Document for Water Quality-based Toxics Control*, TSD, 1991 (Attachment L).
[78] *See* Attachment N.

agency or the permittee. The *Holmesimysis costata* Acute Test (Table 19) is specific to Pacific Coast waters and is not listed at 40 CFR Part 136 for nationwide use. This method has been proposed but not yet approved at 40 CFR Part 136.[79]

Last, also attached is *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms*[80] that states:

> 1.1 This manual describes chronic toxicity tests for use in the National Pollutant Discharge Elimination System (NPDES) Permits Program to identify effluents and receiving waters containing toxic materials in chronically toxic concentrations. With the exception of the Red Macroalga, *Champia parvula*, Reproduction Test Method 1009.0, the methods included in this manual are referenced in Table IA, 40 CFR Part 136 regulations and, therefore, constitute approved methods for chronic toxicity tests. They are also suitable for determining the toxicity of specific compounds contained in discharges. The tests may be conducted in a central laboratory or on-site, by the regulatory agency or the permittee. The Red Macroalga, *Champia parvula*, Reproduction Test Method 1009.0 is not listed at 40 CFR Part 136 for nationwide use.[81]

The biological testing implementation and procedures, described in the attached documents in Attachments M, N and O, comprise the whole effluent toxicity testing that should have been addressed in the EP as supported by the EIA. The EIA is fundamentally flawed. It acknowledges the combination of discharge components but then ignores the requirements of the Ocean Discharge Criteria violating 40 CFR 125.122(a) by failing to consider the aggregate effect and composition of pollutants to be discharged.

MMS must require the applicant to perform an environmental assessment of the actual whole effluent toxicity (WET) and bio-accumulating effect resulting from the aggregate action of the numerous waste discharge types acting together.

Page 5, under Frontier Discoverer Dimensions:

The width is not given.

Page 9, Table 2.0-1 - Permit and Authorization Applications, 6th item that lists "Notices of Intent to Discharge under NPDES General Permit" (AKG280000).

These NOI are incomplete for significant requirements and provide little or no information regarding diagrams displaying the drill ship waste flows pursuant to 30 CFR 250.217(c) as required for MMS. Nor do the NOI provide the flow balance showing average flows between intakes, operations, treatment units and outfalls as required by the NPDES permit. The inadequacy and noncompliant NOIs submitted as part of the EP for the Sivulliq and Torpedo sites are fully discussed in the comments on Appendix C.

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[79] *Id.* at p. 1.

[80] *See* Attachment O.

[81] *Id.* at 1.

Page 9, under "b) Drilling Fluids", 1st par., 2nd sentence:

It states that "[d]rilling fluid discharge volumes and chemistry will comply with the U.S. Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) General Permit AKG-28-0000 conditions."

This statement is inaccurate. The EP will allow chemical discharges of biocides not anticipated or examined as the basis of the EPA NPDES permit. The biocide, Myacide, proposed for use in the EP[82] allows the discharge of Glutaraldehyde and/or Triazine and/or Bronopol all of which are toxic and potentially bioaccumulating. Moreover, neither the EP nor the EIA nor the EPA NPDES permit considered the biodegradation, bioaccumulation or octanol/water partitioning of the drilling fluid polymer Poly Pac R polymer, i.e., carboxymethylcellulose.

Page 17, 5th bulleted item under "Biological Environment Reports":

Lists "Hydrographic profiles and water samples" but does not discuss. The next paragraph goes on to state that "[t]he sample location and the results of the sampling are discussed in Section 16.0, Environmental Impact Analyses." However, Section 16 on page 127 of the main EP merely directs the reader to "[s]ee Appendix H for the complete text of the Environmental Impact Statement."

The actual hydrographic profiles and water samples discussion actually takes place in EIA Section 3.2.4 – Water Quality, on EIA Pages 52 through 61. Of particular importance is the "Temperature and Salinity" discussion on EIA Pages 56 through 58. These pages are excerpted, from the 1260 page EP report, and attached below.[83] The EIA states:

> In summer, Beaufort Sea coastal waters become stratified with warm freshwater blanketing underlying colder dense seawater. Stratification produces warmer, brackish water along the shoreline where an abundance of fish, birds, marine mammals, and other biota can feed and travel. Stratification is disrupted by storm activity or wind that agitates the water column delivering nutrient rich water to the surface. Stratification ceases as temperatures cool surface waters producing a uniform temperature water column. October through June, the water column remains unstratified and fairly uniform with salinities range from 24,000-35,000 ppm. Marine waters colder than 28.4 °F (-2.0° C) typically freeze. [84]

The temperature and salinity vertical profiles are displayed for Sivulliq and Torpedo in EIA Figures 3.2-5 and –6, respectively.[85] These figures show obvious strongly stratified conditions in the Beaufort Sea in the vicinity of the proposed Sivulliq and Torpedo exploration plan

[82] *See* EP , page 24 continuation of Table 6.0-2 - Drilling Fluid Components and Load Out List for the Camden Bay Exploration Drilling Program, see item Myacide under "Component" column.
[83] *See* Attachment I.
[84] EIA Page 56, Par. 1 under "Temperature and Salinity".
[85] That is EIA Figure 3.2-5 on EIA Page 56; and EIA Figure 3.2-6 on EIA Page 57.

discharges. That is, in summer, lighter estuarine[86] water resulting from warmer surface temperatures and lower salinities is resting on top of a separate deeper layer of colder, saltier seawater.

Dunton, et al. (2009) clearly acknowledge that estuarine conditions exist in the Beaufort Sea stating:

> The coast and shelf of the Beaufort Sea extends from Point Barrow, Alaska to Banks Island in Canada, incorporates three distinct shelf environments and two large river systems, the Colville and the Mackenzie. In marked contrast to the Chukchi-Bering ecosystem on the west and the Queen Charlotte Islands on the west, **the Beaufort Sea, and the eastern Alaskan Beaufort in particular, is decidedly estuarine in character**. The combined flows of the Colville and the Mackenzie Rivers add nearly 350 km3 of runoff plus 130 x 106 tons sediment to a relatively broad shelf that ranges in width from 40 km in Alaska to 150 km in Canada (MacDonald et al., 2004). In addition, the Alaskan Beaufort Sea coast, from Barrow to Demarcation Bay, is skirted by an irregular and discontinuous chain of barrier islands that enclose numerous shallow (<8 m) lagoons that are fed by many small rivers and streams.[87]
> (Emphasis Added)

Stratified and estuarine conditions are a highly restrictive mixing condition[88] that has remained unexamined in the EP. This is despite the condition that the majority of waste discharges from exploration activities would be released directly the mixing restricted upper surface layer of the Beaufort Sea. Nor did the EPA in establishing the NPDES permit AKG280000 that applies to waste discharges from oil and gas exploration activities consider this condition.[89] Moreover, the Ocean Discharge Criteria Evaluation (ODCE) for the Arctic,[90] relied upon by the EP, fails to evaluate the restrictive mixing effects of estuarine and stratified conditions in the Beaufort Sea.

Page 17, 5th bulleted item under "Biological Environment Reports":

Lists "Hydrographic profiles and water samples." However, two-layer stratified and estuarine ambient conditions, and their restrictive impacts on mixing and concentrations of effluent toxics and bioaccumulating chemicals, were ignored and never analyzed in the EP and EIA.

Both the estuarine and ocean waterbody designations in EPA's TSD, section 4.4.2 Critical Design Periods for Waterbodies, page 74, identify stratification as an important consideration in determining actual mixing at discharge sites.

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[86] Estuarine waters are mixed freshwater and seawater.

[87] *Impact Assessment for Exploratory Drilling in Camden Bay (Sivulliq), Alaska*, by Dunton, Schonberg and McTigue, University of Texas Marine Science Institute, report commissioned by Shell Alaska, 2009. See Page 5 under "1.0 Introduction", par. 2, sent. 2.

[88] TSD, Page 74.

[89] *See* NPDES permit AKG280000 Fact Sheet and Arctic ODCE for AKG280000.

[90] *Final Ocean Discharge Criteria Evaluation of the Arctic NPDES General Permit for Oil and Gas Exploration* (Permit No. AKG280000), by: Tetra Tech, Inc., for U.S. Environmental Protection Agency, Region 10, Office of Water and Watersheds. EPA, 2006.

The full TSD guidance for mixing zone studies for ocean conditions is as follows:

> 4) Oceans
>
> Critical design periods for ocean analyses are described in two separate documents, the Section 301 (h) Technical Support Document [22] and the Section 301 (h) document, Initial Mixing Characteristics of Municipal Ocean Discharges [24]. The following subsection contains a summary from these documents. Like discharges to estuaries, discharges to ocean waters are subject to two-dimensional horizontal flows. **Oceanic critical design periods must include periods with maximum thermal stratification, or density stratification.** These periods shorten the distance of vertical diffusion that occurs in the zone of initial dilution. Thus, during these periods it is difficult to achieve the recommended l00-to-1 dilution that is to occur before the plume begins a predominantly horizontal flow as compared to vertical flow. Periods when discharge characteristics, oceanographic conditions (spring tide and neap tide currents), wet and dry weather periods, biological conditions, or water quality conditions that indicate that water quality standards are likely to be exceeded should also be noted. The 10th percentile value from the cumulative frequency of each parameter should be used to define the period of minimal dilution.[91]
> (Emphasis Added)

The full TSD guidance for estuaries and coastal bays states:

> 3) Estuaries and Coastal Bays
>
> This receiving water category encompasses estuaries, which are defined as having a main channel reversing flow, and coastal bays, which are defined as having significant two-dimensional flow in the horizontal directions. For both waterbodies, the critical design conditions recommended here are based on astronomical, not meteorological, tides.
>
> **Determining the nature and extent of the discharge plume is complicated in marine systems by such conditions as differences in tides, riverine input, wind intensity and direction, and thermal and saline stratification. Because of the tidal nature of the estuaries and coastal systems and their complex circulation patterns, dilution of discharges cannot be determined simply by calculating the discharge rate and the rate of receiving water flow (i.e., the design flow).** For example, tidal frequency and amplitude vary significantly in different coastal regions of the United States. Furthermore, tidal influences at any specific location have daily and monthly cycles. These and additional factors require that direct, empirical steps be taken to ensure that basic dilution characteristics of a discharge to salt water are determined.
>
> In estuaries without stratification, the critical dilution condition includes a combination of low-water slack at spring tide for the estuary and design low flow for riverine inflow. In estuaries with stratification, a site-specific analysis of a period of minimum stratification and a period of maximum stratification, both at low water slack, should be made to

[91] TSD, EPA 1991, page 74 (Attachment L).

> evaluate which one results in the lowest dilution. In general, minimum stratification is associated with low river inflows and large tidal ranges (spring tide), whereas maximum stratification is associated with high river inflows and low tidal ranges (neap tide).
>
> After either stratified or unstratified estuaries are evaluated at critical design conditions, an off-design condition should be checked. The off-design condition (e.g., higher flow or lower stratification) recommended for both cases is the period of maximum velocity during a tidal cycle. This off-design condition results in greater dilution than the design condition, but it causes the maximal extension of the plume. Extension of the plume into critical resource areas may cause more water quality problems than the high-concentration, low-dilution situation.
>
> Recommendations for a critical design for coastal bays are the same as for stratified estuaries. **The period of maximum stratification must be compared with the period of minimum stratification in order to select the worst case.** The off-design condition of maximum tidal velocity should also be evaluated to predict the worst-case extent of the plume.[92]
> (Emphasis Added)

Page 21, par. 1, sent. 1 states that:

> Tables 6.0-1A and B present relevant information on the generation and disposal of solid and liquid wastes expected to be generated by the Discoverer during the Camden Bay 2010 drilling program. This information is being submitted concurrently to the EPA to support Notices of Intent (NOIs) (Appendix C) for authorization to discharge wastes under NPDES General Permit AKG-28-0000 for Shell's planned Sivulliq N and Torpedo H drill sites.

The NOI contain numerous and substantive errors related to depth of discharge, contents of discharge, and NOI omissions. These problems are fully discussed in the comments to Appendix C of the EP that are below.

Page 21, par. 1, sent. 3 states:

> The projected wastes and amounts listed in tables 6.0-1 A and B are only applicable to the Discoverer; support vessels are not subject to General Permit AKG-28-0000. Some of the following discharge volumes were calculated based on empirical information and past experience, taking into account several wells drilled in the Beaufort and Chukchi Seas and thousands of wells drilled in the Gulf of Mexico and other parts of the world.

Permit AKG-28-0000 does not exclude support vessels involved in exploration activities. Support vessels must be added.

Page 21, Section 6.0, 1st par. and Table 6.0-1A (and Table 6.0-1B on page 22):

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[92] *Id.*

Estimates of potential discharges are vague and undocumented.

The discharge types and volumes are unsubstantiated. In estimating discharge volume, the EP refers to "empirical information and past experience" yet provides no specific information on actual comparison facilities. None of the facilities and associated conditions and pollutant quantities, supposedly based on discharges into the Beaufort and Chukchi Seas or the Gulf of Mexico, are identified. Normal estimating practice based on comparison facilities requires that those operations be identified with associated effluent conditions including pollutant types, concentrations and loads, discharge flow magnitude and ambient receiving water conditions.

Please demonstrate the comparison facilities and actual quantities forming the basis of the estimates in Tables 6.0-1A.

Page 21, Table 6.0-1A - Projected Generated Wastes – Sivulliq Prospect Drill Site N lists Cooling Water as item 10 under the Type of Waste column.

The NPDES permit identifies Discharge Number 009 – Non-Contact Cooling Water produces thermal pollution, which remains unexamined in the EP and violates the requirements 30 CFR 250.217 pertaining to the MMS as well as the EPA 40 CFR 125.122. The waste heat discharged from the drill ship is considerable at both the Torpedo and Sivulliq exploration sites. Daily average thermal discharge is 1,890,000 gallons per day (gpd) at both sites[93] for the duration of the summer and early fall (July 10 through October 31).

The use of biocides in the non-contact cooling water, which are toxic and potentially bioaccumulating, is proportional to the size of the thermal discharge at the exploration sites. The daily discharge of non-contact cooling water of 1.9 million gpd (mgd) to the Beaufort Sea is considerable. The once-through (open) cooling system dumps all its waste heat, toxic compounds and bioaccumulating chemicals into the Beaufort Sea.

Attachment P contains some of the key Material Safety Data Sheets (MSDS) for sample Myacide products. This is the biocide used by the discharger in its drilling fluid, non-contact cooling water and other discharge types.[94] The manufacturer of Myacide (BASF – The Chemical Company) lists 13 types of Myacide. All of the Myacide products are acutely and chronically toxic to fish and invertebrates, such as copepods, which Bowhead Whales rely on as prey species.

The following chemical biocides are discharged under the brand name Myacide: 2-Bromo-2-Nitro-1,3-Propanediol also known as Bronopol (e.g., Myacide AS Plus, Myacide AS Technical, Myacide S 2 through 30), 1,5-Pentanedial also known as Glutaraldehyde (e.g., Myacide GA 15 through 50, Myacide GDA Technical), 2,2',2"-(hexahydro-1,3,5-triazine-1,3,5-triyl)triethanol also known as Triazine (e.g., Myacide HT and Myacide HT Technical).

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[93] *See* EP, page 25, Tables 6.0-3A and B. Cooling water daily average rate reported at 45,000 bbl/d, which calculates to 1,890,000

[94] Table 6.0-2 – Drilling Fluid Components and Load Out List for the Camden Bay Exploration Drilling Program, which is continued on EP page 24.

All of these chemicals are known toxics yet have received no evaluation for toxic effects in the EP, associated EIA or IHA. This is despite the large amount of chemical load discharged in drilling fluid and non-contact cooling water as biocide. NSB recommends evaluation of bioaccumulation potential, particularly in reference to subsistence species.

Page 21, Table 6.0-1A - Projected Generated Wastes – Sivulliq Prospect Drill Site N:

Indicates that the majority of discharges pass through the disposal caisson. However, Table 6.0-1A does not associate discharge types with the discharge number in the NPDES permit AKG280000. Nor do all the discharge type descriptions listed in Table 6.0-1A corresponds precisely with the NPDES permit. The following tables summarize the actual discharge types and locations based on present understanding.

For Sivulliq and Torpedo Sites

	Discharges (Indicate all that apply)		Discharge Method
001	Drilling Mud and Cuttings	Yes	Disposal Caisson
002	Deck Drainage	Yes	Disposal Caisson
003	Sanitary Waste	Yes	Disposal Caisson
004	Domestic Waste	Yes	Disposal Caisson
005	Desalination Unit Waste	Yes	Disposal Caisson
006	Blowout Preventer Fluid	Yes	Disposal Caisson
007	Boiler Blowdown	No	-----
008	Fire Control System Test Water	No	-----
009	Non-Contact Cooling Water	Yes	Vague "[d]ischarged to the water at several sites"
	Note, however, Table 6.0-1A and the NOI for Sivulliq use the vague term "Cooling Water".		
010	Uncontaminated Ballast Water	Yes	Disposal Caisson
	Note, however, Table 6.0-1A and the NOI for Sivulliq use the vague term "Ballast Water".		
011	Bilge Water	Yes	Disposal Caisson
012	Excess Cement Slurry	Yes	Seafloor
013	Mud, Cuttings, Cement and Seafloor	Yes	Seafloor
014	Test Fluid Water Depth:	No	-----

Table 6.0-1A uses the Type of Waste phrase "Cooling Water". This is unclear and does not satisfy MMS requirements for completeness. Does the applicant mean Discharge Number 009 under the Discharge Description "Non-Contact Cooling Water" for the permit AKG280000? Or does the applicant mean that the cooling water does in fact come in contact with process wastewater during the cooling equipment process?

The Discharge Method for "Cooling Water" in Table 6.0-1A is vague, i.e., being "[d]ischarged to the water at several sites". The table omits a description of the discharge water depth and "flow of discharged waste streams through the facility." Does the cooling water discharge at or near Beaufort Sea surface? How deep is the cooling water discharge? These omission errors are propagated from the NOI for Sivulliq in Appendix C.[95]

The EP is required to put its discharge types and descriptions in a manner consistent with the NPDES permit. The EP must be revised to accurately describe discharge types and locations of discharge.

Page 23, paragraphs 1 through 3 after Table 6.0-1B:

The discharge water depth is through the disposal caisson at 19.6 feet below MSL. This is a considerably shallower discharge than the discharge water depth of 107 feet reported for all discharge types in the NOI in EP Appendix C[96]. Paragraphs 1 through 3 read:

> The disposal caisson runs vertically through the sponson from the main deck level to the base of the sponson. The sponson is an exterior reinforced cladding on the hull to provide ice resistance. It is hollow and extends from the main deck level to well below the water line. Waste streams are collected aboard the drillship to a point on the main deck near the mud room. A 15-in. diameter pipe exits the hull, turns downwards and is connected to the top of the disposal caisson.
>
> The disposal caisson is a 15-in diameter pipe welded into the sponson top and bottom (such that the inside of the sponson remains dry). The bottom of the sponson is 5.6 ft (1.7 m) above the keel depth. The disposal caisson is not equipped with a "float" valve; it is an open pipe. Since it remains open to the sea at all times, the disposal caisson is constantly filled with water. This caisson is not equipped with a "float" valve; it is merely an open conduit to the sea through which most waste streams are disposed below sea level.
>
> With the bottom of the sponson 5.6 ft above the keel, the base of the disposal caisson while drilling is 25.2 ft – 5.6 ft = 19.6 ft (6.0 m) below mean sea level. Because of heave, the water level inside the caisson is constantly changing.

Page 23, para. 3 after Table 6.0-1B:

The discharge condition with discharge into the upper (surface layer) of the Beaufort Sea. Discharges into stratified environmental conditions were not anticipated or evaluated by EPA in

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[95] *See* EP Appendix C, second Table 1 entitled "Projected ocean discharges – Sivulliq Prospect Drill Site N". This second Table 1 can be found as page 20 of 22 (unnumbered) contained in Appendix C. The NOI for 009 Non-Contact Cooling Water does not provide an accurate discharge water depth or "a line drawing that shows flow of discharged waste streams through the facility". This is required in the NOI information sheet pursuant to the AKG280000 permit as on page 16 of 22 (unnumbered) contained in Appendix C.

[96] EP Appendix C - National Pollutant Discharge Elimination System Permit (NPDES) Notice of Intent (NOI) Applications.

the in the AKG-280000 permit fact sheet or Arctic ODCE. [97] Ocean stratification is a limiting condition restricting mixing in the upper layer of the Beaufort Sea and reduces mixing of effluent discharged from the drillship. EPA did not consider that stratification was a "reasonable potential" ambient condition for Arctic discharges. However, measurements of temperature and salinity clearly indicate that stratification[98] obviously occurs rendering the EPA's permit limits unreliable for discharges into the Beaufort Sea.

In setting permit limits in AKG-280000 EPA relied upon the guidance in the TSD:[99]

"In determining whether water quality-based limits are needed and developing those limits when necessary, EPA follows guidance in the Technical Support Document for Water Quality-based Toxics Control (TSD; EPA, 1991). The water quality-based analysis consists of four steps: (1) determine the appropriate water quality criteria that apply to each discharge, (2) determine if there is "reasonable potential" for the discharge to exceed the criteria in the receiving water, (3) develop a WLA if there is reasonable potential, and (4) develop effluent limitations based on the WLA."[100]

Page 24, Table 6.0-2 - Drilling Fluid Components and Load Out List for the Camden Bay Exploration Drilling Program, Myacide is the 8th item listed under Component:

This biocide contains toxic compounds that remain unevaluated for discharge effects on Beaufort Sea organisms and subsistence resources.

The Arctic ODCE anticipated that, for NPDES permit AKG280000:[101]

> Biocides, typically organic amines, chlorophenols, or formaldehydes, kill bacteria that may produce toxic hydrogen sulfide gas.

Myacide, the EP proposed biocide, does not have these compounds as primary ingredients. Rather Myacide contains the toxic compounds Glutaraldehyde, or Triazine, or Bronopol (which also form carcinogenic nitrosamines).

MMS must evaluate the biological effects of discharging toxic chemicals into the Arctic Ocean environment that were unanticipated in the existing NPDES permit. Drilling muds and non-contact cooling water discharges are specifically subject to evaluation because of the addition of alternative biocides in these discharges.

Page 27, par. 1, sent. 1 under the "Modeling Report" states that:

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[97] Reserved.

[98] *See* attached Appendix I or EP EAS pages 56 through 58.

[99] Page 12, last par. of the Fact Sheet for NPDES permit AKG280000. The TSD is the *Technical Support Document for Water Quality-based Toxics Control* (EPA, 1991)

[100] *Arctic Oil and Gas General Permit* (AOGGP, EPA, 2006) as referred to by EPA. Full permit title is Offshore Oil and Gas Exploration Facilities on the Outer Continental Shelf and Contiguous State Waters - NPDES Permit Number: AKG280000 for discharges to the Beaufort Sea, Chukchi Sea, Hope, and Norton planning basins. This also includes the associated Fact Sheet (AOGGP FS, EPA, 2006)

[101] Arctic ODCE, Page 2-3, 6th bulleted item under "Drilling muds typically have several additives."

Schematic diagrams displaying the waste flow for the *Discoverer* are presented in Appendix C.

The schematic diagrams are not modeling reports. No model reports relating to the proposed discharges, and resulting water quality in the Beaufort Sea, has been provided as part of the EP. This violates 30 CFR 250.217(d) as required by MMS.

Nor is it correct that schematic diagrams have been presented displaying waste flows for the majority of discharges. The Notice of Intent for the Torpedo and Sivulliq sites, which are contained in Appendix C, each require submission of "a line drawing that shows flow of discharged waste streams through the facility." None of this information, for either site, has been submitted for the majority of discharge number types described in the AKG280000 permit and the NOI information sheet. This is summarized in the following table.

Missing Line Drawing(s) and Flow Balance of Intakes and Waste Streams
Applies to Both the Sivulliq and Torpedo Sites

	Discharges	Line Drawing?	Flow Balance
001	Drilling Mud and Cuttings	No	No
002	Deck Drainage	No	No
003	Sanitary Waste	Partly	Partly
004	Domestic Waste	Partly	Partly
005	Desalination Unit Waste	No	No
006	Blowout Preventer Fluid	No	No
009	Non-Contact Cooling Water	No	No
010	Uncontaminated Ballast Water	No	No
011	Bilge Water	No	No
012	Excess Cement Slurry	No	No
013	Mud, Cuttings, Cement and Seafloor	No	No

[A]Line Drawing of Waste Streams Submitted as required by NPDES permit NOI?

There are a total of 22 pages comprising Appendix C. Only one schematic drawing was submitted for each of the sites. For the Torpedo and Sivulliq sites, the schematics are on the unnumbered pages 11 and 21, respectively. The schematics are both labeled "Schematic for Black & Grey Water Systems in Accommodation." Nine of the eleven identified discharge types, for each of the two drill sites, are ignored in the NOI.

The single schematic representing the two sites is vague. Is the provided "Schematic for Black & Grey Water Systems" intended to represent discharge number types 003 – Sanitary Waste and 004- Domestic Waste discharges, respectively? If so the schematic does not show the most basic required information including "intake sources, operations contributing to the effluent, and treatment units labeled to correspond to the discharges (001 through 014)".

The NOI applicant is required to:

> Construct a flow balance on the line drawing by showing average flows between intakes, operations, treatment units, and outfalls. If a flow balance cannot be determined, provide a pictorial description of the nature and amount of any sources, and any collection or treatment measures.

The applicant has developed no flow balance. The NOI and EP must be amended to include the flow balances of the 11 discharge types and associated seawater intakes.

Page 27, par. 1, under "Projected Cooling Water Intake":

Indicates that large loadings from thermal discharges will occur compared to those anticipated by the NPDES permit. The EP states that:

> A saltwater service system supplies the Discoverer's need for saltwater, including for drilling operations. The system is primarily used to supply cooling water to equipment heat exchangers. The system consists of two saltwater pumps (Aurora 5-483-11C), one flare-burner spray pump, five sea suctions (each with a strainer having 5mm openings), and associated distribution piping. **It is anticipated that approximately 45,000 bbl/day of cooling water will be needed.** Intake flow velocity will be approximately 0.2 m/second (sec). The cooling water will be discharged overboard at several sites around the *Discoverer*. (Emphasis added).

A thermal discharge of 1.89 mgd (i.e., 45,000 bbl/day) emanating from the once-through cooling system of the drillship is planned in the EP. The NPDES permit (AKG280000) is claimed as the basis for this allowance. However, neither the NPDES permit, NPDES Fact Sheet, nor EPA's related Arctic ODCE anticipate or evaluate such a large thermal discharge. For example, the Arctic ODCE states that:

> 2.4.4. Non-Contact Cooling Water
> Non-contact cooling water is sea water that is used for non-contact, once-through cooling of various pieces of machinery (e.g., power generators) on the platform. Biocides can be used to control biofouling in heat exchanger units. Recommended dosages are very situation-dependent and can vary from 1.0 to as high as 1,200 ppm. There are, however, little or no quantitative data on biocide concentrations in this discharge.
>
> The volume of non-contact cooling water required for drilling operations can vary depending on the system used. Discharges of non-contact cooling water from an Alaskan offshore oil rig is approximately 210,000 gpd based on discharge monitoring reports. Individual discharge values are provided in Table 2-6. Therefore, **it is estimated that discharges of non-contact cooling water will be less than 210,000 gpd when discharged**. This general permit requires the facilities to report total quantity discharged rather than flow rates to provide a more adequate future analysis of non-contact cooling water quantities discharged. The general permit also requires the permittee to provide an annual inventory of the type (product name) and quantity of biocides and chemicals (other than water or seawater) added to this discharge.

Additionally, the general permit prohibits the discharge of free oil in this waste stream. (Emphasis Added).

As can be calculated, the proposed thermal discharge is nine (9) times greater than the maximum anticipated by the EPA in the Arctic ODCE for the NPDES permit AKG280000.[102] Despite departing from the basis conditions of the NPDES permit, the EP provides no thermal evaluation of the excessive discharge.

MMS has not adhered to the requirements of 30 CFR 250.216, which require MMS to evaluate the biological environmental effects of a significant discharge on the Beaufort Sea. The proposed non-contact cooling water discharge (NPDES 009) is the largest of the 11 planned discharge types resulting from the oil and gas exploration. The fundamental waste product is excess heat discharged to the Beaufort Sea. Yet, nowhere in the EP or the EIA is the biological effect of discharge temperatures and waste heat assessed. This is despite the effect on copepods, on which Bowhead Whales and small fish rely.

Page 27, par. 1, sent. 3 under "Projected Cooling Water Intake":
The large thermal discharge of 45,000 bbl per day (1.8 million gpd) also implies increased pollutant loading from biocides, under NPDES Discharge Number 009, used to control organic growths in the once-through cooling system.

The NPDES (AKG280000) Fact Sheet states for Non-Contact Cooling Water:[103]

> b. Biocide and Chemical Inventory. The proposed permit retains the requirement for an annual inventory of the type and quantity of biocides and chemicals added to non-contact cooling water. The permit proposes that the report be submitted to EPA by March 1 of the following year. **The basis for this requirement is to provide EPA with information regarding the specific chemicals added to discharge to ensure current permit limitations and requirements are protective of water quality.** (Emphasis added).

Neither the MMS, nor the EPA, has "ensured current permit limitations and requirements are protective of water quality" because no assessment has been made of the "annual inventory of the type and quantity of biocides". This data is already available as it has been collected over the 3 years of existing NPDES permit. The NPDES FS did not anticipate the types of biocides suggested for use in the EP. For example, Myacide, which contains toxic compounds, was not considered in the NPDES permit development and no action to inform or assess new chemicals was undertaken by MMS or the EPA.

Appendix C[104]

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[102] Page 2-15, 2nd par., 2nd sent. under section 2.4.4. Non-Contact Cooling Water of the Arctic ODCE for the NPDES permit AKG280000 only anticipated flows up to 0.21 mgd but 1.89 mgd is proposed in the EP. This results from 1.89 divided by 0.21, i.e., 1.89/0.21=9 times greater flow.

[103] NPDES FS (2006), Page 25, under section II.D.13.b.

[104] EP Appendix C - National Pollutant Discharge Elimination System Permit (NPDES) Notice of Intent (NOI) Applications

There are a total of 22 pages comprising Appendix C. The 22 total pages include the cover and blank sheets contained in Appendix C. Specifically, Appendix C contains the two (2) Shell Offshore Inc. Notice of Intent (NOI) Applications for authorization to discharge wastes under NPDES General Permit AKG280000 for Shell's planned Sivulliq N and Torpedo H drill sites. Page numbering in the comment section begins at the Appendix C cover page, which is page 1 of 22.

Page 3 of 22 (unnumbered), par. 1, sent. 3: the Shell cover letter for the NOI for Torpedo - H states:

> This NOI and accompanying materials is submitted in satisfaction of the requirements of 40 CFR 55.4 (a) and (b) for an OCS source.

The requirements of the submitted NOI are referred to in permit AKG280000 and rely on 40 CFR 122.28(b)(2) and 40 CFR 121.21 for NPDES discharges.[105] Shell wrongly refers to the controlling regulations as 40 CFR 55.4, which relates to air regulation.

Page 6 of 22 (unnumbered), Table Section Labeled "Discharges":

Provides incorrect discharge water depth for a number of discharges.

For Torpedo - H

	Discharges (Indicate all that apply)		Incorrect Discharge Water Depths in NOI	Correct Discharge Water Depths Consistent with EP Main Report [106]
001	Drilling Mud and Cuttings	Yes	Water Depth: ~~120 feet~~	120 feet (cuttings) and 19.6 feet (cuttings & mud)
002	Deck Drainage	Yes	Water Depth: ~~120 feet~~	19.6 feet
003	Sanitary Waste	Yes	Water Depth: ~~120 feet~~	19.6 feet[A]
004	Domestic Waste	Yes	Water Depth: ~~120 feet~~	19.6 feet
005	Desalination Unit Waste	Yes	Water Depth: ~~120 feet~~	19.6 feet
006	Blowout Preventer Fluid	Yes	Water Depth: ~~120 feet~~	19.6 feet
007	Boiler Blowdown	No	-----	-----
008	Fire Control System Test Water	No	-----	-----
009	Non-Contact Cooling Water	Yes	Water Depth: ~~120 feet~~	Surface[A]
010	Uncontaminated Ballast Water	Yes	Water Depth: ~~120 feet~~	19.6 feet
011	Bilge Water	Yes	Water Depth: ~~120 feet~~	19.6 feet
012	Excess Cement Slurry	Yes	Water Depth: ~~120 feet~~	120 feet
013	Mud, Cuttings, Cement and Seafloor	Yes	Water Depth: ~~120 feet~~	120 feet
014	Test Fluid Water Depth:	No	-----	-----

[A] This depth is estimated because the actual discharge method configuration, depth or outfall for treated sewage and non-contact cooling water is omitted in the NOI.

[105] NPDES permit AKG280000, page 7 of 61, Section I.D.; and Fact Sheet AKG280000, page 7, Section I.D.1. and 2.

[106] The correct discharge water depths must be consistent with the EP Main Report (page 23) which states that the

This is a considerable problem because the EIA obviously shows a stratified upper layer in the Beaufort sea in the discharge vicinity; and a number of significant discharges will be discharged and trapped in this upper layer.[107] Of specific additional concern is that this upper layer is where bowheads swim during migration, as well as spend the majority of their time feeding. The area surrounding the proposed drill sites is a prime feeding ground for the species.[108]

Page 13 of 22 (unnumbered), par. 1, sent. 3:

The Shell cover letter for the NOI for Sivulliq - N states:

> This NOI and accompanying materials is submitted in satisfaction of the requirements of 40 CFR 55.4 (a) and (b) for an OCS source.

The requirements of the submitted NOI are referred to in permit AKG280000 and rely on 40 CFR 122.28(b)(2) and 40 CFR 121.21 for NPDES discharges.[109] Shell wrongly refers to the controlling regulations as 40 CFR 55.4, which relates to air regulation.

Page 16 of 22 (unnumbered), Table Section Labeled "Discharges":

Provides incorrect discharge water depth for a number of discharges.

For Sivulliq - N

	Discharges (Indicate all that apply)		Incorrect Discharge Water Depths in NOI	Correct Discharge Water Depths Consistent with EP Main Report [110]
001	Drilling Mud and Cuttings	Yes	Water Depth: ~~107 feet~~	120 feet (cuttings) and 19.6 feet (cuttings & mud)
002	Deck Drainage	Yes	Water Depth: ~~107 feet~~	19.6 feet
003	Sanitary Waste	Yes	Water Depth: ~~107 feet~~	19.6 feet[A]
004	Domestic Waste	Yes	Water Depth: ~~107 feet~~	19.6 feet
005	Desalination Unit Waste	Yes	Water Depth: ~~107 feet~~	19.6 feet
006	Blowout Preventer Fluid	Yes	Water Depth: ~~107 feet~~	19.6 feet
007	Boiler Blowdown	No	-----	-----
008	Fire Control System Test Water	No	-----	-----
009	Non-Contact Cooling Water	Yes	Water Depth: ~~107 feet~~	Surface[A]
010	Uncontaminated Ballast Water	Yes	Water Depth: ~~107 feet~~	19.6 feet
011	Bilge Water	Yes	Water Depth: ~~107 feet~~	19.6 feet
012	Excess Cement Slurry	Yes	Water Depth: ~~107 feet~~	120 feet
013	Mud, Cuttings, Cement and Seafloor	Yes	Water Depth: ~~107 feet~~	120 feet

[107] *See* Page 6, par. 1, of EPA *Dilution Models for Effluent Discharges*, 1994. (Attachment M).

[108] Moore, SE and Reeve, RR. 1993. Distribution and Movement. *In* Burns JJ, Montague JJ, Cowles CJ, editors. *The Bowhead Whale*. Special Publication Number *2* The Society for Marine Mammalogy. Lawrence, KS Allen Press, Inc. pp. 701-744.

[109] NPDES permit AKG280000, page 7 of 61, Section I.D.; and Fact Sheet AKG280000, page 7, Section I.D.1. and 2.

[110] The correct discharge water depths must be consistent with the EP Main Report (page 23) which states that the

014 Test Fluid Water Depth: No ----- -----

[A] This depth is estimated because the actual discharge method configuration, depth or outfall for treated sewage and non-contact cooling water is omitted in the NOI.

This is a considerable problem because the EIA obviously shows a stratified upper layer in the Beaufort Sea in the discharge vicinity; and number of significant discharges will be discharged and trapped in this upper layer.[111]

Appendix H[112]

Page 59, 1st par., sent. 3, under "Trace Metals":

It states that "[o]verall, concentrations are lower than EPA criteria for the protection of marine life (Boehm et al. 1987)." The cited document makes no comparison to "EPA criteria". Nowhere in the "Trace Metal" sediment discussion is there a comparison with EPA criteria for sediments.

Page 60, Table 3.2.4-1 - Summary Data for Metals in Sediments Measured Sivulliq Locations and the [sic] Along the Beaufort Sea:

Lists chromium mean sediment values ranging between 58.8 and 86.5 mg/kg (i.e., ppm). Sediment sampling sites contain sediment data from previous well sites where cuttings and drilling muds were released to the seafloor in the vicinity of the well. All of the values in this range adversely exceed the threshold value of 25 ppm for chromium, as presented in the *National Perspective on Sediment Quality.*[113]

The EP proposes to dump cuttings and drilling muds to the seafloor at both the Sivulliq and Torpedo exploration sites. Chromium is a toxic and bioaccumulating chemical[114] and would be allowed to discharge to the seafloor under the proposed NPDES Discharge Number 013 – Mud, Cuttings, Cement at Seafloor; and to the water column for Discharge Number 001 – Drilling Fluids and Drilling Cuttings which will eventually find their way into the sediments through solids settlement.[115] This is despite the likely result that chromium concentrations levels will fail to protect aquatic life, wild life and human health. This is a violation of 40 CFR 125.120 – Subpart M – Ocean Discharge Criteria, which requires 40 CFR 125.122 - Determination of unreasonable degradation of the marine environmental.

Moreover, 40 CFR 227 – Criteria for the Evaluation of Permit Application for Ocean Dumping of Materials prohibits "Materials insufficiently described by the applicant in terms of their compositions and properties to permit application of the environmental impact criteria of this

[111] *See* Attachment M - Page 6, par. 1, of EPA *Dilution Models for Effluent Discharges*, 1994.
[112] EP Appendix C – Environmental Impact Statement.
[113] *See* Table 1 of the *National Perspective on Sediment Quality*.
[114] *See* pages 90-95 under chromium in *Quality Criteria for Water*, 1986.
[115] NPDES permit AKG280000, see Table 1 on page 20 of 61 for discharge 001; and Table 15 on page 35 of 61 for discharge 013.

subpart B".[116] The EP fails to adequately describe the cuttings and drilling mud discharge to the seafloor because it did not compare known quantities of discharge components with established EPA sediment criteria for protection of the environment.

Page 60, 2nd par., under "Hydrocarbons":

It states:

> Concentrations of total petroleum hydrocarbons (TPH) and total polycyclic aromatic hydrocarbons (TPAH) in surface sediments sampled throughout Camden Bay during summer 2008 remained at background values for 45 of 46 locations. The HH-5 site (Figure 3.2-2) located approximately 2.5 mi (4 km) west of the current Sivulliq prospect held a TPH and TPAH concentration between 4 and 6 times greater than that measured at other sampling locations. **All 46 samples of PAH however, remained below effects range low (ERL) and effects range medium (ERM).** The nature of the hydrocarbons at HH-5 indicate deposition from a naturally occurring source rather than an industrial one. The HH 2 well was never flow tested, and no oil was ever produced from the well." (Emphasis Added)

This statement is incorrect, Trefry et al.[117] from which the PAH sediment data was reported, states:

> "All 46 samples from the 2008 survey of Camden Bay contained concentrations of TPAH that were below the ERL and ERM (Table 3.8). Concentrations of 9 or 11 individual PAH were below the ERL and ERM for all 46 stations; **two substances (acenapthene and fluorene) were present at concentrations slightly above the ERL at one location, station HH-5 (Table 3.8)."** (Emphasis added).

The EIA is obviously wrong when it says that all 46 samples of PAH were below the ERL. Trefry and Trocine reports that the PAHs, acenapthene and fluorine were above the ERL. Accordingly, compare exceedances of fluorine measured at 39 ng/g (i.e., ppb) with the ERL of 19 ppb; also compare exceedances of acenapthene measured at 27 ppb with the ERL of 16 ppm.

Moreover, Trefry and Trocine make no statement as to the source being naturally occurring. Rather they state:

> This TPH anomaly in the surface sediments was believed to have been introduced from a trace amount of petroleum input at some time during the past 20 years and it is equivalent to <1% of the background levels of naturally occurring organic matter.[118]

PAHs including fluorene and acenapthene are toxic, bioaccumulating and carcinogenic chemicals[119] and would be allowed to discharge to the seafloor under the proposed NPDES

[116] Specifically, 40 CFR 227.5(c).
[117] Trefry and Trocine, July 2009, Page 80 of *Chemical Assessment in Camden Bay (Sivulliq Prospect and Hammerhead Drill Site), Beaufort Sea, Alaska*. See also Table 3.8 on Page 81 of the Trefry and Trocine report.
[118] Trefry and Trocine, 2009, 2nd par., particularly last sentence.

Discharge Number 013 – Mud, Cuttings, Cement at Seafloor; and to the water column for Discharge Number 001 – Drilling Fluids and Drilling Cuttings which will eventually find their way into the sediments through solids settlement.

The EIA must accurately rely on supporting information from identified physical and biological effects reports. Distortions of the information contained in the Trefry and Trocine report only undermines the integrity of the EIA and requires that the impact of PAH (and metals) discharges as part of the exploration process be accurately assessed.

The EIA's must analyze the fate and transport of known toxics and bioaccumulating PAH and Metals that will be discharged under the EP and collect in the adjacent sediments.

Health Impacts

A lack of appropriate health data and health impact assessment has historically complicated efforts to understand how observed illness trends and other health factors within the NSB population are determined or influenced by industrial activities. MMS has in recent years recognized this shortcoming, and has acknowledged its responsibility to see that appropriate human health impact analyses are conducted in association with the major actions it oversees. The potential risks of this proposed project to the health of our North Slope residents who either reside in the immediate project area, or who rely on the harvest of migratory resources that transit the area must be evaluated using available regional health data and accepted mechanisms of health analysis in order to first, identify any potential adverse or positive impacts, and then to identify appropriate measures to maximize health benefits and mitigate negative effects.

The rationale for evaluating public health in Shell's Camden Bay Exploration Plan is to assess how project activities may directly or indirectly affect the health of the populations in the area – specifically the residents of Kaktovik, Nuiqsut, and Barrow. The evaluation should include the social, economic and environmental influences on health status. In general, the Health section of the EIA, appears to attempt to tier to a Health Impact Assessment (HIA) that was prepared by Dr. Aaron Wernham on behalf of the North Slope Borough and was included by MMS in the Draft Arctic Multi-Sale EIS for Lease Sales 209, 212, 217 and 221 (MMS 2008a; Wernham 2007)(the Draft Multi-Sale). Health is one of the effects that must be considered in an EIS. See 40 CFR 1508.8(b), 40 C.F.R. Sec. 1508.27(b)(1), 40 C.F.R. Sec 1508.14. Tiering to the Draft Multi-Sale EIS is a concern for two reasons. First, the HIA prepared by the Borough for MMS was primarily relegated to an appendix. We continue to seek integration of the full HIA into the broader impact analysis of the EIS, such that consideration of potential human health effects is addressed in the same fashion as potential effects to all other resources and conditions. It is, therefore, an issue that Shell's EIA tiers to a document that is a draft, and that we are hopeful will be modified in the final Multi-Sale EIS. It is also a concern with respect to the Draft Multi-Sale EIS that the fate of the health-related mitigation measures we have proposed remains unclear. While appropriate human health impact analysis is essential, it is only through associated mitigation measures that identified potential risks can be avoided or minimized.

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[119] *See* pages 248-249 under Polynuclear Aromatic Hydrocarbons in *Quality Criteria for Water*, 1986.

Impacts to Subsistence

3.11.3 Health, page 161-162

"The distance from these two communities to the exploration site is sufficient to avoid any project operations from intruding on everyday community life. The project area is approximately 60 mi (96.5 km) from Kaktovik and 120 mi (193 km) from Nuiqsut."

Kaktovik and Nuiqsut, both Inupiaq communities of the North Slope and nearest to the proposed exploration activities (60 miles and 125 miles from project area, respectively) are heavily dependent on subsistence resources; in 2003, Shepro et al. states that over 90% of Inupiat households in Kaktovik and in Nuiqsut participate in the local subsistence economy. Stated in Shell's Camden Bay EP, "the residents of Kaktovik use large amounts of marine mammals," and stated "Nuiqsut villagers hunt large land and small mammals, coastal and marine birds, and a high percentage of marine mammals including seals, walrus and bowhead whales." This underscores the importance of oil and gas development to avoid limiting access to, and impacts on, subsistence resources. With such a high percentage of NSB residents dependent on subsistence foods, particularly the bowhead whale, it is imperative that Shell's exploration activities do not restrict access to the bowhead whale or impact the quality and quantity of these marine mammals.

Neither the health discussion in the EIA, nor the cumulative impacts analysis, considers the potential for project activities, in combination with foreseeable industrial operations in Canadian waters and elsewhere in the Alaskan Beaufort Sea, to impact the subsistence harvest of bowhead whales by Barrow hunters. The concern is that whales exposed to industrial noise east and "upstream" in the fall migration of Shell's operations, and then exposed again by Shell's operations (when operations resume after Kaktovik and Nuiqsut whaling has concluded) and any other industrial operations "downstream" of Camden Bay, will be rendered more skittish, and therefore more difficult to approach and harvest by the time they reach the Barrow area. Potential impacts to Barrow residents must be part of the EP's health discussion.

Consumption of subsistence foods benefits the North Slope Inupiat because subsistence resources are high in nutritional value and serve to protect against chronic medical problems such as high blood pressure, obesity, diabetes, and cardiovascular disease. Impacts to subsistence harvest could impact food security and encourage the consumption of store-bought foods with little nutritional value, as these foods are affordable and abundant in rural Alaskan villages.

According to testimony from Nuiqsut residents during the MMS Proposed Multi-Sale Community Meeting held in Nuiqsut on February 4, 2009, "A lot of interference have happened in the past. Air traffic, marine vessels to and from is causing a lot of interference on the bowhead migration...making it difficult for the Cross Island whalers to harvest their catch." In addition to this testimony, hunters have expressed "179 personal experiences with disruption or displacement of subsistence resources by noise," (Stephen R. Braund et.al., 2009). In 1983, an OCS Beaufort Sea Subsistence Synthesis Session[120] concluded in a report that lease sales near Barrow and Kaktovik, "including the high use areas such as Peard Bay, Elson Lagoon, Camden

[120] A Description of the Socioeconomics of the North Slope Borough, Appendix: Transcripts of Selected Iñupiat Interviews. Kruse, J.A., M. Baring-Gould, W. Schneider, J. Gross, G. Knapp, and G. Sherrod, Institute of Social and Economic Research, University of Alaska. Contract No. A12/PB 85-162055.

Bay, and the coast east of Kaktovik to Humphrey Point are relatively more likely to result in resource use conflicts" (Burns 1983; Kruse et al., 1983:172).

3.11.3 Health, page 161
"To mitigate any concerns, it is important to clarify why the activities associated with the 2010 exploration project will not pose any risks to the residents and communities of Kaktovik and Nuiqsut."

Shell's proposed exploration activities pose potential risk to the communities of Kaktovik, Nuiqsut, and Barrow. Deflection of subsistence resources will pose potential risk to subsistence hunters as they may have to travel farther, which increases the chances of bothinjuries and the loss or spoilage of harvested resources. This is particularly concerning due to the fact that injuries are the 2nd leading cause of death on the North Slope. In additional to the potential threats to subsistence and the well-being of hunters , additional impacts to subsistence resources and human health may occur from the sizeable toxic and cooling water discharges that are identified and discussed in the attached water quality comments. Also, nowhere in the document is there a discussion of the possibility that bowheads and other resources may deflect as readily around discharges they sense as around waters impacted by industrial noise.

Air Quality
3.11.3 Health, page 161
"To mitigate any concerns, it is important to clarify why the activities associated with the 2010 exploration project will not pose any risks to the residents and communities of Kaktovik and Nuiqsut."

Air emissions from exploration activities pose a potential risk to public health. Air emissions from Shell's exploration activities must be cumulatively considered as they add to the other air impacts in the North Slope region, such as the various other oil and gas activities already occurring as well as the global transport of contaminants. Additionally, there is risk associated with the consumption of subsistence resources tainted as a result of exploration activities, since pollutants from operations can contaminate local subsistence resources and expose those that consume those resources. For more information, please refer to our air quality comments above. In addition, even a perception of tainting may lead to a reduction is subsistence harvests, and associated health effects.

Page 9 "The implementation of best available control technology and compliance with other provisions of the permit will ensure that air emissions authorized under this permit, therefore, will have no adverse effect on public health, and all health-based NAAQS will be met."

Assuming this to statement to be true, air emissions that purport to comply with NAAQS standards does not guarantee that adverse effects on human health is avoided. Air quality standards are often determined with broader considerations of economic, regulatory, environmental, and health impacts in mind. In fact, a study funded by the EPA and the National Institutes of Health in March 2006 published in the Journal of the American Medical Association[121], stated that exposure to PM 2.5 below the NAAQS would put the elderly at an

[121] NIEHS press release, Accessed 8/24/2009 at http://www.niehs.nih.gov/oc/news/pArcticle.htm

increased risk of cardiovascular and respiratory disease. Additionally, as identified in NSB's air quality comments, none of the support vessels appear to be controlled by BACT standards and they account for the largest share of the sizeable emissions associated with this action.

General Health and Well-being and Psychosocial Issues

Page 162 *"Few studies have directly examined the influence of oil and gas operations on social and psychological health in the North Slope, however benefits related to economic gains and employment are well-documented and according to some social studies, may underlie some of the documented improvement in social and psychological health indicators discussed above, including the importance of a cash economy to support subsistence activities" (Pedersen et al.; MMS 2008a)*

Documented improvement in social and psychological health indicators were not previously discussed in the EP. It must also be noted that adverse cultural change and departure from subsistence activities has also occurred in some cases alongside positive economic gains.

Health Services Infrastructure

Page 164 *"Health Services Infrastructure is provided though a mix of federal, state, and local government services. The NSB Department of Health and Social Services (DHSS) provides health care services to the residents of the region. The physical isolation of Kaktovik and Nuiqsut, however, can make access to health care extremely difficult for these two communities (NSB 2005)."*

The Arctic Slope Native Association provides primary health care services to the residents of the region by staffing and managing the Samuel Simmonds Memorial Hospital based in Barrow, while the NSB Department of Health and Social Services (DHSS) provides emergency and primary health care in the surrounding six of seven villages (Maniilaq Association provides services to Point Hope) through the Community Health Aide Program (CHAP). According to the Community Health Aide Manual[122], CHAP uses a primary care model that includes emergency, acute, chronic and preventative health components. Kaktovik and Nuiqsut both have community health clinics staffed with one Community Health Practitioner (CHP) and varying degrees of Community Health Aides (CHAs). CHAs and CHPs consult with a doctor once a day from the Samuel Simmonds Memorial Hospital in Barrow or as needed.

Social Influx

Page 165 *"Cultural stress mitigation is necessary at times because of the large influx of nonresident workers creating the potential for cultural conflict. Recognizing this potential conflict, MMS has developed lease stipulations that require lessees to develop and institute a cultural orientation program for workers (MMS 2008a)."*

In addition to a cultural orientation program, another mitigation measure should be imposed to minimize exploration project worker interaction with local community residents to avoid the transmission of any contagious illnesses. The H1N1 influenza is of particular concern, as there has been reported exposure among Prudhoe Bay industrial workers. Of concern in this respect is

[122] Peabody, Sharon, et al., Alaska Community Health Aide/Practitioner Manual, CHAM, Patient care Visit, 4th edition 2006.

the potential for locally hired marine mammal observers and other workers to bring contagions back to communities during of downtime or at the conclusion of the project season. Shell may consider making any vaccines developed available to its local hires and other workers to reduce this risk. In addition, Shell must develop medical emergency protocols for situations involving contagious illnesses that do not include the utilization of village clinics.

Environmental Justice

Environmental Justice is an initiative that culminated with President Clinton's February 11, 1994 Executive Order 12898. The EO directs each federal agency "to make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." A Presidential Memorandum accompanying the EO directs federal agencies to analyze "the environmental effects, including human health, economic and social effects, of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by the National Environmental Policy Act of 1969 (NEPA)."

The Presidential Memorandum states that the EPA "shall ensure that the involved agency has fully analyzed environmental effects on minority communities and low-income communities, including human health, social, and economic effects."

Shell, in both its EP and EIA does not demonstrate the necessary baseline subsistence resource and health impact information or analysis in a variety of resource areas. EPA has cautioned MMS about this in its comments on prior environmental analyses, particularly in regards to Air and Water quality.[123] Without this information, MMS is disabled from making an adequate determination, without further collection and analysis of additional data, of the disproportionate impacts which are already being incurred by the Alaska Native Inupiat population and Minorities on the North Slope.

MMS has also failed to indicate how it will meaningfully involve the known EJ communities and actual public of the North Slope. Other than proposing to meet with the NSB and the Inupiat Community of the Arctic Slope, there has been no indication of a public comment period or hearings associated with this action, despite our previous call to do so.[124]
Only 21 days to review Shell's accepted materials was provided.

Recommendation:

MMS needs to procedurally and substantively re-evaluate its Environmental Justice approach and analysis to conform to the spirit of Executive Order 12898 and according to CEQ's *EJ NEPA Guidance* for identifying and addressing environmental justice under NEPA. MMS should integrate analyses of environmental justice concerns in an appropriate manner so as to be clear, concise, and comprehensible within the general format suggested by 40 C.F.R. § 1502.10.

[123] *See* attached Clean Air Act 309 letter from April, 2009 from Christine Reichgart , Region X, EPA.

[124] *See* Attachment A, Letter from NSB Mayor Edward S. Itta to Interior Secretary Salazar.

Principles of environmental justice demand that MMS take guidance from EPA and allow for meaningful public involvement by allowing for public comment and on-slope public hearings for disproportionately impacted residents of the North Slope. When conducting its environmental review of Shell's plan, MMS must provide comprehensive and meaningful public participation in a manner that addresses the unique needs of our communities of the North Slope. For instance, public comment and public hearings must be made available and should be scheduled so as not to interfere with the time-sensitive subsistence activities, during which time our subsistence hunters may be from home. It is also helpful to our elders when a translator is provided at hearings and when environmental documents are made available in our native language.

MMS needs to also require Shell to acknowledge the best available science regarding climate change. There is no longer any credible scientific dispute: that warming—and the associated melting of sea ice, disruptions in traditional lifestyles, changes in world climate, and all of the other effects described above—is caused by human emissions of greenhouse gases.[125] Given the known disproportionate impacts of climate change in the Arctic, Shell would do well to get with the program and see what is occurring here. Our climate change comments are expanded below and also in the technical comments provided by the NSB Wildlife Department.

Marine Mammal Monitoring and Mitigation Program for 2010

General Comments

It appears that Minerals Management Service (MMS) will conduct an Environmental Assessment for Shell's planned drilling operations. It is difficult to see how Shell's proposed monitoring and mitigation plan will allow MMS to conclude a finding of no significant impact (FONSI). Based on previous monitoring activities in Camden Bay in the late 1980s and early 1990s, many bowheads were deflected away from exploratory drilling and its associated activities, including ice management. If large numbers of whales are seen feeding or migrating in the area, Shell does not provide for adequate mitigation. The drill operations and ice management will continue even in the presence of many whales. If a large portion of the population is deflected, a considerable amount of energy could be expended by the whales possibly impacting survival or reproduction. Additionally, feeding opportunities might be missed if whales were deflected. MMS and NMFS should require an enhanced mitigation plan that relies on the use of hydrophones or aerial survey results from the east of the project area to shut down drilling or other loud operations to allow bowheads to migrate through the area with a minimum of exposure to industrial activities.

Specific Comments

Pg. 1, 4th paragraph, 1st sentence: Shell intends to monitor and compare results during drilling activity and during periods when drilling activity is not occurring to assess the number of marine

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[125] *See* IPCC Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the 4th Assessment Report of the IPCC Summary for Policymakers (Feb. 2007) at 5 (stating that "warming of the climate system is unequivocal" and "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations[.]").

mammals potentially affected by the exploration operations and facilitate real time mitigation. This approach and objective is not sufficient. The vessels that Shell intends to use for anchor handling, ice management, re-supply and other activities will also impact bowhead whales and possibly other marine mammals. BP's operations at Northstar showed that bowheads are deflected by the low levels of sounds produced by boats (Richardson 2009). Therefore, Shell must also assess the number of marine mammals its vessels disturb even when drilling is not occurring.

Pg. 2, 4th paragraph, 2nd and 4th bullet: Information from the vessel based monitoring is proposed to be used to estimate the number of takes of marine mammals. It is not clear how this information will be used. Because vessels cause bowheads to deflect, the vessel will not collect accurate information on densities of animals. Thus, estimates of take will be biased low. NMFS and MMS must require Shell to use an appropriate method for estimating takes.

g. 3, penultimate paragraph, 3rd -5th sentences: There has been concern about disturbance to not only cow/calf pairs, but also to migrating, resting, and feeding whales. NMFS has required Shell to monitor the 120 dB zone and if aggregations of bowheads were observed, seismic operations should be halted. The North Slope Borough, the Alaska Eskimo Whaling Commission, whaling captains and others are concerned that Shell's drilling activities will disturb many bowhead whales. In the 4th sentence Shell states that "NMFS may require monitoring for cetaceans at a distance within which continuous received levels from drilling operations are >120 dB rms." NMFS and MMS should require Shell to monitor a larger area than just where a continuous 120 dB received level occurs. BP's analyses at Northstar show that bowheads respond to levels of sounds that are 120 dB or lower even though the sounds are not continuous. The whales respond to transient levels of boat sounds. Further, Shell's ice management and other support vessel will produce considerable sounds. The 120 dB zone of industrial sounds will extend considerably farther than the 120 dB sounds just from drilling. Therefore, Shell should be required to monitor the larger area. The final sentence in this paragraph states that safety and disturbance zones for marine mammals "during drilling activity, have not been well established by the NMFS." While this statement may be true, NMFS and MMS should use the best available information, which was collected in Camden Bay in the late 1980s and early 1990s. Bowheads were excluded from a 9.5 km zone around a drilling vessel in 1986 and few whales were seen closer than 15 km. The received levels were approximately 105 to 130 dB (LGL and Greeneridge 1987). In 1992 and 1993, bowheads were also deflected from a drilling vessel. They began deflecting in 1992 at a distance of 32 km (Brewer et al. 1993) and in 1993, whales were nearly excluded from an area within 20 km of the vessel (Davies 1997, Hall et al. 1994).

Pg. 5, 3rd paragraph, 2nd sentence: NMFS and MMS should ask the AEWC to approve the Inupiat observers who will be used as Marine Mammal Observers (MMO). This will ensure that the observers are well qualified.

Pg. 6, Monitoring Methodology, 1st paragraph, 1st sentence: Shell should provide the approximate eye height of the vessel based MMOs and the distance that they should be able to observe in calm conditions and in inclement weather. Previous data presented by Shell showed that MMOs were not able to observe the entire safety and disturbance zones during seismic operations. Understanding the capability of MMOs will allow decision makers and the public to assess the appropriateness of the monitoring and mitigation plan during Shell's planned drilling operations.

Pg. 7, Monitoring at night and in poor visibility, 1st paragraph, 2nd sentence: Shell indicates that night vision goggles are not terribly effective for monitoring during darkness. NMFS and MMS should not allow Shell to drill or manage ice at night or in inclement weather unless Shell can demonstrate their ability to monitor safety and disturbance zone. If they are not able to make such a demonstration, it will be difficult for MMS and NMFS to conclude that Shell's activities will not result in a Level A take or conclude a FONSI.

Pg. 8, Reporting, 1st sentence, and 1st sub-bullet under bullet 4: Estimate of takes should not be based on density estimates of marine mammals collected from on-board the vessels. Vessels disturb bowheads and probably belugas. Thus, estimate of density will be biased low. Instead, estimates should be based on aerial survey data. Further, walrus or other pinnipeds might be attracted to vessels. If so, vessel based observations used to estimate densities of pinnepeds could be biased high.

Pg. 9, Objectives: In the past, Shell has stated that the aerial survey program was used in part to help provide mitigation, especially for observation of cow/calf pairs or aggregations of whales. It does not appear that mitigation is one of the objectives for 2010. NMFS and MMS should require Shell to use the aerial survey program for mitigation. If large numbers of whales are seen in Camden Bay, as were observed by Shell in 2007 and 2008, the drilling operation and other activities should cease so that only small numbers of whales are deflected. This will be especially important if MMS relies on an Environmental Assessment, which much reach a conclusion of a FONSI. Large numbers of bowheads could be deflected by Shell's operations. Therefore, a FONSI must require stringent monitoring and mitigation measures, more than what Shell proposes in their plan.

Pg. 9, Flight and Observation Procedures, 1st sentence: It is not clear whether the aerial surveys will begin 5-7 days before drilling begins or before vessels arrive. The aerial surveys should begin 5 to 7 days before the vessels arrive.

Pg. 11, Survey Design, last sentence: Previous researchers have shown that Camden Bay is a feeding area. Some of these observations were collected during BWASP surveys (see Moore et al. 1989). Furthermore, hunters have long known that Camden Bay was important for resting and feeding bowheads, including cow/calf pairs. Shell and MMS must acknowledge that Camden Bay is an important area for bowhead whales and protect the area appropriately.

Pg. 13, Estimation of Numbers "Taken", 2nd sentence: When Shell estimates the number of marine mammals it takes during its drilling operations, it must consider the impact of vessels and not just whether the drill ship is drilling or not. Bowheads are sensitive to ship sounds (Richardson 2009), thus estimates of takes much also include those that occur from ships, both when Shell is and is not drilling.

Pg. 13, last paragraph (#3), 2nd sentence: Shell needs to explain how they intend to use "relevant vessel-based observations to estimate how many cetaceans were exposed" to anthropogenic sounds are prescribed levels. Because vessel will also cause bowheads to deflect, observations from vessels will be biased low. More detail is needed here.

Pg. 19, Objective: Shell should also examine calling behavior compared to various levels of industrial sounds. If a whale alters its calling rate because of Shell's activities, that would indicate the whale had been disturbed or taken.

Oil Spill Review

Key Areas of Concern:

1. EIA does not analyze the site-specific, project specific impact of a blowout.

2. MMS needs to verify the proposed 5,500 bbl/day blowout rate is representative of the historical Sivulliq and Torpedo prospect data.

3. The ODPCP assumes the M/V Discoverer will not be damaged in a blowout and will be able to move away and drill its own relief well. There is no alternative plan in the event of damage.

4. The total blowout spill volume is estimated at 5,500 bbl/day for 30 days, based on the assumption that surface control or a relief well can be achieved in 30 days; this may not be possible. The blowout volume is over 6,000,000 gallons (equivalent to roughly ½ Exxon Valdez Spill). Additional time needed to control the well would increase this catastrophic spill volume.

5. Year 2000 Beaufort Sea field trials demonstrated that the maximum operating limit for the barge-based mechanical recovery system in ice-infested waters was 0-1% in fall ice. Shell's ODPCP recovery factor assumptions far exceed field test data results.

6. There is no historical record of a successful in-situ burn of emulsified 20oAPI crude oil ever being conducted in arctic conditions after it has percolated 100-120' through a seawater column. The claim that this response tactic will be successful is unsubstantiated.

7. The ODPCP proposes to drill until October 31st. If a well blowout occurred on October 31st and continued for 30 days (until November 30th), a spill of over 6,000,000 gallons of crude oil would occur with no option for recovery in fall freeze-up conditions when mechanical response and in-situ burning are both ineffective.

8. Spill impacts to endangered species are not evaluated for the blowout scenario.

9. It is not clear if the M/V Discoverer has been certified by ABS or USCG as an ice-classed drillship, suitable for drilling in arctic conditions.

Recommendations:

EIA, Page 332, para. 1: states: "...because the occurrence of a large spill from exploratory operations is not a reasonably foreseeable event, this EIA does not analyze the impact of a large spill."

The NSB disagrees that the risk of an oil spill from an OCS exploration well is not a "reasonably foreseeable event." Table 4.1.19-1 lists the potential for a blowout of 287,100 bbls of crude oil and water emulsion (165,000 bbls crude oil spilled over a 30 day period). A well blowout is a "reasonably foreseeable event." Well blowouts have occurred from exploration wells. The Oil Pollution Act of 1990 and State of Alaska law both require planning for a worst case oil spill scenario (in this case an oil well blowout). It is inconsistent for the EIA to determine that on oil well blowout is not a "reasonably foreseeable event," when federal and state law clearly indicates it is, requiring detailed planning for this type of "foreseeable event."

Shell concludes there is a 0% risk of a crude oil spill, which is unrealistic, and technically unsupported. To assume a 0% risk, no human or mechanical error could occur.

Clearly, there is more than a 0% risk, because Shell is required to demonstrate its ability to provide oil spill response personnel and equipment in the event of a well blowout. Indeed, in this very EIA, Page 332, Table 4.1.19-1, Shell details the potential for an uncontrolled crude oil blowout of 287,100 bbls, including emulsion and free water (165,000 bbls crude oil spilled over 30 days).

Figure 2-6 of Shell's Draft 2009 ODPCP confirms there have been 116 offshore blowout events in the US and Norway, alone, during the period 1980-2003. An average of five (5) offshore blowouts per year in only two countries is not an "unforeseeable event."
The EP at p. 201 states that Shell did not analyze the impact of a large liquid hydrocarbon spill, because "any spill greater than 48 bbl is regarded as too remote and speculative to be considered a reasonably foreseeable impacting event resulting from Shell's proposed project." Shell rationalizes that "... it is reasonable to not analyze the impacts of such a highly conjectural occurrence." Shell also notes that: "MMS did proceed with an analysis of the potential impacts of a large spill from a blowout in OCS EIS/EA MMS 2003-001 at IV-229 to IV-247," believes this work to be an adequate replacement for a site-specific, project specific Worst Case Discharge (WCD) oil spill assessment required at 30 CRF 254, and an analysis of the impact required by 30 CFR 250.227.

MMS's 2003 Lease Sale analysis at OCS EIS/EA MMS 2003-001 is an inadequate replacement for Shell's obligation to comprehensively examine the potential site-specific impacts of a large spill on human health and the environment for the following reasons.

1. MMS's analysis OCS EIS/EA MMS 2003-001 at p. A-1-1 used Gulf of Mexico (GOM) spill assumptions and BP's Northstar/Liberty Development assumptions neither which are directly applicable to an exploration well drilled from a drill ship in 100-120' of water in Camden Bay. GOM drilling conditions, risks, equipment and environmental conditions do not compare to Shell's proposed operation in Camden Bay. BP's Northstar and Liberty projects are drilled from gravel islands, using purpose built land-based rigs, which do not compare to Shell's plan to use a drillship to drill two exploration wells in Camden Bay in fall freeze-up conditions.

2. MMS's analysis OCS EIS/EA MMS 2003-001 at p. IV-229 states that MMS's analysis relies on an industry assessment of a 15 day oil spill from BP's Northstar facility for a spill of 180,000

bbls, from a drilling blowout from a land-based drilling rig located on the nearshore Northstar gravel island. Shell is required to examine a 30 day spill of the worst case discharge volume. The oil spill trajectories and environmental impact analysis completed in 1998 for Northstar, are applicable to a potential oil spill much further west, and much closer to shore than Shell's proposed operations.

The NSB requests the EIA comprehensively examine the potential impacts of a large spill on human health and the environment. Exploration activity by definition enters into "unknown" and "unpredictable" oil and gas formations and pressures. Human error and mechanical failure cannot be reduced to zero or to being speculative. Blowouts do and have occurred, such as the1987 Cook Inlet blowout that took over 6 months to drill a relief well, etc.

EIA, Page 332, Table 4.1.19-1: lists the potential for an uncontrolled crude oil blowout at the seabed floor of 287,100 bbls, including emulsion and free water (165,000 bbls crude oil spilled over 30 days). The EIA references the ODPCP for further information on the volume estimate and response strategies.

The basis for the blowout flowrate of 5,500 barrels of oil per day (bopd) for a 30 day duration is not explained. Due to the confidential nature of exploratory well data, the productivity and geologic prospect data was redacted from the Shell Camden Bay Exploration Plan version provided to the NSB. Therefore, the NSB is unable to independently confirm whether 5,500 bopd is an appropriate flow rate for a Sivulliq or Torpedo well. The EIA at p.13 lists eight wells that were drilled in this area, with two wells into the Hammerhead Prospect (now renamed Sivulliq). The NSB requests that MMS validate whether 5,500 bopd is a conservative flow rate for both the Sivulliq and Torpedo wells for an uncontrolled well blowout through an unobstructed opening.

While a flow rate of 5,500 bopd is a default rate allowed by the State of Alaska ADEC under 18 AAC 75 for exploration wells where there is no flow rate/ well productivity data, there is no specific default provision in 30 CFR 254 establishing a default rate. Also, there is no information in the State of Alaska administrative record that the NSB is aware of to technically support the use of 5,500 bopd as a conservative, worst case discharge for an exploration well in the Beaufort Sea. There does not appear to be a technical basis for selecting this flow rate. MMS regulations at 30 CFR 254.26 require oil spill planning for a Worst Case Discharge (WCD). Please verify that 5,500 bopd is a WCD flow rate.

EP, Section 8.0, para. 1, states: the ODPCP is a fundamental component of the exploration program, and is incorporated by reference in both the EP and the EIA documents. The current NSB review of the ODPCP has identified the followings areas of concern:

1. **Completeness**: The ODPCP is a draft, redlined version of Shell's 2007 ODPCP approved by MMS. The redlined version available has not been deemed complete by the State of Alaska. NSB contacted ADEC staff to verify the ODPCP status. ADEC verified that the State of Alaska has not deemed the revised ODPCP complete, or ready for public review. ADEC has begun preparing its Request for Additional Information and plans to send that request to Shell shortly. Contact with MMS staff indicates that MMS has deemed the ODPCP complete, but has not

approved the changes. The NSB requests that a complete copy of the (most up-to-date draft) ODPCP be provided to the NSB for review and comment, along with a copy of all materials referenced. The NSB does not support reliance on an ODPCP that has not been determined complete by both state and federal governments to support an EP and EIA.

2. **Well Depth**: The ODPCP at p. I-3 states that: "[t]he depth of these wells will terminate well above any geologic formations that may potentially be hydrocarbon bearing. Two ice management/anchor handling vessels will assist these operations. Alaska Clean Seas will be present to provide response equipment and personnel during these non-critical drilling operations."

The NSB requests that Shell clarify which wells will terminate above any geologic formation that will potentially be hydrocarbon bearing. Demonstrate whether this will apply to the 2010 Sivulliq and Torpedo wells.

The NSB also requests that Shell explain how it will know to instruct the drilling staff to stop drilling prior to encountering a hydrocarbon bearing zone, keeping in mind the unknown geologic and geophysical properties of an exploration well.

3. **ODPCP Duration**: The NSB requests that MMS explain its plans for amending the 2007 ODPCP in relation to the 2010 Shell Camden Bay Exploration Plan. Will the 2007 ODPCP be amended in 2009 for another two year period per 30 CFR 254.30, expiring in 2011?

4. Relief Well Drilling Capability: The 2007 Shell ODPCP included the Kulluk for additional relief well capability in the event the M/V Discoverer drillship is damaged during a well blowout. Shell has removed the Kulluk from the ODPCP without replacement. The 2007 Shell ODPCP stated the Kulluk provided an important mitigation measure by providing immediate relief well drilling capability in the event of a well blowout from the M/V Discoverer (ODPCP at p.1-26). Shell has not explained its rationale for eliminating this mitigation measure, nor has it provided alternative plans for a relief well in the event the M/V Discoverer is damaged during a blowout. Shell only states that it plans to use the M/V Discoverer to "commence relief well drilling," "unless it is damaged," and that this plan is "prudent" (ODPCP at p. 1-25).

If the M/V Discoverer is damaged during a well blowout event it may not be available to drill its own relief well. In the current draft ODCPC Shell does not provide any details of its plans in this event. What other options are available to provide relief well capability? How long will it take to bring in another rig capable of drilling in 120' of ice laden water? How will this new relief well plan impact the total potential oil spill volume? The current spill volume is based on an assumption that a relief well can be drilled in 30 days. Is this a reasonable assumption if the M/V Discoverer is damaged during a well blowout?

For example, if drilling continues until October 31, 2010, and the M/V Discoverer is damaged during a blowout that occurs in the later half of October, will it be possible to obtain a second rig and bring it to location in order to drill a relief well before winter ice sets in? Will a delay in locating an alternate relief well result in a larger foreseeable oil spill than 165,000 bbls (which was based on 5,500 bopd for a 30 day period)? The NSB is concerned that the inability to provide immediate relief well capability could result in an uncontrolled blowout continuing into, and potentially even throughout, the winter season, spilling much more oil than 165,000 bbls.

The NSB Municipal Code (NSBMC) sets specific standards for relief wells. The NSBMC §19.70.050(H)(6) states:

> *"Plans for offshore drilling activities are required to include a relief well drilling plan and an emergency countermeasure plan.* **The relief well drilling plan must identify suitable alternative drilling rigs and their locations; identify alternative relief well drilling sites; identify support equipment and supplies including, mud, casings and gravel supplies which could be used in an emergency; and specify the estimated time required to commence drilling and complete a relief well.** *The emergency countermeasures plan must identify the steps which will be taken to protect human life and minimize environmental damage in the event of loss of a drilling rig; ice override; or loss or disablement of support craft or other transportation systems."*

The ODPCP does not identify an alternative relief well drilling rig in the event the M/V Discoverer is damaged. Please identify an alternative rig and explain the timing and logistics required to bring that rig to location in order to drill a relief well. The time required to complete a relief well should be used as the basis for the oil spill volume.

The 2007 ODPCP included plans for a rapid supply of relief well equipment. This language (ODPCP at p.1-26) was removed from the 2009 draft ODPCP. Please revise the plan to include relief well equipment supply plans.

Relief well planning for this offshore location is critical, because Shell states that the more common alternative well control method, "well capping," is not technically feasible for its drillship subsea wellhead configuration (ODPCP at p.4-5), ruling out an important well control alternative.

5. **Oil/Water Emulsion**: The draft 2009 ODPCP at p. 1-66 states that the oil/water emulsion volume is estimated using a 1.54 factor to inflate the oil spill volume of 165,000 to a total volume of 254,100. There's no basis provided for the 1.54 factor that addresses the oil emulsion volume created by skimming/pumping operations. Please provide the basis for a 1.54 emulsion factor.

The 1.54 factor does not include additional emulsion created from a subsea oil well blowout at the mudline, rising over 100' though the seawater column, nor does it account for additional emulsion created by wave action. Both these factors increase the emulsion and increase the contaminated waste volume that would need to be recovered. Please revise the emulsion factor to account for these site specific variables. The total spill volume, recovery, storage and lightering capacity will need to be reexamined to ensure response capacity exists for the larger volume.

6. **Cross Island Impact Timing**: The draft 2009 ODPCP at p. 1-63 states it will take 67 hours

for the leading edge of an oil well blowout to reach Cross Island, yet Scenario 1 modeling at p.1-67 states it will take 42 hours. The shorter time is consistent with surface current assumptions and initial easterly winds. Please revise the ODPCP to be consistent on this timing and describe how shoreline protection resources will be in place at Cross Island by hour 42.

7. **Scenario 1 Assumptions**: The assumptions used in Scenario 1 are not consistent with a worst case well blowout at the Torpedo drillsite. The scenario is based on an August 1st well blowout; yet Shell does not plan to start drilling the 40 day well until after July 10th, which means the oil zone would not be penetrated until mid-August. Wind, wave and storm conditions typically increase later in August. Please evaluate whether water currents of 0.75 knots WNW, wind from the East, and wave heights of 1.5 – 2' are representative of mid-August conditions.

8. **Drilling Until Oct 31st**: The ODPCP proposes to drill until October 31st. If a well blowout occurred on October 31st and continued for 30 days (until November 30th), a spill of over 6,000,000 gallons of crude oil would occur with no option for recovery in fall freeze-up conditions when mechanical response and in-situ burning are both ineffective.

9. **Endangered Species Impact**: If a spill were to occur in mid-August (Scenario 1), it would place oil in the migratory path of the endangered bowhead whale. Oil spill cleanup would take many months, if not years, yet neither the ODPCP nor the EIA examine impacts of an oil well blowout spill on endangered species, including the bowhead whale. The three sentence wildlife protection plan (ODPCP at 1-88) is inadequate.

Please add a map showing both the oil spill trajectory and bowhead whale migration route, as well as the location of other endangered species that could be impacted by the spill. Please examine the potential ESA impacts of an oil well blowout scenario.

10. **Fuel Spill**: The worst case fuel spill is estimated at 2,000 gallons (ODPCP at p. USCG-3) based on a fuel transfer spill. However, the EP at p. 6 shows the M/V Discoverer with a fuel storage capacity of 6,497 bbls (272,874 gallons), along with additional capacity in other upper wing tanks. The ODPCP lists a potential fuel tank spill in Table 2-1 at 1,555 bbls (65,310 gallons) from the single largest tank, yet no spill scenario addresses a spill of this size. A worst case fuel spill would be the loss of the entire fuel tank in the case of a vessel collision or grounding, damaging the fuel tank. Please revise the fuel spill scenario to address this potential loss.

11. **Logistics**: Scenario 1 at p. 1-74 shows only one skimmer (Lamor 205) operating within the first day. Additional skimmers (Lamor 82 and Transrec 150) arrive at days 2 and 3 respectively. Please explain where this equipment is currently staged, and what steps can be taken to expedite this equipment to the spill location or pre-stage it at the site for a faster response. Additionally, if the equipment is coming from West Dock, explain how it will be transported to the spill site if land fast ice exists.

12. **Land Fast Ice**: The ODPCP at p.1-84 describes an oil spill response during land fast ice conditions that could occur in October. The plan states that land fast ice could prevent shoreline oiling and in that case nearshore response would not be implemented. However, the plan to

recover oil along the seaward edge of the landfast ice is not clear, nor is the logistics plan to supply offshore response vessels in the event that land fast ice renders most of ACS's boats unusable because of their inability to operate in ice.

13. **Declining Light/Impact to Recovery Operations**. The recovery computations in the ODPCP do not take into account the declining light available in fall. The reduction in daylight hours is shown in the ODPCP at p. 2-25, showing daylight at 11.2 hours in October. Yet, Scenario 1 (fall alternative) assumes 20 or more hours of operation. Please explain how lighting systems will be mobilized to location and used to allow around-the-clock recovery operations; or revise the recovery calculations to show the amount of oil that can be recovered during daylight hours.

14. **LOSC**: The NSB serves as the Local On Scene Commander (LOSC) for any spill affecting the NSB. The NSB should be added to the ODPCP at p. 3-9 and Figure 3-2.

15. **Field Testing of Tactics**: Please provide information to demonstrate that all of the tactics referenced in the ODPCP have been field tested and personnel have experience in carrying them out. Untested tactics should not be relied upon.

More specifically, the NSB is particularly concerned about the proposal to use skimming systems in fall freeze-up and slush ice conditions, because skimmers are known to clog and fail in these conditions. Please provide field test data to validate the ODPCP assumption that the proposed skimmers can function for 20 hours of continuous recovery operation in fall slush ice conditions without fail. Please provide field test data to show that the emulsified crude oil/water mixture can be pumped and lightered from one vessel to another at the rates shown in the plan during fallconditions.

Existing field test data in the Beaufort Sea shows that in fall freeze-up conditions in-situ burning and mechanical response are both limited to less than 10% recovery in slush ice conditions. This leaves little or no response method until winter sets in and an on-ice response can be safely initiated. By this time, oil would have frozen into the ice, and contaminated ice mining using civil engineering techniques and yellow-iron equipment would not be possible until ice conditions allow safe access.

There is no record of a successful in-situ burn of emulsified 20oAPI crude oil in arctic conditions after it has percolated 100-120' through a seawater column. The use of in-situ burning in open water conditions has only been used once, unsuccessfully, in the U.S. during the Exxon Valdez Oil Spill. The use of in-situ burning has been used successfully in other applications (e.g. wetlands) but has not been proven in a arctic blowout out response application.

16. **In-situ Burning**: Please:

a. estimate the amount of in-situ burning residue that would be left in the marine environment after a burn, and the estimated affected marine area that would be contaminated by that residue;

b. provide scientific reference material to support assumptions; and estimate the composition, toxicity and bioaccumulation characteristics of in-situ burning residue;

c. provide documentation detailing proven techniques for in-situ burning during fall freeze-up conditions, and for oil trapped under ice; and

d. provide the results of the emulsification study, described by Shell's consultant Spilltech, which supports the ability to use in-situ burning as a response method for a sub-sea well blowout.

<u>Comments from 2007 ODPCP that still are valid and should be continued.</u>

1. **There is no proven oil spill clean-up technology in icy waters**. Spill response experts agree that existing oil spill response technologies cannot effectively clean up a large scale oil spill to ice-infested waters.

> *"Oil spilled in broken-ice cannot be cleaned up effectively, and it is expected that whales would not avoid oil-fouled waters."* (National Research Council 2003b)
>
> *"Today there is no proven response method for recovery of large-scale oil spills in ice-infested waters."* (Evers et al. 2006)
>
> *"If oil is widely distributed throughout broken ice, no countermeasure methods might be practical."* (Owens et al. 1998)
>
> *"Mechanical recovery is extremely difficult in ice-infested waters, and is not an effective response option for large scale oil spills above 30% ice coverage"*. (DeCola, Robertson, Fletcher, Harvey 2006)
>
> *"Adverse weather conditions sometimes preclude any response at all and require a 'wait until thaw' approach"* (Oskins and Bradley 2005)
>
> *"No current cleanup methods remove more than a small fraction of oil spilled in marine waters, especially in the presence of broken ice"* (National Research Council 2003b)
>
> *"In-situ burning has not been demonstrated in actual field tests to be effective in ice coverage above 30% or below 70%. Above 70% coverage, sea ice may provide natural containment, although the sea ice may transport oil great distances so that it is unavailable for response once spring break up occurs. At higher ice concentrations, significant logistical, technical, and safety challenges remain in tracking, accessing, and igniting the oil slicks and recovering burn residues."* (DeCola, Robertson, Fletcher, Harvey 2006)

"In some cases, safety concerns will necessitate the 'monitor and wait' approach rather than attempting a risky marine operation, which might also have a very limited chance of success." (Dickins 2005)

There is no proven technology to clean up an oil spill in icy conditions, especially in fall-freeze up conditions with the currents and wave conditions found in the Arctic Ocean. Broken ice conditions limit spill response options. Fall freeze up conditions create the most challenging response conditions, where slush ice clogs skimmers and covers large areas of the sea, rendering mechanical response and in-situ burning infeasible.

In 2001 ADEC, MMS, DNR, and NSB approved a Joint Agency Report which confirmed industries' inability to meet the state response planning standard using mechanical response in broken ice conditions (Robertson 2001).

The 2000 Beaufort Sea field trials demonstrated that the maximum operating limit for the barge-based mechanical recovery system in ice-infested waters was 0-1% in fall ice, 10% in spring ice without ice management, and 30% in spring ice conditions with extensive ice management. Shell's response plan assumes recovery factors from waters containing ice well in excess of 0-1%, however no basis is provided to substantiate such capabilities.

Shell's ODPCP also does not meet the standard of AS 46.04.030, which requires an operator to demonstrate it has the personnel and resources to contain or control, and clean up, the realistic maximum oil discharge within 72 hours from an exploration facility. State regulations (18 AAC 75.445) require response equipment to meet the applicable response planning standards established under 18 AAC 75.430 - 18 AAC 75.442 using mechanical methods of oil control, containment, and cleanup. Shell has not demonstrated that it can meet the Response Planning Standard (RPS) with mechanical equipment. Furthermore, scientific literature cited in this document confirms that the RPS cannot be met with mechanical equipment.

State regulations at 18 AAC 75.445 require Shell to demonstrate it can achieve the response planning standard for containment, control, recovery, transfer, storage, and cleanup within a specified time and under environmental conditions that might reasonably be expected to occur at the discharge site. Shell has not met this standard for its proposed drilling sites during its proposed drilling times.

Environmental factors, such as wind speed, sea state, visibility, safety considerations, and logistics further narrow the window of opportunity to contain, control, and recover oil spilled in the Arctic Ocean. Oil spilled to water bodies where sea ice is present may become trapped on top of, below, or within ice. Sea ice will impact the weathering and transport of spilled oil, and has the potential to complicate spill tracking, containment, and recovery operations. Ice can also impact logistical aspects of spill response operations, such as safe operation of response vessels or positioning of equipment.

Mechanical recovery of oil spills in open water or nearshore environments involves the physical containment of the oil within natural or man-made barriers and subsequent removal of oil from the surface. Response experts generally agree that conventional open water mechanical recovery technologies operate at significantly lowered efficiencies when sea ice is present (Abdelnour and Comfort 2001). Most technologies used in responding to oil spills in sea ice have been adapted from those typically used on open water and land. Sea ice reduces the efficiency of all response methods (AMAP 1998).

Sea ice, particularly dynamic drift ice, affects the functionality of both boom and skimmers, the primary components of mechanical recovery. Sea ice also impacts vessel operations and may limit or preclude the ability to operate certain classes of vessels. Cold weather conditions can further complicate mechanical recovery, causing efficiency losses for both personnel and equipment.

The presence of dynamic drift ice interferes with the ability to contain oil with sufficient thickness to recover it. Oil tends to disperse and mix into the ice, making it necessary to separate the oil from the ice in order to clean up the spill. Sea ice may reduce the effectiveness of containment booms by interfering with the boom position, allowing oil to entrain or travel under the boom, or causing the boom to tear or separate. Sea ice may also reduce a skimmer's efficiency to recover oil by lowering the encounter rate (rate at which skimmer comes into contact with pooled oil) and increasing the maneuvering and repositioning time to place the skimmer for optimum recovery among ice floes (Abdelnour and Comfort 2001, Fingas 2004).

Conventional marine operations in dynamic drift ice are vulnerable to rapid changes in weather and ice conditions. Significant down-time often occurs in conventional marine operations due to the movement of ice in response to wind conditions, with the sea state further impacting response efficiency (Dickens and Buist 1999). Dynamic ice response trials on the Alaska North Slope in 2000 showed significant problems with ice interference (Robertson 2001).

The limits of open water mechanical recovery systems in sea ice conditions have been correlated to the percent coverage of sea ice. (DeCola et.al. 2006) However, as ice concentrations increase, the potential for the sea ice itself to serve as oil containment increases. Dickins and Buist (1999) found that ice concentrations of 60% or higher provide "an effective means of reducing oil spill spreading." Yet, while the spreading rate is significantly diminished, the recovery rate can also be severely impacted by the logistical inaccessibility of oil accumulations because of vessel, mechanical and human limitations. So the increasing ice concentrations ultimately are not very helpful to the recovery effort, because limits to vessel operations at higher ice concentrations make recovery operations extremely difficult.

In ice concentrations below 70%, additional containment is usually required to concentrate the oil so it can be recovered by a mechanical skimming device. Dickins and Buist (1999) found that most containment booms can be used in light brash ice conditions and ice concentrations up to about 30%. Based on these estimates, ice conditions ranging from 30% to 70% coverage may present the biggest challenge to mechanical response, as conventional booms are likely to be ineffective, but ice conditions are not sufficient to afford natural containment of spills (Evers et al. 2006, Glover and Dickens 1999). These are the ice conditions in which Shell proposes to operate.

Results from other tests and trials generally support the 30% rule, although dynamic drift ice conditions have been demonstrated to significantly reduce recovery efficiency in ice conditions down to 10% coverage. During a series of equipment trials in dynamic ice on the North Slope in 2000, a barge-based mechanical recovery system was demonstrated to be somewhat effective in ice conditions up to 30%, but only if ice management systems were deployed to reduce the amount of oil present at the skimmer to 10% or lower. Sea ice caused considerable strain on containment booms and boom failure was a problem (Robertson and DeCola 2001). The trials demonstrated that the maximum operating limit for the barge-based mechanical recovery system in ice-infested waters was 0-1% in fall ice, 10% in spring ice without ice management, and 30% in spring ice conditions with extensive ice management (NRC 2003b).

BP's oil spill contingency plan for the Northstar facility in the Beaufort Sea supports the 10% limit, noting that at concentrations above 10%, the containment boom concentrates ice as well as oil, and the ice concentration proves problematic for recovery systems (BPXA 2003).

Aside from the challenge of containing oil spilled in ice-infested waters, recovery operations may also be complicated by the presence of ice. Most skimmers operate at a significantly reduced efficiency, or not at all, when drifting ice pieces are present within the oil slick. Some skimmers may be effective recovering oil between the cracks in ice leads, but quickly shut down as ice forms. Positioning the skimmer in ice-free areas can be challenging. Mechanical recovery operations in ice-infested waters are generally more effective on a small scale, such as collecting oil from small leads within ice floes using portable over-the-side skimmers or mobile units. Large-scale collection, such as that which is proposed by Shell will have a very low efficiency.

A report that considers the challenges of using mechanical recovery to clean up a large oil spill from Shell's operations in Sakhalin Russia concludes that the scale of a response reliant on small batch mechanical recovery for a spill of 136 tonnes or more would be untenable. The report notes, "the number of systems required to recover even 10% of the spill becomes unmanageable. There is little to be gained in these cases from bringing in more than a few vessels." (Dickins 2005)

The need to improve mechanical recovery capabilities in dynamic drift ice is cited repeatedly in published literature (Abdelnour and Comfort 2001, Dickens and Buist 1999, Fingas 2004). A 2004 report prepared for the Prince William Sound Oil Spill Recovery Institute and the US Arctic Research Commission (Dickins 2004) identifies a need to "expand the operational capability of existing spill response equipment to enable oil recovery in ice." The same document indicates a "low" confidence in the ability to improve mechanical response in ice, noting "improvements likely to be incremental, resulting in modest increases in recovery effectiveness."

Additionally, there is considerable technical debate among experts about the efficacy of in-situ burning as a primary oil spill response tool in the arctic, particularly under dynamic ice and/or storm conditions. A review of published literature reveals that in-situ burning has not been demonstrated in actual field tests to be effective in ice coverage above 30% or below 70%. Above 70% coverage, sea ice may provide natural containment, although the sea ice may transport oil great distances so that it is unavailable for response once spring break up occurs. At higher ice concentrations, significant logistical, technical, and safety challenges remain in tracking, accessing, and igniting oil slicks and recovering burn residues (DeCola et.al. 2006).

2. **Oil spill impacts will persist in the Arctic**. If spilled, hydrocarbons will persist in the Arctic, because hydrocarbons do not degrade as quickly in the Arctic, recovery seasons are shorter, and oil contamination is more difficult to remove. In addition, if oil cannot be effectively cleaned up, the impact would be greater in comparison to spills in other locations because oil persists for a greater period of time in the Arctic. Therefore, the impact to subsistence resources and areas would be substantial and long lasting.

3. **MV Discoverer Lack of Experience in Ice and Beaufort**. The NSB is concerned about the use of the M/V Discoverer's maiden voyage in ice to drill a Beaufort Sea exploration well. The risk of this scenario has not been evaluated or mitigated. The ODPCP at p. 2-23 describes the vessel as ice capable, but does not provide information on American Bureau of Shipping (ABS) or USCG ice class certification; please provide these materials to the NSB. On March 12, 2007 Shell confirmed that the M/V Discoverer has not yet been approved by the USCG as an arctic ice-classed vessel with a double hull. Neither has Shell provided the NSB with any information since March 12, 2007 to show that the M/V Discoverer is certified as an arctic ice-classed vessel with a double hull. These critical oil spill prevention measures are required by federal law, and are necessary to protect subsistence resources and habitat.

4. **Non-tank vessel plans and financial responsibility**. Shell has not provided data on the non-tank vessels supporting this exploration plan, demonstrating that Shell, and/or its contractors, have proven adequate financial responsibility to operate in the Beaufort Sea. Further, the NSB has not seen that Shell and/or its contractors, have approved ODPCPs in place for these non-tank support vessels. Both ODPCPs and financial responsibility certificates are required prior to operation.

5. **Tank vessel plans and financial responsibility**. Shell has not provided data on the tank vessels supporting this exploration operation to demonstrate that Shell has adequate financial responsibility and ODPCPs in place for this equipment. ODPCPs and financial responsibility certificates are required prior to operation of tank vessels.

6. **Leaving oil in the environment over winter is not an acceptable cleanup strategy and is not consistent with state law**. Shell's ODPCP proposes to leave spilled oil in the Beaufort Sea over winter, and attempt to clean it up during the spring thaw. Leaving oil in the environment is not an acceptable cleanup strategy. It does not meet the state's 72-hour response planning standard and is inconsistent with both statewide standards and NSB policies on habitat and subsistence protection.

7. **In-situ burning efficiency has not been demonstrated**. State regulations at 18 AAC 75.445 require Shell's ODPCP to demonstrate the efficiency and effectiveness of in-situ burning and must include a full assessment of potential environmental consequences, provisions for continuous monitoring and real-time assessment of environmental effects. Shell has not provided sufficient scientific data to demonstrate the efficacy of in-situ burning in an offshore arctic

marine environment, responding to a subsea blowout in the weather conditions present during its planned seasons of operation.

As researchers and spill responders have struggled with the limited effectiveness of mechanical recovery in sea ice conditions, they have simultaneously explored the potential use of in-situ burning to clean up oil spills in ice-infested waters. In-situ burning requires the containment of an oil slick to a sufficient thickness, ignition of the slick in a controlled burn, and removal of any remaining burn residue.

According to the US National Response Team, in-situ burning is considered to be a "viable response method" if certain slick thickness and environmental parameters can be met (NRT 1997a):

- The oil slick must be thick enough to ignite (which is difficult to achieve in ice conditions up to 60% with mechanical booms);
- Wind and wave conditions must be moderate (Arctic ocean natural hazards can produce extremely cold temperatures together with severe and sustained wind and wave conditions);
- The oil must not have significantly emulsified (oil leaking from a subsea blowout 100 feet deep, will be thoroughly emulsified); and
- The downwind emissions must be below threshold concentrations for sensitive populations (NSB residents and other industrial operations are downwind of Shell's proposed operations).

The National Response Team's conditions for a successful oil spill burn will be difficult, if not impossible, to achieve in the Arctic due to the natural hazards present. Additionally, the burning of oil in fall slush ice conditions has not been proven as a viable response strategy.

Interestingly, in-situ burning of marine oil spills has some of the same operational requirements as mechanical recovery. First, spilled oil must be contained to the appropriate thickness to allow for ignition. Instead of recovering oil with a skimmer, as in mechanical recovery, in-situ burning ignites the oil slick. Burn residues must then be recovered.

As in mechanical recovery, oil containment for in-situ burning can be accomplished either with natural barriers (e.g. topographic features on land, snow berms, sea ice) or man-made booms. However, fire boom used for in-situ burning must be constructed of fire-resistant materials.

Once the slick is contained at an appropriate thickness for burning, an ignition source is required to initiate the burn. In order to ignite, the slick must meet minimum thickness requirements, which vary depending upon the temperature, the type of oil, the amount of emulsification, and degree of weathering.

Oil leaking from a subsea blowout, 100-120' deep, would be impossible to boom effectively at the surface. The oil would be so emulsified and dispersed once it reached the surface of the ocean, that ignition would be highly unlikely. Shell has not explained how in-situ burning would work for a subsea blowout.

Scientists have shown that in-situ burning efficacy depends on the characteristics of the oils to be burned. In a 2001 study investigating the potential effectiveness of in-situ burning on a variety of crude oils, researchers found that various characteristics of the oils tested had measurable impacts on the likelihood that the oil could be burned. The researchers' test results indicated that oils with high API gravities (above 38°) tend to burn relatively easily, while those with API gravities below 20° will burn only under "optimal conditions." Their findings for oils with API gravities in the range of 20° to 35° indicated that the suitability of in-situ burning could not be predicted for these oils on the sole basis of their physical properties (McCourt and Buist 2001). Shell's plan states the Sivulliq and Torpedo prospect oil is approximately 20° API which is unlikely to burn, even if released at the surface, and not at all likely to burn when released at 100ft below the surface at the mud line.

At ice coverage up to about 60%, in-situ burning generally requires the use of manmade fire booms to contain the oil to the desired thickness. When ice conditions range from 30% to 60%, in-situ burn operations would face many of the same constraints as mechanical recovery, because of the challenges of deploying containment booms. Boom-towing vessels must be able to maneuver and position booms to contain oil to the desired thickness. An ignition source must then be deployed from a vessel or aircraft. Ice conditions in the 30% to 60% range are considered to be the "most difficult from an in-situ burning perspective" (Evers 2006). In this range, natural containment by the ice is less likely, and containment boom deployment is generally not possible. These are the very conditions that Shell plans to be operating in.

8. **In-situ burning damages ecosystem**. The ocean surface microlayer, approximately the upper millimeter of the water surface, is an important ecological niche that provides habitat for many sensitive life stages of marine organisms. Eggs and larval stages of fish and crustaceans, and reproductive stages of other plants and animals develop in this layer, which often contains dense populations of microalgae with species compositions distinct from the phytoplankton in the layers below (Shigenaka and Barnea 1993). Surface microlayer organisms are vulnerable to impacts from oil slicks and subsequent burning. More research is needed on this topic.

9. **Oil spill cleanup in or under ice does not meet the State's 72-hour RPS requirement**. Shell's ODPCP does not demonstrate it can clean up oil trapped in or under ice as required by AS 46.04.030 and 18 AAC 75.445. Shell's oil spill plan states there are "proven" techniques for removal of oil from within or below ice; however, Shell provides no peer reviewed scientific literature or field evidence to support such an assertion for the Beaufort Sea.

Oil spilled in ice-infested waters, and especially under the ice layer, is not only difficult to contain, it is very difficult to track and/or model. Marine oil spill tracking and remote sensing technologies generally rely on air operations, which can be severely constrained by arctic environmental and logistical factors. Existing mathematical models cannot accurately predict the movement of oil on, under, or among offshore ice, although this is an area where considerable research and development remains ongoing.

Oil trapped under ice may freeze and remain there, as it cannot evaporate. The oil will move with the ice until the spring melt and may ultimately be released a considerable distance from the spill site. This process has been referred to as "encapsulation" or an "oil-ice sandwich" (Evers et al. 2004, Izumiyama et al. 2004, NRC 2003a).

Oil trapped under multi-year ice could remain in the marine environment for many years (AMAP 1998) and may not be released until it slowly migrates to the surface. Some scientists estimate oil could be trapped under multi-year ice for up to a decade (NRC 2003a).

10. **Oil spill trajectories will likely follow currents and routes that are coincident to the migratory paths used by beluga and bowhead whales**. Bowhead and beluga whales follow prevailing currents traveling west from Kaktovik as far as Barrow and then shifting north. This behavior has been confirmed by satellite tagging studies. This data is relevant to the review of Shell's proposed activities because it suggests the whales would be traveling coincident to the trajectory of an oil spill. Unrecovered oil could persist in the marine environment, with the potential to pollute the water column, shoreline, and sea bottom, and contaminate whale feeding grounds. Contamination could linger for years, causing irreparable cumulative damage to an extremely vulnerable sub-species. Impacts to subsistence could be long-lasting and significant.

11. **A blowout would introduce oil contamination at the sea floor; in-situ burning would not be a viable response method**. Shell's ODPCP includes a sub-sea blowout scenario that introduces over 6 million gallons of crude oil into the marine waters at a depth of 100 feet. This is a very large spill (about ½ the size of the Exxon Valdez Oil Spill). Shell assumes that this oil can be removed from the environment by in-situ burning, but has not taken into account that the oil will emulsify as it moves from the seabed through a strong current to the surface of the ocean. By the time the oil reaches the ocean surface it will be laden with water, and any surface currents and wind will further emulsify the oil making it difficult, if not impossible, to ignite and sustain a burn. State regulations at 18 AAC 75.445 require Shell's ODPCP to demonstrate the efficiency and effectiveness of in-situ burning; this has not been done.

12. **Oil toxicity in Arctic Ocean not understood**. Shell's ODPCP does not address the toxicity of an oil spill to the Arctic Ocean and its impact on environmentally sensitive areas and endangered species. By state and federal law, Shell is required to demonstrate it can protect environmentally sensitive areas and endangered species during an oil spill. NSB Toxicologist from the NSB Wildlife Department concludes that spilled oil will be toxic to the ecosystem and its inhabitants. Scientific data from the 1989 Exxon Valdez oil spill show remaining hydrocarbons and hydrocarbon by-products still present a serious threat to a healthy ecosystem after almost 20 years. Oil spilled in the Beaufort Sea, and the toxic byproducts of such a spill, would have a much longer half-life as compared to oil spilled in Prince William Sound. Shell has not provided any scientific data to counter this conclusion.

13. **Vessels discharges pose significant environmental risks to subsistence activities and marine habitats**. Support vessels proposed by Shell present a spill risk both during oil transfer operations and in transit. The potential spill volume from support vessels ranges from a small spill during oil transfer to a catastrophic cargo loss. Vessel spills pose an additional response

challenge because they can occur virtually anywhere along the vessel route. This poses a threat to environmentally sensitive areas, which are located all along the transit route to and from the exploration site, and at the exploration site itself. Vessel spills associated with Shell's project could impact the Chukchi and Beaufort Sea subsistence resources and habitat.

A vessel spill may release hydrocarbons above or below the sea surface, depending upon where the tank is breached. Appropriate spill prevention measures for tank vessels include, but are not limited to: double hulls or double bottoms; leak detection systems; vessel traffic systems; ice detection monitoring systems; weather monitoring systems; navigational restrictions during periods of adverse weather; personnel training; drug and alcohol testing; medical monitoring; and watch standing procedures that ensure adequate crew rest. Human factors – human or organizational errors – have been cited as the cause for approximately 85% of marine vessel accidents; therefore, Shell should implement carefully designed programs that improve human performance. Shell has not demonstrated that it has adequate measures in place to prevent or respond to a spill from a catastrophic breach of a vessel hull transporting or using fuel.

14. **Impacts to Wildlife**. Oil and gas exploration can impact wildlife several ways, from the acute and highly visible effects of a large spill to the less obvious, longer-term impacts of ingestion or uptake of toxic substances. In any marine environment, wildlife impacts from oil spills can include: physical contact with the oil in any part of the water column or on shore which can reduce the insulating capacity of fur or feathers, leading to hypothermia, or hindering the flight or buoyancy of birds (EPA 1999); toxic contamination by ingestion, inhalation, or absorption (in the case of eggs) that could damage the digestive system, liver, or lungs; or contaminants that coud be ingested one time after a single spill event, over years in areas of oil activity, or situations with low level releases, or through the food chain as they are passed to higher trophic levels in the process of bioaccumulation (Hobson 2002). Inhalation of fumes can also lead to fatal brain lesions, stress, and disorientation (Loughlin in Peterson et al. 2003). Additionally, oil spills can cause resource scarcity because inaccessible food can impact both resident and migratory populations (EPA 1999).

The presence of ice may impact the magnitude and/or severity of wildlife impacts in several ways. For example, ice will cause slower rates of biodegradation and dispersion, as well as longer life spans and slower generation turnover (for benthic species). Recovery will take longer in these areas (AMAP 1998).

When considering wildlife impacts, the timing and location of a spill are significant (AMAP 1998). Shell proposed to explore for oil in the immediate vicinity of important subsistence use areas and historic whale migratory routes.

Leads, polynyas, and ice edges tend to be focal points of biological activity (Stirling 1995), and also targets for pooled oil spilled to the surface, impacting birds or bears fishing in these areas, and marine mammals using these features. Since oil can be trapped in ice and released during the melt with minimal signs of weathering, a fall or winter spill could transfer wildlife impacts into the spring or summer. Thus arctic oil spills not only affect resident populations present at the time of the spill, they also affect migratory species seasons later.

Whales are at risk of encountering newly spilled oil—or oil released from ice—when breathing at the surface and feeding on benthic organisms. Some cetaceans appear to be able to avoid oil, but whales have also been observed moving through it (NRC 2003b).

There is no data on the bowhead whale's response to a catastrophic oil spill, but migrating eastern gray whales have been associated spatially and temporally with two major US oil spills. Three dead gray whales were found during their northward migration after the 1969 Union Oil spill in Santa Barbara, California (Brownell 1971 in ISRP 2005), while 26 dead eastern gray whales were found after the 1989 Exxon Valdez oil spill in Alaska (Loughlin 1994 in ISRP 2005).

Ingested petroleum hydrocarbons have been shown to be toxic to all mammals investigated to date. Research on oil spill impacts to bowhead whales shows that spilled oil may be associated with significant negative impacts to those whales' organ systems (NRC 2003b). Scientists believe benthic communities in the arctic and sub-arctic would likely be damaged by an oil spill. After the Exxon Valdez oil spill in Alaska in 1989, ecosystem impacts have been documented more thoroughly and over a longer time period than for previous spills and experiments. The 1989 spill caused significant acute-phase mortality as well as long-term effects. Oil persisted at least through 2001 when a study found over 55,000 kg of oil from the spill still present in sediments. The same study detailed corresponding impacts, including enhanced mortality of seabird and sea otter populations that interact with the sediments. Some populations' exposure to sublethal levels of petroleum also impacted the health of subsequent generations, as manifested in size, weight, and life span (Peterson 2003), because larvae and eggs may suffer damage disproportional to that of adults (AMAP 1998). A series of cascading effects has also been described in the years following the Exxon Valdez spill, caused by impacts to one population, which then changes its interactions with others (Peterson 2003).

15. **In-situ burning is a risk to human health**. Residents are concerned about the proposed use of in-situ burning in response to an oil spill in the Arctic, because of the potential for increased air pollution and respiratory impacts to people. The by-products of in-situ burning include air emissions and burn residue, and the process of burning creates heat at the air-water interface. All of these factors have potential environmental and ecological consequences. In-situ burning is distinguished from other spill response technologies by a number of factors, not least of which is the fact that burn operations yield a highly visible plume of dark smoke. This smoke plume presents a number of response challenges, from predicting the contents and movement of the plume to assessing and communicating the human health and environmental toxicity risks posed by in-situ burn emissions. A number of studies have been performed to assess the chemical content of oil fire emissions, including the smoke plume, particulate matter precipitating from the smoke plume, combustion gases, unburned hydrocarbons, organic compounds produced during the burning process, soot particles, and the residue that remains at the burn site (Fingas et al. 2001a). Beginning in 1991, a team of researchers from Environment Canada, the US Environmental Protection Agency, and the US Coast Guard conducted a series of over 45 mesoscale burns to analyze the contents of emissions and residues resulting from in-situ burning of crude oil and diesel. The researchers analyzed burn emissions and found the following components: particulates, poly-cyclic aromatic hydrocarbons (PAH), volatile organic compounds (VOC), dioxins and dibensofurans, carbonyls, carbon dioxide, carbon monoxide,

sulfur dioxide, and other gases, which all have human and ecosystem impacts. (More on this topic in #19, below)

16. **Icebreakers destroy polar bear habitat**. The use of icebreakers to keep the ice open for industrial operations and spill response activities destroys habitat needed by endangered polar bears to reach offshore ice. This is inconsistent with statewide standards for habitat protection and federal requirements for endangered species.

17. **Vessel traffic and icebreakers used to support oil spill response operations will disrupt subsistence**. Vessels uses for oil spill response and ice breaking will make noise, and scare subsistence animals, making it difficult or impossible for Inupiat hunters to feed their families. This is inconsistent with the NSB subsistence policies.

18. **In-Situ Burning Residue toxicity**. Shell has proposed extensive burning as a cleanup method, but has not estimated the amount of in-situ burning residue that would be left in the marine environment after a burn and the estimated affected marine area that would be contaminated by residue. Shell has not estimated the composition, toxicity and bioaccumulation characteristics of in-situ burning residue and what impact it would have on subsistence resources and habitat.

A burn residue remains following an in-situ burn. Just as individual oil types burn with differing efficiencies under different physical and environmental conditions (see above), in-situ burn residues also have differing characteristics and behaviors depending upon the chemical composition and physical properties of the parent oil, the state of weathering, and the oil slick thickness (Buist et al. 1997). Burn residues may either sink or float. The residues sink only after they have cooled. Models of coolingrates predict that burn residues will reach ambient water temperature in less than 5 minutes for 3 mm-thick residues, and in 20 to 30 minutes for 7 mm-thick residues (SL Ross 1998). Recent research indicates that residues from burns of thicker slicks of heavier crude oils (both fresh and weathered) are more likely to sink in fresh or saltwater, once they have cooled to ambient temperatures, in comparison to burn residues from lighter oils. Research also indicates that crude oil burn residues are generally denser than their parent oils and that residue density is related to the density of the parent oil, the state of weathering, and the slick thickness (Buist et al. 1997).

The issue of whether in-situ burn residues sink or float is salient to determining how to remove the residue from the environment, as well as to determining what resources may be impacted by the residue. If burn residue remains buoyant and it is practical to recover it before collecting and burning additional oil, the residue can be released to secondary containment booms. Whether recovered from secondary booms or the fire boom, the burn residue may be picked up with large strainers, nets, hand tools, viscous-oil sorbents, or standard viscous-oil skimmers; however, this is a very time and labor-intensive process. Efficiency of this method would probably be very low in the Arctic, especially in the presence of natural hazards such as ice.

Burn residues that sink to the bottom are far more difficult to recover. In 2002, the American Petroleum Institute (API) published a study that investigated the potential for residues to sink following an in-situ burn of spilled oil. In this study, the results of small-scale burning experiments were used to develop correlations to predict burn residue densities for specific oils. The researchers found that, of 100 international crude oils tested, about half of the residues would tend to float, and the other half would tend to sink in seawater once the residue cooled to ambient temperatures. Generally, the study found that oils with an API gravity of less than 32° are more likely to generate sinking residues (API 2002). Shell has not provided data on their anticipated oil composition, so the fate and effect of burn residues is hard to predict. But, either floating or sinking, burn residues would likely have an adverse impact on the marine environment and subsistence resources.

Physical properties of burn residues vary depending on burn efficiency and oil type. Efficient burns of heavy crude oils generate brittle, solid residues, while residues from efficient burns of other crude oils are described as semi-solid. Inefficient burns generate mixtures of unburned oil, burned residues, and soot that is sticky, taffy-like, or semi-liquid (NOAA 2002). Floating residues can be stranded much as floating oil slicks along shorelines or other coastal features; however, due to their thick consistency, residues can be difficult to remove using conventional shoreline response technologies. Floating residues may also be ingested by fish, birds, and marine mammals and can foul gills, feathers, fur, or baleen (Shigenaka and Barnea 1993).

Sunken residues can threaten benthic communities and can foul submerged fishing gear, adversely impacting resources that would not otherwise be affected by an oil spill at the water surface. Also, they may be ingested by benthic feeding organisms, including fish, shellfish, or marine mammals. During the Haven spill in Italy in 1991, approximately 102,000 tonnes of oil was burned. The residues sank and were distributed over an area of the seabed approximately 140 square kilometres in size. These residues adversely affected local trawl fisheries because the fishermen feared they would foul their gear (Martinelli et al. 1995).

The ITOPF cites one example of an in-situ burn where the residue tainted fishing grounds (2002): "In the response to the spill from the Honam Jade (South Korea, 1983) crude oil was deliberately ignited. As a result, a dense residue formed which sank and seriously contaminated shellfish beds. When oil does sink to the sea bed and cause problems, the scope for recovering it is limited."

19. **Alaska Clean Seas personnel and equipment availability for incremental Shell project.** Shell has not provided any information on how ACS will respond to the incremental personnel and equipment demands for the Shell Offshore Program, in addition to its existing obligations for all North Slope projects. ACS keeps adding companies and expanding its geographic coverage without evaluating how thinly its resources are being stretched. While state law does not require a single operator to plan for multiple catastrophic spills, state law does require the state to examine the risk of multiple catastrophic spills in a region. The NSB is concerned that ACS's personnel and equipment are not adequate to cover the additional responsibility of exploratory drilling as far east as Camden Bay.

The NSB notes and supports the following improvements that have been made to the ODPCP:

1. **Sensitive Area Protection**: Considerable improvements were made to identify sensitive areas and develop protection strategies.

2. **Fuel Transfer**: Fuel transfer procedures were improved.

3. **Ice**: Recognition that there will be ice encountered in the August – October timeframe.

Coastal Zone Management Act Information (Section 15)

As required by MMS regulations (30 CFR 250.226), an outer continental shelf (OCS)exploration plan (EP) must include specific information demonstrating consistency of the proposed project with the enforceable policies of a state's coastal management program, in this case, the Alaska Coastal Management Program (ACMP) (see 15 CFR 930.76(a), 15 CFR 930.58(a)(2)). Because the Borough does not have an approved Coastal Management Plan at this time, the applicable ACMP enforceable policies include only statewide ACMP standards outlined in 11 AAC 112. Shell's consistency analysis is provided on pages 115 - 142 of Shell's EP.

The Borough agrees with the August 24, 2009 letter to Shell from the Alaska Division of Coastal and Ocean Management (DCOM) that found additional clarification is needed in Shell's consistency evaluation. In addition to the specific issues identified in that letter, the Borough requests that Shell review requirements in 15 CFR 930.58(a)(3) to ensure the evaluation adequately explains how project activities, including associated facilities, are consistent with each of the applicable statewide standards. For many of the standards, the analyses on pages 115

- 142 of Shell's EP do not provide adequate detail. Specific measures that Shell will take/has taken to ensure consistency with each of the ACMP standards need to be provided. In addition to a thorough discussion of such measures, references to the applicable pages of the EP will direct reviewers to more detailed discussions of the measures.

Revisions to the consistency analysis should also address the possibility that exploration activities might extend into November, as is stated in section 1.6.3 of the Oil Discharge Prevention and Contingency Plan.

While the Borough will provide detailed comments on Shell's consistency evaluation after initiation of the state's ACMP consistency review, the following page-specific remarks provide some general comments on the consistency evaluation:

Page 111, Response to Coastal Development standard: This response does not adequately address how the project meets subsections (a) and (b) of the standard.

Page 112, Response to the Natural Hazards standard: Significant hazards exist in the project area. In anticipation of a request to designate natural hazard areas for the ACMP review of this project, Shell should consult the natural hazards section of the North Slope Borough's draft coastal management plan before revising this section. The most recent draft is available at: http://alaskacoast.state.ak.us/District/FinalFinalPlans/NorthSlope.htm

Page 113, Response to the Coastal Access standard: The response to this standard should be revised to address potential impacts to subsistence access by project activities in federal and state waters, including associated facilities (i.e. support vessels).

Pages 114 – 116, Response to Energy Facilities standard: The Borough has no general comments on this section at this time. Additional comments may be made during the ACMP consistency review.

Pages 117 – 116, Response to Subsistence standard: This response should include a description (an inventory) of all subsistence activities occurring in the vicinity of the project area and/or areas coincident to any of Shell's associated activities for this project. The Borough may make additional comments on this section during the ACMP consistency review related to a request for designation of subsistence use areas.

Page 121, Response to Transportation Routes and Facilities standard: This response should be amended to include more details about appropriate mitigation measures to meet this standard, including project activities in state and federal waters.

Pages 122 – 125, Response to the Habitats standard: This response should be amended to include all project activities, including activities in state and federal waters. Specific mitigation measures should be described.

Page 125, Response to Air, Land and Water Quality standard: This section states that no response is required. Federal regulations, however, require that the evaluation include findings relating to the coastal effects of the proposal and its associated facilities to the enforceable policies of the state coastal management program (15 CFR 930.58(a)(3)). Regardless of the "Department of Environmental Conservation carve out," the Air, Land and Water Quality standard is an enforceable policy of the ACMP, and a consistency response for this standard is required.

Page 125 – 126, Response to Historic, Prehistoric and Archaeological Resources standard. The Borough has no general comments on this section at this time. Additional comments may be made during the ACMP consistency review.

Appendix H: Environmental Impact Analysis

Section 3.12.1 Coastal Zone Management Programs

Page 188, Para. 1: The characterization of the CZMA and the ACMA is inaccurate. The CZMA provides for shared management of coastal areas between states and the federal government. The ACMA goes one step further by creating a partnership between the State of Alaska and its coastal districts to manage coastal resources and uses.

Page 188, Para. 2: The statement in sentence 4 states that the proposed NSB enforceable policies "were approved with recommended amendments." In fact, 26 of the 31 proposed policies were disapproved in their entirety, and the 5 policies approved in part would have significantly restricted their effectiveness.

Page 188, Para. 3: The second sentence states that "The geographic location of the project determines if the district standards need to be addressed in addition to the state standards for consistency determination" (emphasis added). This statement is incorrect, because the application of enforceable policies of a state program (including both approved coastal district policies and statewide standards) is dependent on effects to coastal uses and resources regardless of the geographic location of the activity.

Page 188, Para. 3: The third through fifth paragraphs need to be amended to recognize that the consistency evaluation must include a description of impacts from activities related to project activities, including associated facilities. 15 CFR 930.76 requires OCS plan applicants to submit data and information required pursuant to 15 CFR 930.58 which requires a set of findings (i.e., the consistency evaluation) "relating the coastal effects of the proposal and its associated facilities to the relevant enforceable policies of the management program." In other words, activities in the state's coastal zone, including the staging and transport of personnel and supplies, are subject to the ACMP consistency response and therefore must be addressed in the consistency evaluation. Associated facilities are defined in 15 CFR 930.11(d).

Page 189, Para. 3: The third sentence should be revised to clarify that the 50-day timeline for determination of consistency begins when the consistency certification and necessary data and information is received. In other words, the commencement of the state's review is dependent on more than just receipt of the consistency evaluation (15 CFR 930.77(a)(a)).

Page 189, Para. 3: The end of this paragraph identifies two situations where a review schedule can be modified. It should be amended to note that there are additional occasions where a schedule can be modified as identified in 11 AAC 110.430 and 11 AAC 110.270(a).

Planning

General

MMS deemed Shell's EP submitted despite multiple instances where Shell provided incomplete information regarding details that are needed in order to fully understand and evaluate the exact protocols Shell proposes to employ as part of its drilling operations. In some places the argument is made that additional, detailed information will be available at some later stage, for example regarding the very generalized Critical Operations & Curtailment procedures (COCP) and Ice-Management Plans (IMP) (Attachments 9.0-1 and 9.0-2, Pg. 54-62) that are provided, with accompanying language that "detailed COCP and IMP's will be submitted with Applications for Permit to Drill (APDs) before drilling."

Ice Management

Pg. 44 (60 of 1260) of Shell's EP reads: *"Shell's IMP relies heavily on the observations and experience of its Ice Specialists and Ice Advisors, a group of arctic-seasoned mariners whose sole duty is to provide critical information and advise drilling vessel supervisors and the drilling vessel master about any and all ice-related threats. These observers and advisors will be* *stationed on the drillship, the ice management vessel and the anchor handler."* All previous comments NSB has made regarding the inabilities and difficulties for marine mammal observers to see marine mammals from aboard a given vessel conducting seismic operations apply here. We expect that significant visual handicaps will exist—not only during periods of adverse weather and at night, but also simply because ice can be hard to see from the angle provided while onboard a vessel and the majority of a given iceberg is subsurface. Shell should be working with experts in the field of remote sensing using satellite- and other advanced methodologies in addition to requiring manual observation from the vessels;

On Pg. 87 of Shell's EP (Pg. 103 of 1260) and again on Pg. 119 (135 of 1260) it is stated that "*Ice management will involve preferentially "redirecting, rather than breaking, ice floes while the floes are well away from the drill site.*" However there is no further discussion or references to unequivocally verify that this is feasible and practical given the specific equipment Shell plans to have available in Camden Bay. In order to make this case, Shell should provide, (i) analyses of the expected relative frequency distribution of different sized floes of both first-year and multi-year ice that might be encountered in Camden Bay during the drilling season, (ii) maps and descriptions of the expected prevailing winds and currents to which these floes would be subject, and (iii) documentation showing that the specific fleet of vessels Shell plans to have in Camden Bay are capable of "shoving" the expected sized floes of first-year and multi-year ice out of the way. Obviously such analyses need to demonstrate not only the ability to "manage:" the expected inventory of ice, but also, to "manage" said ice against the countervailing propulsion of currents and winds.

Toxic materials in the proposed discharge streams

- In the table of components that may be added to drilling fluids on Pg. 34 of Shell's EIA (Pg. 752 of 1260) are "*40,000 Lbs of Partially hydrolyzed polyacrylamide*." Polyacrylamide is a very toxic neurotoxin. Please demonstrate whether the discharge of polyacrylamide is contemplated in the Arctic General Permit.

Calculation of Acoustic discharges to the marine environment

- Pg. 37 of Shell's EIA (755 of 1260) states that "*Helicopters will be used for air support and crew changes. The level and duration of sound received underwater from helicopters depends on altitude and water depth. Received sound level decreases with increasing altitude. At an altitude of 1,000 ft (305 m) there were no measured sound levels in water depth of 121 ft (37 m) (Richardson et al.1989, citing Green 1985).*" There is a significant problem with this logic and analysis, and that is that it assumes vulnerable species exist only at the bottom of a sea that's 121 feet deep. Shell needs to provide data from a more appropriate calculation that assumes the species of concern are at or just below the surface—not at a depth of 121 feet.

Conclusion

Thank you for considering our comments. It is our hope that the planning process associated with this action will depart from that of the past administration. We look to MMS and the Department of Interior to adopt a cooperative, responsible, scientifically-driven and comprehensive approach that takes into account the significant and disproportionate impacts of Arctic OCS development on our residents. For more than thirty years, our people have borne the risks and felt the impacts, while receiving little of the benefits of the Arctic OCS oil and gas program. As these proposals continue, we are increasingly overwhelmed and exhausted by these efforts to develop the resources of our ocean garden.

With this in mind, the time is right to be cautious in an environment that is clearly in flux. The more we learn about Arctic waters, the more it seems we do not know. As fast as data can be gathered, it makes clear that conditions are changing quickly and unpredictably. No one, including our residents who will be most impacted by the decisions MMS makes, expects those decisions to be made in an environment of absolute certainty. We do expect, however, that the highest standards possible be applied and that the decisions made concerning our waters and the future of our people be based on better information and analysis than is contained in Shell's 2010 Camden Bay Exploration Plan.

We look forward to working with Shell, MMS and its sister agencies to collect the proper information, and to pursue a detailed environmental impact statement for this proposed exploration activity.

If you have any questions, feel free to contact my office.

Sincerely,

Edward S. Itta
Mayor

Attachments:

Marked as attachments A-Q.

cc:

Bessie O'Rourke, NSB Attorney
Taqulik Hepa, NSB Director Department of Wildlife Management
Dan Forster, NSB Director Department of Planning & Community Services
Karla Kolash, NSB Mayor's Office
Andy Mack, NSB Mayor's Office
Jeffrey Walker, Minerals Management Servic
Don Perrin, ADNR

NSB - Exploration Plan Review

Shell Offshore Inc. - 2010 Outer Continental Shelf Lease Exploration Plan - Camden Bay, Alaska

Regulation Section	Regulatory Information	EP Section	Additional Infor. §250.201(b) (Yes/No)	Limiting Information §250.201(c) (Yes/No)	Complete as Submitted (Yes/No)	Recommendation (X)	Commenter	Page	Paragraph	Sentence	Identified Problems; Deficiencies; Recommendations
Attachment Commun. and Consultation with N Slope Subsistence Stakeholders (Barrow POC comments)		Attachment B									Page 7 of testimony: Shell's answers to the first two questions are inaccurate. Current research conducted by the NSB-DWM and NEOUCOM have shown that bowheads have more than "little or no sense of smell", as well as taste sensory modalities. Below this comment, a comment is made about the NSB Science Advisory Committee stated that the discharged muds and cuttings would not harm the environment, marine mammals or local communities. This is a false statement. This subject has not been subject to a full SAC review and has only received a cursory and poorly aimed review by one person that was asked by the SAC to answer a specific question. The NSB was not satisfied with the breadth of the answer supplied, as it did not answer many of the concerns brought up by the community.
		Appendix H						6	2	last	Will Shell submit to inspection/pilotage by Alaska Marine Pilots?
		Appendix H 2.3.1						30	2	last	The NSB finds the discharge of cuttings and muds unacceptable. The plan for discharge of extra unused muds into the sea at the end of the operation shows flagrant disregard to subsistence community concerns and the wishes of the NSB.
		Appendix H Table 2.3.2-3						34			What will 10,000 lbs of biocide will do to the environment? There is no indication that this has been investigated and details are needed. The amount of barite that is planned to be discharged into the local area (over 2 million lbs) is astounding.
		Appendix H Table 3.2.4-1						60			While this table is somewhat helpful, the lack of standard deviations/error data is unfortunate, especially in the case of Hammerhead, where only 10 samples were collected. This makes it impossible/near impossible to determine the appropriateness of the sample size and the variability in the data.
		Appendix H Persis.						61			Shell has failed to present any data in the section beyond a cursory explanation of what POPs are. I recommend striking this or adding some actual information on the presence of POPs in the exploration area. If

		Organic Poll.									Shell doesn't have these data, a statement to that effect would be appropriate.
		Appendix H/ Sound Generation /Marine mammals						36/ 116			There is a deficiency in information related to sound generated by icebreakers in both this EP and the Shell IHA. Both bubbler system noise and propeller cavitation noise have been shown to have effects on beluga whales in both near and offshore environments. Masking and potential direct physiological impacts have been modeled within range (35-78 km) of the icebreaker investigated (Erbe and Farmer, J. Acoust. Soc. Amer, 108, 2000). Additionally, this noise has the potential to be ADDITIVE with other environmental noise, which again, required an analysis of cumulative effects. These things need to be considered in this EP.
		Appendix H Marine Mammals						106			Harbor porpoise are being seen in greater numbers each year and, as far as the NSB-DWM is aware, their numbers have not been quantified, to say they are rare in the Beaufort is inaccurate, as data to support this statement do not exist.
		Appendix H Marine mammals (spotted seals)						112	1	1	Shell is underestimating both the importance of the spotted seal as a subsistence resource, as well as the likelihood of their presence in the exploration area. The numbers in the sightings chart seem quite low and do not parallel what I know about subsistence kills of these animals. What kind of effort was exerted at what time of year? There are many MMO observations of "unidentified seals". Shell needs to consider the possibility of these being spotted seals.
		Appendix H Marine Mammals (gray whales)						119	1	1	A person that has participated in several years of aerial surveys in the Beaufort Sea stated at the 2009 IWC meeting that in 2006 "up to 100" gray whale carcasses were seen in the Beaufort, in and around the Deadhorse region. This would lead one to believe that gray whales are present in more than "small numbers" in the Beaufort.
		Appendix H Marine mammals (walrus)						122	1	1	The NSB is receiving more and more reports of walrus in the Beaufort and is concerned that changes in sea ice are leading to changes in distribution. This is an unknown at this time.
		Appendix H End. Spp. Humpback whale distribution						129	1	1	It is worth mentioning here that range may be changing as climate variability increases. This species may become more and more common (more were noted in 2009) and this concept is not conveyed in this section.

		Appendix H End. Spp. Bowheads						130	1	1	Shell's proposed mitigation is ineffective out to the120 if aerial surveys are not used. Cow-calf pairs are not being sufficiently protected.
		Appendix H End. Spp. Polar Bears						135 - 138	all	all	This section provides little information on what the impact of these exploration activities will have on this species. It only provides basic biological information.
		Appendix H 3.11.9						186	2	1	It is worth noting that as marine mammal resources become less predictable (i.e., walrus distribution), many villages are being forced to fall rely more heavily on fish-based subsistence resources. This is variable from year to year.
		Appendix H Phytoplankton Analysis of Impact of Drill Cuttings and Drilling Mud Discharges						230	1	2	"Discharges could potentially impact phytoplankton by generating suspended sediments in the water column. However, short-term increases in turbidity and suspended sediments are not expected to have negative effects on phytoplankton near the proposed drill sites" This statement makes little sense, as the first part states there will be impacts while the second part says that there will not. If this is a chronic vs. acute issue, please state. Otherwise, this comment needs clarification.
		Appendix H Analysis of Impact of Small Liquid Hydrocarbon Spill						231	all		There are numerous claims made in this paragraph with almost no supporting data/citations. These need to be included to validate statements such as "The impacts of a small spill on phytoplankton are expected to be negligible and similar between the Sivulliq and Torpedo prospects."
		Appendix H						244	last		It should be made clear that proposed acoustic monitoring has not been assessed for efficacy and may be of limited use in "real time". In this case, deflection will only be measureable after the fact, when data is summarized and analyzed. This is often months later.
		Appendix H Marine						243	last		It is unacceptable for Shell to avoid analyzing the effects of a large spill by saying that they feel it is unforeseeable. This should be a requirement no matter how low the chances may have been calculated as.

		mammals									
		Appendix H Marine mammals						244	3	all	The 4MP, with its current proposed plan of monitoring (i.e., the unclear use of aerial monitoring) may not fully protect marine mammals and therefore it is unclear if it fulfills the requirements of these agencies. More details are needed to be able to assess efficacy. See comments from the NSB's comments on the Shell IHA.
		Appendix H						246	1	1	This lack of disturbance is highly likely to be dependent on what the seal's behavior was in the first place. Blanket statements such as this should not be taken from this work, as a seal pupping or resting on ice is likely to react very differently to an ice breaker than a seal swimming in open water later in the year.
		Appendix H Analysis of Impact of Vessel traffic						245	4		It should be noted that gray whales have been known to *approach* vessels and rigs making noise in their habitat. This could be a complicating factor (MMS website: "Although gray whales seem to ignore most low-amplitude vessel sounds, avoidance and approach responses have been observed in field studies."). There is far more useful, published information on gray whale noise reaction that has been included here.
		Appendix H Analysis of Impact of Vessel Traffic						245	all		Nowhere in this section of the document is there any concern about the potential for this noise to mask intraspecific communication in gray whales.
		Appendix H Analysis of impacts of drill cuttings and muds						248 - 250	all		Neither cumulative effects of discharges from multiple wells, nor the effects of bioaccumulation are considered here.
		Appendix H Analysis of Impact of Other Permitted Discharge						250			"The impact of other NPDES permitted discharges will be negligible and temporary". Shell does not have the data to back up this statement and is remiss in ignoring concerns about deflection of marine mammals by sediment plumes and discharge wastes with smells and tastes.

		s									
		Appendix H Analysis of Impact of Small Liquid Hydrocarbon Spill						251	all		"Petroleum residues can be stored in lipids inside the body, but there has been no evidence of resulting metabolic or physiologic effects." There are numerous studies, many carried out by the OWCN that show effects. Once ingested, oil can cause direct injury to the gastrointestinal tract, which can impair the ability to digest and absorb food, having a serious metabolic and physiologic effect on a marine mammal. Metabolism of absorbed oil components by the kidney and liver can cause extensive damage to those organs as well. Reproductive effects have also been documented.
		Appendix H Analysis of Impact of Project Activities on Community Health						298	1	last	Will this work take into account the cumulative effects of multiple industry projects being developed near these communities at one time?
		Appendix H Analysis of Health Impact of Permitted Discharges						299		1	This is true when one or two wells are considered. Shell has projected that this area could be "the next Gulf of Mexico" (R. Fox). How does this scenario change with 10-100 wells discharging these materials? No one has tackled this analysis sufficiently, including Shell.
		Appendix H Analysis of Impact of Liquid Hydrocarbon Spill						299	1	1-2	Shell should be responsible for performing this analysis, even if they find this to be a remote possibility. Human error is always a possibility, and when tankers carrying large amounts of fuel are involved in operations, you must consider the possibility of a large spill. Shell also needs to consider not only the direct effects of a spill, but the effects of perceived contamination of subsistence foods after something such as this happens.
		Appendix H Analysis of Project Activities on						300	1	all	This makes little sense in context of what has been previously presented (which showed impacts to the areas/hunts of NUI and KAK to be most likely). Just based on geographical location, if a spill or other negative event were to occur, these two communities would be far more greatly affected than the other NSB villages.

		Minority and Lower Income Groups									

Regulation Section	Regulatory Information	EP Section	Additional Infor. §250.201(b) (Yes/No)	Limiting Information §250.201(c) (Yes/No)	Complete as Submitted (Yes/No)	Recommendation (X)	Commenter	Page	Paragraph	Sentence	Identified Problems; Deficiencies; Recommendations
		10.0						76	1st	2nd after bullets	"Any impacts to whales and seals would be temporary and result in only short-term displacement of seals and whales from within ensonified zones…" This statement is not supported by data. There is very little information about the long-term efforts or the significance of displacement of whales and seals from migratory routes. The statement is Shell's opinion but no studies are referenced to support that opinion.
		10.0						76	1st	3rd after bullets	Shell suggests that the 160 dB zone is the area of influence where behavioral impacts to migrating bowheads would occur. This assumption does not use the best available science. Traditional knowledge and western science have both shown that migrating bowheads can be very sensitive to anthropogenic sounds, at least as low as 120 dB. Assessing exposures and impacts to whales that might be exposed to 120 dB is necessary.
		10.0						77	2nd	1st	Shell states that their marine surveys for site clearance work have not identified "any biological populations or habitats that may require additional protection." While this statement is true, it must be clarified that their surveys would only identify unique habitats such as the boulder patch or some other seafloor habitat. Other unique habitats would likely not be identified using sonar or similar types of marine surveys.
		12.0				X		85	2nd bullet	1st	Beginning drilling on 10 July will require that the drill ship, icebreakers and other support ships will need to transit through the Chukchi Sea in late June or early July. This could create a problem for beluga hunters at Point Lay and Wainwright, where beluga hunting occurs in late June through the middle of July. Sometimes beluga hunting at Wainwright occurs in early August. To ensure the beluga hunt at Point Lay is not impacted by Shell's activities, Shell should not transit through the Chukchi Sea until 15 July or once the hunt is completed. Recent satellite tagging data (NSB, unpublished data), shows that belugas are using offshore areas in the Chukchi Sea in May and June before moving

											to nearshore areas where the hunt occurs. Therefore, Shell's vessels in offshore areas could cause belugas to alter their movement patterns and negatively influence the hunt.
		12.0				X		85	5th bullet	1st	What are the implications of recycling drilling muds? How much does this reduce discharge of muds? Continuing onto page 86, Shell states that they suspect they will have 1500 bbl of excess water based muds that they want to dump into the Beaufort Sea before demobing. Why would excess muds be dumped? Shell should be required to haul those muds off site. They should not be dumped into the Beaufort Sea.
		12.0			X			86	3rd bullet, Mar. Mam.	2nd	Shell should not operate its aircraft in the vicinity of subsistence hunters. Even flying at 1500 agl could disrupt the hunt.
		12.0			X			86-87	Last bullet on 86		Transiting the drillship and support vessels through the Chukchi Sea could create safety issues for the Chukchi Sea villages. If hunts are disrupted, the villages may not have the necessary healthy food for its residents. Thus, for the safety of Shell employees and the villages, the transit should not occur in June or early July. Beluga, seal and walrus hunts should be allowed to occur before the transit of Shell's vessels, especially if icebreaking is needed. Shell states that they will notify communities if they have to change their transit route through the Chukchi Sea. It is not clear what this will accomplish? Is Shell proposing some type of mitigation measure that will be initiated if they have to call the villages about a change in transit routes?
		12.0						87	4th bullet		Shell should provide more details about what is included in its "critical operations".
		12.0						87	Last sect.		How will Shell ensure that no takes of Steller's or Spectacled eiders will occur?
		13.0						91	1st	3rd	Shell proposes to use the *Affinity* to store liquid commodities that the *Discoverer* will use during drilling operations. The *Discoverer* will also be loaded with liquids for drilling. If the two ships can be used to store liquids to be used during drilling, then certainly they could be used to store liquids that might otherwise be discharged into the Beaufort Sea. To help achieve zero discharge, Shell should use the *Affinity* and the *Discoverer* to store liquid wastes.
		13.0			X			91	3rd	1st	Shell states they expect to fly their aerial surveys for 4 hr/day for 4 days/week. In the monitoring plan (Appendix J), Shell states they will

											fly every day when drilling is occurring. There is a discrepancy here. Shell should plan on flying every day.
		13.0			X			91	Sec. C. 2nd para.	1st	Shell's "West Dock Supply Vessel may make several resupply runs to and from West Dock". It is not clear what these resupply runs will entail. One could assume that the vessel will be transporting discharge back to West Dock since this sentence is in the "Drilling Fluids and Chemical Products Transportation" section. Shell should use the resupply vessel to help achieve zero discharge. Materials slated for discharge from the drilling vessel should instead be transported back to West Dock for disposal onshore.
		13.0			X			91	Sec. D. 1st para	2nd	Shell plans to use a lightering barge to transport waste streams that cannot be dumped overboard. Shell should use this same lightering barge to transport as much discharge as possible back to shore to help achieve zero discharge. It appears that only 1000 bbl or so of non-dischargeable material will need to be transported back to West Dock over the course of the summer. The West Dock supply vessel is 134 feet long. It seems that this vessel could handle much more than 1000 bbl of discharge over the course of the summer.
		Appen. B, 3.1.1.			X			6	2nd bullet		As mentioned previously, Shell should not discharge unused drilling muds. They should not be dumped in the Beaufort Sea but should be recycled by Shell for another drilling operation or reinjected into an onshore disposal well.
		3.1.2			X			6	1st in sec.	1st	Using MMOs to "ensure that drilling and support vessel activities do not disturb marine mammal resources" is not a reasonable statement. In Shell's previous work, they have shown that MMOs are not able to see the entire zones where marine mammals may be disturbed. This is especially true for bowheads. MMOs are not able to mitigate impacts to marine mammals because they cannot see the entire disturbance zones in good viewing conditions and the situation is even more difficult during inclement weather and darkness, such as would occur in late Aug., Sep. and Oct.
		3.1.2			X			6-7	Last para on Pg. 6	Overlapping sentence	Shell suggests that a marine mammal approaching the drillship will not be regarded as harassed and Shell's activities will continue. Given that Shell intends to discharge a considerable amount of waste into the Beaufort Sea, their suggestion is not reasonable. An approaching marine mammal could be exposed to high concentrations of discharge. This could result in risk to the health of marine mammals. If a marine mammal approaches the drill ship, discharge should be discontinued, if Shell is given permission to discharge at all.

		3.1.2			X			7	5th bullet		Vessel speed should also be reduced during darkness, which will occur in Aug., Sep., and Oct.
		3.2						9	3rd bullet	1st	Shell states that sound modeling will occur for vessels used for seismic. This statement is confusing since the EP is for drilling. Clarification is needed.
		Appen. E									It should be noted that Shell's IHA application for 2010 has not yet been approved by NMFS. The application has not yet been published in the Fed. Reg.
		Appen. E						27	3rd		Shell has been very selective of its use of reference material. For example (from LGL and Greeneridge 1987), Shell does not mention that no bowheads were detected closer than 6 miles from the drillship in 1986 at Hammerhead (essentially the same location as Sivulliq). Further, few were seen closer than 9 miles. Estimated received levels at 9 miles were 105 to 130 dB. From Brewer et al. (1993), whales began deflecting 19 miles away from the drillship at Kuvlum (near Sivulliq) in 1992. In 1993 at Kuvlum, whales were nearly excluded from an area within 12 miles of the drilling platform (Davies 1997, Hall et al. 1994). These studies show that impacts to bowheads from drilling operations could be substantial. This is especially concerning, given that the two drill sites are well within the autumn bowhead migratory corridor and many whales could be exposed to industrial sounds.
		Appen. H. Env. Impact Analysis									The environmental impact analysis did not include a thorough analysis of the most recent and best available science. Many of the references are to previous NEPA documents or past summary documents put out by an agency. This is troubling because MMS has invested a great amount of public funding to help fill data gaps, yet many of the recent studies, including those published in peer review journals, were not referenced in the analysis. Below, are a few of many examples.
		Appen. H. Env. Impact Analysis						89	Sec. 3.6		Shell fails to acknowledge that 100,000s of migrating eiders will move through their project area. This involves most of the Pacific population of King and Common eiders in North America.
		Appen. H. Env. Impact Analysis						89	Sec. 3.6, 4th para	Last sentence	"Exploration activities will occur during a time period when there will be few birds near the project area." This statement is false. As mentioned above, 100,000s of migrating eiders will occur in the project area from July through Oct. There is a chance that these migrating eiders could strike the drill ship or support vessels. Furthermore, many birds could be impacted in the event of an oil spill. It is not clear how Shell's other proposed discharges might impact migrating eiders.

		Appen. H. Env. Impact Analysis						89	Sec. 3.6		MMS funded numerous King Eider studies over the past 8 to 10 years. Those include satellite tracking of eiders to collect information about use of the Beaufort and Chukchi seas. Many of these studies were published but are not used in the impact analysis and should have been. The references include: Phillips et al. 2006, 2007, Phillips and Powell 2006, Oppel et al. 2009, Powell et al. 2005, etc.
		Appen. H. Env. Impact Analysis						90	6th	1st	Short-tailed Shearwaters are not alcids. Shearwaters belong to the family of seabirds known as tubenoses (Procellarids). Their distribution, life history and vulnerabilities are completely different from alcids. This section needs to be revised with accurate information. Also, Shell does not mention that Horned Puffins (an alcid) also occurs in the project area.
		Appen. H. Env. Impact Analysis						106	Sec. 3.7, last para		Shell should indicate that harbor porpoise are one of the most common cetaceans seen during their aerial surveys in the Chukchi Sea. The number of sightings is larger than previous aerial surveys is likely due to climate change. Therefore, harbor porpoises could occur in the project area and should be evaluated for impacts from drilling operations or transit of vessels to the Beaufort Sea.
		Appen. H. Env. Impact Analysis						112	1st	1st	Shell suggests that spotted seals would most likely not occur in the project area. Shell's fails to mention that there are several spotted seal haulouts along the Beaufort Sea coast, including the Colville River delta. Also, spotted seals are taken in Kaktovik, east of the project area, sometimes in relatively large numbers (Fuller and George 1997). Therefore, many spotted seals must have migrated through the project area in order to get to Kaktovik. This section does not include the best available information and needs to be revised.
		Appen. H. Env. Impact Analysis						116	Beluga whale		As with most of the other marine mammal sections, Shell references NMFS's stock assessment reports. This is not sufficient for an impact analysis for the project Shell is proposing. The original literature will have much more detailed and pertinent information that is essential for impact analysis.
		Appen. H. Env. Impact Analysis						116	5th	4th	Shell states that "few belugas remain in the central Beaufort Sea in the summer" and references (BPXA 2004). The most recent published literature, a MMS report (Suydam et al. 2005, OCS Study MMS 2005-035) shows that many Chukchi Sea belugas inhabit the shelf break of the Beaufort Sea in the summer. This section and analysis needs to be revised.
		Appen. H. Env. Impact						117	last	2nd	Shell states that no belugas were seen by MMOs onboard Shell's vessels. The lack of observations by MMOs provides little useful information about belugas because belugas appear to be very sensitive

		Analysis									to anthropogenic sounds.
		Appen. H. Env. Impact Analysis						130	Bow head whal es	2nd	Shell states that their operations "have proven effective in …avoiding impacts to bowhead whales". From reading Shell's reports, it is difficult to find the information that was used to support this statement. Whales appeared to be deflected or their calling rate changed during seismic activities. Shell has not provided evidence for how long whales may have been impacted. Additionally, several dead bowheads were found floating in the Beaufort and Chukchi seas in the past several years with evidence of possible ship strikes. Those carcasses were never thoroughly examined. If Shell is going to make such over arching statements as the one above, details are needed to support them. The impact analysis of impacts to bowheads is not sufficient; More detailed information is needed.
		Appen. H. Env. Impact Analysis						130	Last para.		There are additional references about bowhead use of the Beaufort Sea. Some of these references point out that Camden Bay is a feeding area for bowheads (Moore et al. 1989, Rep. int. Whal. Commn.). Also, whaling captains from Nuiqsut have stated that Camden Bay is a feeding and resting area for bowhead mothers and calves. This information is vitally important for decision makers, agencies, and the public in evaluating the impact statement and Shell's proposed activities. Because Camden Bay is an important feeding area for bowheads, a much more thorough review and analysis of impacts is needed above and beyond what Shell has provided.
		Appen. H. Env. Impact Analysis						131			Growing scientific evidence shows that bowheads are remaining in the Alaskan Beaufort and Chukchi seas during the summer months. Recent satellite tracking (L. Quakenbush, ADFG, unpublished data) included several whales in the Beaufort Sea during July and early August. Hunters also report seeing large whales north of Barrow throughout the summer. Thus, there are potential impacts to bowhead whales from summer drilling before what is considered the traditional migratory time for bowheads. This is another example of where Shell's impact analysis is insufficient. Additional analyses are needed about impacts from vessel transit, noise produced during drilling in July and August, and discharge during July and August.
		Appen. H. Env. Impact Analysis						134	Map		This map is a good illustration of the potential impacts to bowhead whales. The map shows whales sighted during autumn migration from surveys conducted through the BWASP program. Shell's two proposed well locations are situated near the middle of the migratory route, which could cause substantial deflection. Previous studies of impacts from

											drilling ships, with and without ice management, have shown substantial exclusion of whales from within 6 to 12 miles of the drill rig and deflection occurring before that, at least as far as 19 miles from the drill rig (LGL and Greeneridge 1987, Brewer et al. 1993, Davies 1997, Hall et al. 1994).
		Appen. H. Env. Impact Analysis						141	Map		This map shows the distribution and relative abundance of Steller's Eiders on the North Slope. Unfortunately, the map is not very helpful because it just shows relative densities instead of actual densities. For example, the area around Barrow is where most Steller's Eiders are seen and very few are observed consistently in other locations on the North Slope. Other waterfowl maps also show relative densities. These maps do not help decision makers because it is not clear how many birds might be impacted by Shell's activities near shore or along the coast. The maps should be redone to provide the appropriate information needed for those evaluating impacts from Shell's activities, especially those potential impacts to listed species.
		Appen. H. Env. Impact Analysis						171	Penu ltima te para.		This paragraph does not mention caribou hunting as an important subsistence activity. Shell does mention caribou hunting later in the section, but if someone were going to just read the introduction to this section, that important subsistence activity would be missed. The impact analysis needs to be more thorough and complete than what Shell has presented.
		Appen. H. Env. Impact Analysis						177	2nd		Shell does not use the most up to date information. The NSB has published several reports on the subsistence harvest of Kaktovik and other North Slope villages (i.e. Fuller and George 1997). These reports have been provided to Shell but are not included in the impact analysis. Because of the potential for Shell to impact subsistence harvests of marine mammals and other resources, the most recent and best information must be included in any impact analysis.
		Appen. H. Env. Impact Analysis						177	Last para.	1st	Shell states that 1000 edible pounds are obtained from a harvested beluga. Where did this information come from? There is no reference. The number may be correct, but it cannot be verified without a reference.
		Appen. H. Env. Impact Analysis						210 & 212	3rd & Tabl e 4.1.7 -1		Shell provides only cursory analyses of potential impacts from cooling water discharges to various biological resources. Shell is proposing to discharge 45,000 bbl of cooling water into the Beaufort Sea every day of drilling. There may be substantial impacts to the organisms that live near the drill location or bowheads or other marine mammals could be diverted away from the warmer water produced from the drilling rig. Impacts from cooling water need to be carefully considered. Additional

											analyses are needed.
		Appen. H. Env. Impact Analysis						222, 223			These figures suggest that muds and cuttings will only be deposited to a depth of ~1 cm near the drill rig. Given the amount of muds and cuttings that Shell is planning to discharge, it seems likely that the thickness will be considerably deeper. The information provided by Shell about the depth of discharge deposits should be checked carefully.
		Appen. H. Env. Impact Analysis						243	Last 2 para.		Shell states that its activities "could cause some temporary avoidance of the immediate area of a vessel by marine mammals but these effects would be minor, short term and localized" and impacts from small spills "would be limited to a biologically insignificant proportion of the total population" of bowheads. Shell does not have data to support these statements. We do not know the duration of impacts, whether temporary or long-term. Nor do we know the biological significance of impacts. Shell's monitoring program may not be designed sufficiently to document the duration of impacts or the biological significance of those impacts. Finally, if there were even a small spill that occurred during a peak in bowhead migration, many whales could come in contact with the spill. Thus, there may be a significant portion of the population that could be impacted. A more realistic analysis of impacts is needed.
		Appen. H. Env. Impact Analysis						245	2nd	Penultimate	How will aerial monitors record data on the "impacts"? More detailed information is needed.
		Appen. H. Env. Impact Analysis						245	4th	2nd	Shell states that "critical habitats for these species are not found in or near Shell's prospects." This statement is very misleading. Shell collected data in 2007 and 2008 showing that bowheads were feeding in Camden Bay. Previous researchers have also recorded bowheads feeding in Camden Bay, in the vicinity of Shell's prospects. Feeding is a vital life function that is critical to the survival and reproduction of bowheads. Additional analyses are needed to correctly assess the potential for impacts to marine mammals, especially bowheads. Decision makers and the public are entitled to know how important Camden Bay is to bowheads.
		Appen. H. Env. Impact Analysis						245	penultimate	Last two	Shell cites MMS (2003) that ice conditions "will likely have a greater impact on migration of the whales than vessel traffic". It is not clear why this statement is being made. Is Shell suggesting that impacts from vessel traffic are not important? We know from studies at Northstar that bowheads can be sensitive to even low levels of received sounds

											from vessels (Richardson 2008). Thus, careful consideration must be given to impacts from vessel traffic in conjunction with impacts from drilling. The cumulative impacts may be substantial. In the last sentence, Shell states that impacts to belugas will be temporary in nature. What data is this supposition based on? There is no information about the duration of impacts to belugas from drilling ships, ice breakers or other industrial activities.
		Appen. H. Env. Impact Analysis						249	last	1st	Shell states that muds and cuttings will disperse up to 330 feet in beluga feeding areas. It is unclear what is meant by this statement. Does Shell have information about beluga feeding in Camden Bay?
		Appen. H. Env. Impact Analysis						253	last	penult imate	Shell stats that "bird densities are expected to be low in the project area within Camden Bay during the short period of proposed operations." This statement is not true. Hundreds of thousands of King and Common eiders will migrate through the project area during summer and autumn, precisely when Shell plans to drill. This analysis must be revised to consider impacts to migrating eiders and other birds.
		Appen. H. Env. Impact Analysis						254	1st	First 3 sente nces	Shell states there will be "no adverse impact on coastal or marine bird populations." They go on to say that mitigation measures will "reduce the likelihood of bird strikes." This conclusion is confusing. If there is some likelihood of bird strikes then there may be impacts. This section of the analysis must be revised to assess impacts to migrating eiders.
		Appen. H. Env. Impact Analysis						280 and 281	Para cross ing btwn pp.		Shell does not use the most relevant information about impacts from drilling on bowhead whales. LGL and Greenridge (1987) detected no whales closer than 6 miles to the Hammerhead drill site in Camden Bay during operations. Brewer et al. (1993) observed that bowheads began deflecting away from the drill rig at 19 miles away from the Kuvlum drill rig in 1992. Hall et al. (1994) and Davies (1997) states that whales were nearly excluded from an area within 12 miles from a drill rig at Kuvlum in 1993. This information is the most pertinent for assessing impacts to bowheads from Shell's proposed activities. Decision makers and the public need to be aware of this information when reviewing the exploration plan. Furthermore, the research on impacts from sounds produced at Northstar show that very low levels of sound, particularly sounds produced from vessels, causes bowheads to deflect (Richardson 2008). That pertinent information is not included in this assessment. This section and the analysis needs to be revised.
		Appen. H. Env. Impact						283	4th	penult imate	Shell states "is is reasonable to not analyze the impacts of such a highly conjectural occurrence [a large hydrocarbon spill]". Oil spills occur where exploration and development occur. Therefore a large oil spill is

		Analysis									not conjectural at all and must be analyzed in this environmental impact analysis. Decision makers and the public are entitled to understand the full potential for impacts from Shell's activities.

Regulation Section	Regulatory Information	EP Section	Additional Information §250.201(b) (Yes/No)	Limiting Information §250.201(c) (Yes/No)	Complete as Submitted (Yes/No)	Recommendation (X)	Commenter	Page	Paragraph	Sentence	Identified Problems; Deficiencies; Recommendations
		Sec.9 Relief Well						p.51			There is no indication in this section, or elsewhere in the document, that Shell is prepared to deal with a late-season blowout. Depending on the depth of the blowout well, the time to well killing is predicted to be 16-34 days. We are told repeatedly that activities will extend through October 31, depending on ice and whether. To assure the ability to complete a relief well and achieve blowout well killing, drilling operations must be planned to cease no later than 34 days prior to when weather and ice can best be predicted to render drilling of a relief well impossible.
		Appendix H						p. 6			Distances are given from the drillsites to various communities and industrial sites. They should also be provided with reference to Cross Island, as its location relative to the drilling operations is as important as the location of Nuiqsut.
								p.7	Fig. 1.1-1		Same as above. Cross Island should be shown on this, as well as other, maps showing planned operations.
		App. H Sec. 3.0						p.39 Table 3.1.1-1			It should be unacceptable to MMS that the temperature data presented in the table is current for Prudhoe Bay only through 1999, and for Barter Island only through 1988.
								p.40 Table 3.1.2-1			Same as above with respect to precipitation data.
								p. 39 and following			Throughout the EIA, Shell repeatedly cites large and complex summary documents, including, but not limited to the Beaufort Sea Planning Area Multi-Sale EIS (MMS 2003) and the 2007-2012 OCS Leasing Program EIS (MMS 2007a). The citation to such summary documents, rather to the underlying data and reports upon which they rely and from which they draw their conclusions, prevents any independent verification of the appropriateness of what are

											now essentially second generation conclusions in the Shell document. A responsible review at this point would first demand the daunting task of locating in those large cited documents any text and conclusions that might support the conclusion and citation by Shell, then assessing whether it is an accurate statement of earlier conclusion, and finally assessing whether the earlier conclusion was well-founded based on any citations provided. Neither the Borough, nor our affected communities, have the resources or time to conduct such investigations for all conclusory statements offered in the EIA and supported by citations to summary documents.
		3.1.6 Climate Change						p.40			Shell uses more than half of the absurdly short 2-page section on climate change to suggest that given factors other than anthropogenic causes the arctic warming observed today is the result of naturally occurring cycles and that, in any event, the contribution of the Discoverer to overall greenhouse gas emissions in Alaska would be minute. Shell completely misses the essential points requiring analysis with respect to the relationship between warming trends and its proposed activities. We urge MMS to first ignore the misdirection offered by Shell with respect to the causes of climate change, and instead endorse the scientifically-driven conclusion espoused by then-Senator Obama, who said in 2006 that "All across the world, in every kind of environment and region known to man, increasingly dangerous weather patterns and devastating storms are abruptly putting an end to the long-running debate over whether or not climate change is real. Not only is it real, it's here, and its effects are giving rise to a frighteningly new global phenomenon: the man-made natural disaster." For the purposes of this review, MMS and Shell must first acknowledge that there is no longer any question that human activity is causing global climate change. The latest report by the United Nation's Intergovernmental Panel on Climate Change found (with 90% certainty) that the release of carbon dioxide and other heat-trapping gases from human activity has played a central role in raising the average surface temperature of the earth by more than 1 degree Fahrenheit since 1900. Shell and MMS must then consider

											to what extent arctic warming trends have already changed the numbers, behavior, or distribution of wildlife resources in the project area, or destabilized or stressed those resources, such that proposed activities could exacerbate those effects. Shell and MMS must also consider to what extent warming trends have changed environmental and climatological conditions such that long-term and (see above) less than current data regarding those conditions may be inadequate for planning purposes.
		3.3.2 Geologic Hazards						p.63			While there is some discussion of shallow faulting in the immediate project area, there appears to be no discussion in the EIA concerning the implications of potential earthquake/seismic activity occurring during planned activities. This was a concern raised in legal action involving state lease sale planning in Camden Bay many years ago. The UAF Geophysical Institute reports the highest concentration of earthquake activity offshore of the North Slope to be in the Camden Bay region. A search for events of 3.0 magnitude or greater in the immediate project area (between 69 and 71 N Lat. and 143 and 147 W Long.) yielded 52 results since Jan. 1, 2003.
		3.11.7 Subsistence Resources						p.171	2nd	1st	The list of regional subsistence activities should include the hunting of caribou and other large land mammals.
									3rd	1st	The statement regarding the choices of young Inupiat men, drawn from a decades-old report, is a poor introduction to a necessary discussion of the mixed and inter-dependant subsistence-cash economy and culture of North Slope residents.
								p.183	last		Burton Rexford passed away some years ago.
		4.1.10						p.245 see also p.146 Sec. 3.9 and p. 288 Sec. 4.1.15	1st	2nd	It is stated that critical habitats for marine mammals are not found in or near Shell's prospects. Without greater research effort and focus, it would be more accurate to say that studies have yet to determine whether marine mammal or other critical habitats, or (as discussed in Sec. 3.9 and Sec. 4.1.15) sensitive biological areas or habitats, exist in the region.
								p.266	last		A cited conclusion of MMS that deflection of caribou from preferred coastal foraging and insect relief habitat will be

											localized and temporary is an insufficient analysis of the potential harm to individual animals or populations resulting from such deflections. This is an example of the need as well to integrate current climate change information with impact assessment throughout the document. Even temporary deflections could be more harmful if recent changes in local foraging and insect relief habitat are already affecting the body condition and health of area caribou.
		4.2 Cumulative Impacts						p.340			The cumulative impacts analysis fails to consider the potential for project activities, in combination with foreseeable industrial operations in Canadian waters, to impact the subsistence harvest of bowhead whales by Barrow hunters. The concern is that whales exposed to industrial noise east and "upstream" in the fall migration of Shell's operations, and then exposed again by Shell's operations (when operations resume after Kaktovik and Nuiqsut whaling has concluded), will be rendered more skittish, and therefore more difficult to approach and harvest by the time they reach the Barrow area.

Regulation Section	Regulatory Information	EP Section	Additional Infor. §250.201(b) (Yes/No)	Limiting Information §250.201(c) (Yes/No)	Complete as Submitted (Yes/No)	Recommendation (X)	Commenter	Page	Paragraph	Sentence	Identified Problems; Deficiencies; Recommendations
30 CFR 250.212(d) & 250.216		Section 5						19			The Plan of Cooperation and agreement to set up Com. centers and hire MMOs discussion does not comply with Section 30 CFR 217 requirements for socio-economic information. Please address.
30 CFR 250.222		Section 11						80			Shell states that “Sound modeling will be required for the planned drilling program in the Camden Bay area . . .” NSB requests the sound modeling, or sound “profiles,” or descriptions of field verification regarding how these tests will be used for mitigative purposes to comply with lease stip. 4.
30 CFR 250.212(l) &250.224		Section 13						95			Figure 13-2 indicates aircraft travel routes to Sivulliq and Torpedo. Please identify the analytical reasoning for this route selection.
		Appendix H 2.3.4						36			The sounds generated by drill ship have not been measured. The vessel is stated to be close to a similar size to the Explorer, more demonstration of either their similarity, or the actual noise generated should be made.
		Appendix H 2.3.5						37			Please demonstrate the distances from and reasoning for the distances between vessels and the rig during exploration.
		Appendix H Sec. 3.7						109			Ribbon seal contains no reliable abundance estimate. No baseline provided.
		Appendix H Sec. 3.7						110			Ringed seal contain no reliable abundance estimate. No baseline provided.
		Appendix H Sec. 3.7						112			Spotted seals contain no reliable population estimates. No baseline provided.
		Appendix H Sec. 3.7						116			No complete abundance estimate provided.

		Appendix H						122			Pacific Walrus – Though at particular and identified risk from climate change by the USFWS, there is no abundance/population data provided. This information should be verified against the recently released USFWS data as it does not seem updated. No baseline provided.
		Appendix H						262-63			EIA concludes that the impact of sound from drilling an d ice management will be negligible, but appears to do that with inadequate foundation. The next page states “there have been no studies of the direct effects of ice management vessel sounds on fish.” Please clarify.
40 CFR 1508.27		Appendix H						301			P. 301 references the MMS definitions of levels of impact utilized in the 2008 Draft Multi-Sale for Lease Sales 209, 212, 217, and 221. The document relied upon is a draft and the NSB disagrees with establishing significance thresholds other than those identified in CEQ regulations. *See* 40 CFR 1508.27. The CEQ has provided guidance on the meaning of significance in the context of assessing impacts, and MMS Draft Multi Sale EIS is not the appropriate citation for this determination. Please review the entirety of the EIA and adjust accordingly in conducting any further Environmental Assessment for determination of significance when considering an EIS. NSB, applying these factors, has determined an EIS is appropriate.
		Appendix H						305			The EIA concludes “Shell expects temporary and localized impacts to seals, but impacts to subsistence seal hunting activities and to the hunters may vary.” While NSB does not see the analytical support for the conclusion that project impacts will be temporary and localized, we agree with Shell’s openness regarding the varying risks to subsistence and looks forward to further analysis of this issue.
		Appendix H						306, 312			The EIA states that Shell anticipates little or no impact to land mammal hunting. However, Shell provides an exception to this statement – Caribou. Shell identifies the importance of Caribou to the subsistence users of Kaktovik and Nuiqsut, and acknowledges that the timing of hunting matches the timing of the operation. Shell also acknowledges the science showing air vessel impact on caribou, but then inconsistently states what the level of impacts may be. Please clarify and identify how the POC is sufficient mitigation for these impacts.
		Appendix H						306			Shell acknowledges the investigations cited in Section 4.1.12 showing that fish react and move away when engines and propeller sound exceeds certain levels. It also acknowledges the local and traditional knowledge regarding vessel sound impacts on fish, and that subsistence activities may be altered by project operations. However, Shell then appears without foundation to conclude that impacts will generate

											negligible effects. Please provide foundation for the conclusion and also demonstrate how Shell's proposed mitigation measures are sufficient.
		Appendix H						316			Shell recognizes in the EIA that its activities, including ice management, drilling and vessel traffic, may impact that subsistence hunt of beluga whales in Kaktovik. Shell concludes that beluga "may temporarily deflect from hunting and migration grounds" and that vessels may impose on hunters traditional subsistence hunting grounds. Given these concessions, the only logical conclusion is that these activities may have an adverse impact on the availability of such species or stock for taking for subsistence uses. See 16 U.S.C. § 1371(b). Shell, however, simply provides unsupported conclusions that its activities will not have a "lasting impact to beluga whale hunting." Shell does not explain how it reaches this conclusion, nor does it explain why it focuses on a standard – "lasting impacts" – that has no relevance to the legal requirements of NEPA or the significance criteria of NEPA found at *See* 40 CFR 1508.27.
		Appendix H						318			Shell states that impacts to subsistence seal hunting activities and to hunters may vary, and acknowledges that subsistence activities may be impacted in a greater extent even than the species themselves. Please review and demonstrate compliance with the 16 U.S.C § 1371(b). Also please review the criterion located in CFR 1508.27 for determining significance of impacts and support conclusions according to NEPA requirements.

Projected Ocean Discharges

Tables 6.0-3A and B list the projected ocean discharges based on the projected generated wastes. Information regarding the projected generated wastes (Tables 6.0-1A and B) is based on empirical information and past experience. Therefore, the projected ocean discharges are subject to actual generated waste volumes.

TABLE 6.0-3A PROJECTED OCEAN DISCHARGES – SIVULLIQ PROSPECT DRILL SITE N

Type of Waste	Total Amount to be Discharged*	Discharge Rate*	Discharge Method
Drill Cuttings	3,483 bbl/well (Cuttings only; no drilling muds used)	697 bbl/day (discharged over 5 days)	Deposited at the seafloor
Spent drilling fluids	2,761 bbl/well (when multiple wells drilled in same season, same water based mud system will be transferred to next well)	95 bbl/day (discharged over 29 days; includes discharge of excess water base fluid at end of the season, approx 1500 bbl)	Discharged to water through disposal caisson diluted 30:1 with seawater
Drill cuttings from water base drilling fluid interval	1,261 bbl/well	43.5 bbl/day (discharged over 29 days)	Discharged to water through disposal caisson diluted 30:1 with seawater
Excess cement	50 bbl/well	two occasions at 1 bbl/min	Discharged at seafloor during 30-inch and 20-inch cementing operations
Cooling water	1,530,000 bbl/well	45,000 bbl/day	Discharged to the water at several sites
Sanitary wastewater	918 bbl/well	27 bbl/day	Treated in the MSD prior to discharge to meet NPDES limits (based on 124 people at 9 gal/person/day)
Domestic wastewater	3,822 bbl/well	83 bbl/day	Discharged to water through disposal caisson below the water's surface (based on 124 people at 28 gal/person/day) Food wastes will not be discharged, they will be incinerated onboard
Desalination unit brine water	4,250 bbl/well	125 bbl/day	Discharged through disposal caisson below water's surface
Deck drainage	170 bbl/well	5 bbl/day (dependent on rainfall)	Drains to oily water separator. Uncontaminated water discharged through disposal caisson below water's surface. Oily water is stored onboard in waste oil tank, then transferred by boat to an approved treatement/disposal facility.
Ballast water	21,080 bbl/well	620 bbl/day	Discharged through disposal caisson below water's surface
Firewater bypass	0 bbl	0 bbl/day	No routine firewater system testing anticipated

TABLE 6.0-3A PROJECTED OCEAN DISCHARGES – SIVULLIQ PROSPECT DRILL SITE N

Bilge water	1,000 bbl/well	28.6 bbl/day	Treated in an oil/water separator. Uncontaminated water discharged to sea through the disposal caisson, oily water is stored onboard then transferred by boat to an approved treatment/disposal site
BOP fluid	42 bbl/well	Up to 6 BOP tests at an average 7 bbl/test	Discharged at the seafloor at the BOP

Notes:
* assumes 5 days to complete the MLC and 36-inch section; 29 days to complete the remainder of the well

TABLE 6.0-3B PROJECTED OCEAN DISCHARGES – TORPEDO PROSPECT DRILL SITE H

Type of Waste	Total Amount to be Discharged*	Discharge Rate	Discharge Method
Drill Cuttings	3,393 bbl/well (Cuttings only; no drilling muds used)	679 bbl/day* (discharged over 5 days)	Deposited at the seafloor
Spent drilling fluids	2,881 bbl/well (when multiple wells drilled in same season, same water based mud system will be transferred to next well)	82 bbl/day* (discharged over 35 days; includes discharge of excess water base fluid at end of the season, approx 1500 bbl)	Discharged to water through disposal caisson diluted 30:1 with seawater
Drill cuttings from water base drilling interval	1,381 bbl/well	39 bbl/day* (discharged over 35 days)	Discharged to water through disposal caisson diluted 30:1 with seawater
Excess cement	50 bbl/well	two occasions at 1 bbl/min	Discharged at seafloor during 30-inch and 20-inch cementing operations
Cooling water	1,800,000 bbl/well	45,000 bbl/day	Discharged to the water at several sites
Sanitary waste	1,080 bbl/well	27 bbl/day	Treated in the MSD prior to discharge to meet NPDES limits (based on 124 people at 9 gal/person/day)
Domestic waste	3,320 bbl/well	83 bbl/day	Discharged to water through disposal caisson below the water's surface (based on 124 people at 28 gal/person/day) Food wastes will not be discharged, they will be incinerated onboard
Desalination unit brine water	5,000 bbl/well	125 bbl/day	Discharged through disposal caisson below the water's surface
Deck drainage	200 bbl/well	5 bbl/day (dependent on rainfall)	Drains to oily water separator. Uncontaminated water discharged through disposal caisson below water's surface. Oily water is stored onboard in waste oil tank, then transferred by boat to an approved treatment/disposal facility.
Ballast water	24,800 bbl/well	620 bbl/day	Discharged through disposal

TABLE 6.0-3B PROJECTED OCEAN DISCHARGES – TORPEDO PROSPECT DRILL SITE H

			caisson below the water's surface
Firewater bypass	0 bbl	0 bbl/day	No routine firewater system testing anticipated
Bilge water	1,000 bbl/well	25 bbl/day	Treated in an oil/water separator; uncontaminated water discharged to sea through the disposal caisson, oily water is stored onboard then transferred by boat to an approved treatment/disposal site
BOP fluid	42 bbl/well	Up to 6 BOP tests at an average 7 bbl/test	Discharged at the seafloor at the BOP

Notes:
* assumes 5 days to complete the MLC and 36" section; 35 days to complete the remainder of the well

National Pollutant Discharge Elimination System Authorization to Discharge

Shell's NOIs for authorization for the *Discoverer* to discharge wastes regulated under NPDES General Permit AKG-28-0000, for the planned drilling operations outlined in this EP, are present in Appendix C. Shell has submitted separate NOIs for authorization to discharge at the Torpedo H and Sivulliq N drill sites.

Modeling Report

Schematic diagrams displaying the waste flow for the *Discoverer* are presented in Appendix C.

Projected Cooling Water Intake

A saltwater service system supplies the *Discoverer's* need for saltwater, including for drilling operations. The system is primarily used to supply cooling water to equipment heat exchangers. The system consists of two saltwater pumps (Aurora 5-483-11C), one flare-burner spray pump, five sea suctions (each with a strainer having 5mm openings), and associated distribution piping. It is anticipated that approximately 45,000 bbl/day of cooling water will be needed. Intake flow velocity will be approximately 0.2 m/second (sec). The cooling water will be discharged overboard at several sites around the *Discoverer*.

The saltwater service system consists of one 22.5 gal service pump at 80 pounds per square inch (psi) in each pump room taking suction from a sea chest located at sea level via a duplex strainer (common to fire water systems). The sea chest is located at sea level. Each pump discharges independently to the system distribution loop under the main deck. The system is designed to operate with one pump running continuously and the other on standby.

North Slope Borough

OFFICE OF THE MAYOR

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Edward S. Itta, Mayor

October 5, 2009

Mr. Mike Lidgard
U.S. EPA, Region 10
Office of Water and Watersheds, NPDES Permits Unit
1200 Sixth Avenue, Suite 900, M/S OWW-130
Seattle, Washington 98101

RE: Notices of Intent (NOI), NPDES General Permit AKG-28-0000
Shell Gulf of Mexico 2010 Outer Continental Shelf Lease Exploration Plan,
Chukchi Sea, Alaska, Drillship M/V *Frontier Discoverer*
Lease Number OCS-Y-2111, Lease Block 6864;
Lease Number OCS-Y-2142, Lease Block 7007;
Lease Number OCS-Y-2321, Lease Block 6912;
Lease Number OCS-Y-2267, Lease Block 6714;
Lease Number OCS-Y-2280, Lease Block 6764.

Dear Mr. Lidgard:

Thank you for the opportunity to comment on the Notices of Intent (NOI) for Shell Gulf of Mexico's (Shell's) proposed NPDES General Permit (GP) discharges associated with its proposed 2010 Chukchi Sea Exploration Plan.

Shell proposes to discharge between 1.9 and 2.9 million gallons of effluents, including toxic and bioaccumulating waste, each day into the Chukchi and Beaufort Seas over the course of a 120 day exploration season. Many of the species likely to be impacted by the proposed discharges are critical to our subsistence harvest. As you have learned from your extensive discussions with our people, we favor keeping Alaska North Slope marine habitats as free from pollution as possible. Although we are engaged in wage employment, we continue to depend heavily on subsistence harvests for food. Traditional foods are far more nutritious than many types of imported "store-bought" food.[1]

[1] The subsistence diet protects against obesity and diabetes, and associated problems such as hypertension and cardiovascular disease. Restricted access to subsistence foods therefore places the community at increased risk for these problems. If the fundamental role of subsistence is displaced, very significant increases in obesity and diabetes in the impacted communities would predictably ensue. *See*

Subsistence activities also provide spiritual and cultural affirmation, and are crucial for passing skills, knowledge and values from one generation to the next, thus ensuring cultural continuity and vibrancy. The North Slope Borough (NSB) thus takes seriously the regulation of industrial discharges to the marine environment. We have established a number of policies to preserve the fragile environment on which most NSB residents depend for subsistence.[2] We hope that EPA reviews our comments with these policies in mind.

NSB prepared the attached comments after extensive internal review, consultation with the Minerals Management Service and coordination with you and your staff at EPA to assist you in determining whether the proposed discharge activities are suitable for coverage under the NPDES General Permit AKG-28-0000 and whether the Shell NOI are complete.

Our conclusion is that you should require that the proposed discharges be individually permitted pursuant the Clean Water Act's National Pollutant Discharge Elimination System (NPDES), 33 U.S.C. §§ 1311(a), 1342, and the factors articulated in 40 C.F.R. § 122.28(b)(3) for determining whether a project fits within the General Permit. The proposed effluent discharges are inaccurately characterized in the NOI to fit under the NPDES discharge categories listed in the General Permit. The very high volumes of effluent discharges associated with this proposed activity are under-reported and un-quantified in terms of toxic waste pollutant loads, and the discharges are not assessed for aggregate effects. Moreover, likely adverse effects to subsistence resources, including endangered bowhead whales, seals, walrus and fish—all directly impacted by the toxic and bioaccumulating wastes associated with the proposed discharges are not addressed in the NOI. Permitting the discharges individually would provide for the use of technologies and practices that can significantly control or abate the impacts of the significant volumes that Shell plans to discharge.

The NSB has multiple interests at stake in the Chukchi Sea Exploration Plan underlying

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Ebbesson SO, Kennish J et al. Diabetes is Related to Fatty Acid Imbalance in Eskimos. *International Journal of Circumpolar Health*. 58: 108-119. 1999.

Shephard R and Rode A. The Health Consequences of Modernization: Evidence from Circumpolar Peoples. Cambridge University Press. 1996.

Curtis T, Kvernmo S et al. Changing Living Conditions, Lifestyle, and Health. *International Journal of Circumpolar Health*. 64(5) 442-450.

Jorgensen M, Bjerregaard P et al. Diabetes and impaired glucose tolerance among the Inuit of Greenland. *Diabetes Care*. 26: 1766-1771. 2002

Zinman, B. Diabetes in indigenous populations: genetic susceptibility and environmental change. Accessed at www.d4pro.com/idm/site/diabetes_in_indigenous_populations__.htm on 6/22/2006.

Ebesson S, Schraer C et al. Diabetes and impaired glucose tolerance in three Alaskan Eskimo Populations. *Diabetes Care*. 21: 563-569. 1998

Indian Health Service. *Interim Report to Congress: Special Diabetes Program for Indians*. December 2004. Accessed online on August 9, 2006 at http://www.ihs.gov/MedicalPrograms/diabetes/resources/r_rtc2004index.asp.

Hogan P et al. Economic Costs of Diabetes in the U.S. in 2002. *Diabetes Care*. 2003. 26: 917-932.

[2] *See*, for example., NSBMC 19.70.50 (L) (NSB does not permit development that will likely result in significantly decreased productivity of subsistence resources or their ecosystems, or development on or near a shoreline that has the potential of adversely impacting water quality, unless there are no alternatives, and the developer has taken all feasible and prudent steps to avoid the adverse impacts); NSBMC 19.70.50 (R) (Development is required to minimize its negative impact and to maintain the natural permafrost insulation quality of existing soils and vegetation.)

these NOI. First and foremost are those related to the health and welfare of our residents, who are rightfully concerned about potential health impacts associated with wastes from oil and gas development on the North Slope.

With this in mind, we ask you to take the time necessary to assure that the contemplated discharges are individually permitted and that the best available technologies and practices be considered for controlling or abating these significant discharges to our marine environment. We also ask that you strive to meaningfully involve the local communities in the individual permitting process, particularly the Inupiat people who will be disproportionately impacted by proposed action as is required by Executive Order 12898, NSB subsistence resource policies and your own regulations.

If you have any questions regarding these comments, please feel free to contact me.

Sincerely,

Mayor Edward S. Itta

Appendices/Attachments

CC: Taqulik Hepa, NSB Director Department of Wildlife Management
Dan Forster, NSB Director Department of Planning & Community Services
Bessie O'Rourke, NSB Attorney
Karla Kolash, NSB Mayor's Office
Andy Mack, NSB Mayor's Office
Hanh Shaw, EPA, Region 10
Ted Rockwell, EPA, Region 10
Jeffrey Walker, Minerals Management Service

NORTH SLOPE BOROUGH'S COMMENTS ON SHELL'S NOTICES OF INTENT

I. SHELL'S PROPOSED DISCHARGES ARE UNSUITABLE FOR COVERAGE UNDER THE GENERAL PERMIT.

Congress enacted the Clean Water Act (CWA) to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251(a). The Act prohibits the discharge of pollutants from a point source without a permit issued under the terms of the National Pollution Discharge Elimination System (NPDES), 33 U.S.C. §§ 1311(a), 1342. General NPDES Permits are procedurally and substantively similar to individual permits, but when suitable, may apply to large numbers of sources discharging into many different bodies of water.[3]

Both individual and general permits are intended to include substantive restrictions on the discharge of pollutants in order to meet the goals of the CWA.[4] The effluent limitations contained in most permits specify the quantity or concentrations of specific pollutants that may be discharged from point sources. When a discharge is outside of the scope contemplated in a general permit, or when new technologies or practices exist which undercut the general permit's application, the discharge should be individually permitted to assure that the permittee meets water quality standards, complies with other federal laws, applies the best available technology to control or abate the contemplated discharge, and affords the affected public an opportunity to be involved in the process. EPA provides a regulatory mechanism for individual permitting in a general permit context found at 40 CFR § 122.28(b)(3)(i).

The factors identified at 40 CFR § 122.28(b)(3)(i) make clear that the discharges contemplated by Shell's 2010 Chukchi Exploration are unsuitable for coverage under the general permit. Changes have occurred in the availability of demonstrated technologies and practices for control or abatement of pollutants contemplated by the action. 40 CFR § 122.28(b)(3)(i)(B). Additionally, the discharges contemplated by Shell are a significant contributor of pollutants. 40 CFR § 122.28(b)(3)(i)(G).

A. There are demonstrated technologies or practices now available for control or abatement of the pollutants related to Shell's Exploration activities.

As demonstrated in the attached material, the proposed Outer Continental Shelf (OCS) exploration can be accomplished using one of several viable options for waste handling: (1) annular injection of waste streams into the exploration well while drilling, (2) temporary storage of wastes and subsequent disposal into the exploration well prior to abandonment, (3) transportation of waste to the nearest onshore treatment facility or (4) a combination of these

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[3] EPA defines a "general permit" as an NPDES 'permit' issued under 40 CFR §122.28 authorizing a category of discharges under the CWA within a geographical area." 40 CFR § 122.2 (2006).

[4] In addition, NPDES permits typically contain monitoring and reporting requirements and a variety of other standard conditions. 40 CFR § 122.41.

four alternatives.[5] As discussed below, these options would significantly control or abate the pollutants related to Shell's exploration activities and should be considered within an individual permit process.

As indicated in the attached materials, injection has been achieved during offshore exploration drilling operations on a mobile offshore drilling unit (MODU) through a subsea wellhead. An individual permitting process would consider whether this technology is appropriate for Shell's discharges, and whether there are site-specific reasons for not utilizing this technology. The individual permitting process would also consider whether transportation of waste to an onshore treatment facility is a viable option. While Shell does not currently own offshore or onshore-based waste disposal facilities on the North Slope, its intent for long-term operation in Alaska on a number of projects makes this an investment opportunity. Current operators have established fee-based agreements for use of existing facilities, and this can be a temporary option for Shell, until it invests in its own facility.

B. Shell's significant proposed discharge is outside the scope of the NPDES discharge categories of the general permit.

An individual permit is appropriate when the discharge is a significant contributor of pollutants. 40 CFR § 122.28(b)(3)(i)(G). In making this determination, the EPA should consider the following factors: (1) the location of the discharge with respect to waters of the United States; (2) the size of the discharge; (3) the quantity and nature of the pollutants discharged to waters of the United States; and (4) other relevant factors. *Id.*

1) The discharges are proposed to occur in the Chukchi Sea, which is home to an abundance of marine species, yet there is a conceded lack of baseline data regarding its water quality and environmental sensitivity.

The discharges contemplated in the NOI will be deposited in the Chukchi Sea, one of the most biologically rich, yet scientifically uncharacterized waters of the United States.

The Chukchi Sea, a portion of the Arctic Ocean north of the Bering Strait and west of the Beaufort Sea, provides habitat and rich feeding grounds for a great variety of marine life and irreplaceable subsistence resources upon which Inupiat communities along its coast have depended for thousands of years. Sensitive populations of bowhead whales, humpback whales, fin whales, polar bears, and spectacled and Steller's eiders, all protected by the Endangered Species Act, 16 U.S.C. § 1531, *et seq.* (ESA), inhabit the sea. Every spring, nearly the entire Western Arctic stock of bowhead whales, including mothers and calves, migrates north and east through the Chukchi Sea on their way to summer feeding grounds, and every autumn they return south and west through the sea en route toward southern wintering grounds. The lead system,

[5] *See* Attachment 1: Harvey, Susan, *Review of Shell Exploration and Production Company's August 2008 Analysis of the Pros and Cons of Zero Discharge of Muds and Cuttings During Exploration Drilling in the Alaska Beaufort Sea Outer Continental Shelf, and Shell's May 2009 Supplemental Information on Annular Injection and Barents Sea Exploration Permits,* June 16, 2009, written as a response to Shell Oil *Analysis of the Pros and Cons of Zero Discharge of Muds and Cuttings During Exploration Drilling In the Alaskan Beaufort Sea Outer Continental Shelf,* August 2008 (also included).

polynyas, ice edge and coastal areas of the sea also provide vital feeding and denning habitat for polar bears. Pacific walrus, particularly females, calves, and sub-adults, use the Chukchi Sea as primary feeding grounds in summer and autumn. Ringed, spotted, ribbon and bearded seals, beluga whales, killer whales, minke whales, gray whales, and harbor porpoises, as well as many species of fish, including Pacific salmon and Arctic cod, and over 40 species of marine and coastal birds, also inhabit the Chukchi Sea.[6]

The Chukchi Sea is the center of the culture, identity, and subsistence way of life for Inupiat Eskimo communities along its coast. The sea provides these communities with food, clothing, and materials for traditional arts. For example, a large majority of the households of Point Hope obtain half or more of their food from harvesting local subsistence resources. The nutritional benefits of subsistence foods to the Inupiat cannot easily be replaced by store-bought foods. Barrow, Point Hope, and Wainwright engage in subsistence hunting of bowhead whales each spring and, in the case of Barrow, fall. These communities and others, such as Point Lay and Atqasuk, engage in extensive food sharing and bartering, which is an integral part of traditional Inupiat family organization. Thus, all across the North Slope, in communities that engage directly in whaling as well as in communities that do not, the bowhead is of unique spiritual importance—a focal point of sharing, cooperation and the preservation of cultural traditions. Aside from the bowhead, Chukchi Sea communities engage in subsistence hunting of walrus, seals, beluga whales, polar bears, birds, and fish, all of which depend upon the health of the Chukchi Sea ecosystem. The importance of these subsistence activities can hardly be overstated – they are at the core of Inupiat identity.[7]

a. Absence of Water Quality Baseline

Despite the cultural and biological significance of the Chukchi Sea, there is a profound lack of basic scientific knowledge about the sea and the wildlife that inhabits it. This lack of knowledge has been identified by the EPA on multiple occasions, most recently in comments to the Minerals Management Service on the proposed Beaufort and Chukchi Sea Oil and Gas Lease Sales 209, 212, 217 and 221 Draft Environmental Impact Statement:

> Currently, there are large data gaps and limited analyses of air and water quality in the DEIS. It also appears that data necessary for EPA permitting under the Clean Air Act and Clean Water Act are not currently available, and may not be available at the point when permit applications are submitted. EPA is also concerned about the extent and range of uncertainties that result from these gaps, and the lack of adequate support for many of the conclusions in the document, including impact analysis conclusions and conclusions based on some TEK [traditional environmental knowledge] information. **EPA recommends that baseline environmental data be collected throughout the lease sale process and prior to exploration activities,**

[6] All the described environment of the Chukchi Sea is found at: MMS AR 975-977 Minerals Management Service, Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea, Final Environmental Impact Statement OCS EIS/EA MMS 2007-026, (May 2007).

[7] *Id.*

> and that new information be utilized by MMS in its management strategies and subsequent NEPA analyses.[8] (Emphasis added)

The lack of baseline data about the sea is compounded by the rapid changes to the ecosystem caused by global climate change. The Chukchi Sea is one of the "principle bellwethers to climate change in North America and the Arctic Ocean."[9] During recent decades, the Arctic has warmed more quickly than any other region on earth.[10] Perennial sea-ice cover is disappearing at a rate of about 9 percent per decade.[11] Summer sea-ice has retreated an average of 13.1 additional days each decade.[12] Winter sea-ice extent was at a record low in 2005 and 2006.[13] Summer sea-ice extent retreated to record lows in 2002, 2005, and again in 2007, and extreme minima were observed in 2003, 2004, and 2006.[14] These changes appear to be accelerating.

Climate change in the Chukchi Sea has the potential to adversely affect the subsistence practices and human health of Inupiat communities across the North Slope. The subsistence way of life depends on healthy wildlife populations in the Chukchi Sea.
Diminished health of Chukchi wildlife, such as ice-dependent walrus, threatens communities' ability to rely on these species for subsistence. Sea-ice change may threaten subsistence livelihoods, by altering migration patterns and the distribution of important subsistence species, including bowhead whales and walrus, and increasing the dangers inherent in hunting on the sea-ice.[15]

b. Environmental Sensitivity

On April 17, 2009, the D.C. Court of Appeals determined in *Center for Biological Diversity v. Dep't of Interior,* 563 F.3d 466 (D.C. Ct App, 2009) that the Department of Interior violated the Outer Continental Shelf Lands Shelf Act (OCSLA) in approving a 2007-2012 OCS Leasing Plan that did not conduct an environmental sensitivity analysis under Section 18(a)(2)(G) of OCSLA. Pending completion of this sensitivity analysis, the validity of all actions carried out in Alaska pursuant to 2007-2012 plan—including the lease under which Shell proposes to discharge into the Chuckchi Sea---are in question.

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[8] *See* April, 2009 Letter from Christine Reichgott (EPA Region 10) to John Goll prepared in accordance with EPA's responsibilities under the National Environmental Policy Act (NEPA) and Clean Air Act Section 309 regarding the MultiSale DEIS for Lease Sales 209, 212, 217 and 221.

[9] *See* MMS AR 975-977 Minerals Management Service, Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea, Final Environmental Impact Statement
OCS EIS/EA MMS 2007-026, p. 42 (May 2007)(hereinafter cited as Lease Sale 193 FEIS).

[10] *See* Memorandum from Steve Lewis, U.S. Fish and Wildlife Service, to Henri Bisson, Bureau of Land Management, Re: Endangered Species Act, Section 7 Biological Opinion for the proposed Amendment to the Northeast National Petroleum Reserve-Alaska Integrated Activity Plan / Environmental Impact Statement, pp. 7-8 (January 13, 2005).

[11] *See* Andrew E. Derocher, *et al.*, *Polar Bears in a Warming Climate*, INTEGR. COMP. BIOL., 44:163-176 (2004).

[12] *See,* Center for Biological Diversity, Petition to List the Polar Bear (*Ursus maritimus*) as a Threatened Species Under the Endangered Species Act, p. 5 (February 16, 2005).

[13] Lease Sale 193 FEIS, p. 35.

[14] *Id.*

[15] *Id.* at pp. 236-242.

As demonstrated above, despite the vital importance of the Chukchi Sea to the Inupiat people, there are large data gaps regarding water quality and overall environmental sensitivity of the area to discharge.

2) The discharge will far exceed any amounts contemplated in the General Permit, and will include toxic and bio-accumulating waste.

The NOI propose significant pollutant discharge volumes that are entirely unanticipated and unevaluated in the NPDES General Permit, Arctic Ocean Discharge Criteria Evaluation (ODCE) or justified by existing Oil &Gas exploration operations in the Chukchi and Beaufort Seas.[16]

a. The NOI Are Mischaracterized to Fit Under the NPDES Discharge Categories Listed in the General Permit.

Table 1 below evaluates discharges for the five (5) proposed exploration wells in the Chukchi Sea for which the discharger has requested discharge approval under the General Permit. Additionally, the two (2) proposed exploration wells in the Beaufort Sea are listed in Table 1 because it is significant that these wells are also planned for the same period, from July through October 2010.

The proposed NOI effluent discharges are inaccurately characterized to fit under the NPDES discharge categories listed in the General Permit.[17] The effluent discharges are un-quantified in terms of toxic waste pollutant loads, and the discharges lack assessment concerning aggregate effects of the waste composition being released. Moreover, because the NOI fail to address toxicity and bioaccumulation impacts on the prey species for whales, seals and fish, all subsistence resources are directly affected.

Figure 1 and Table 2, also below, show the project well discharge rates based on the NOI. Table 2 specifically shows project discharge rates for 10 of the 11 proposed Chukchi Sea discharges from the Burger F well. The Burger F is representative of the other four wells because all the discharge rates from the other exploration wells are similar. The proposed Discharge Number 012 - Excess Cement Slurry was not included in the figure because it is listed as a smaller one-time discharge volume.

b. The Contemplated Thermal Discharge Volume Alone Triggers Need for Individual Permit.

The biocide-treated thermal discharge contemplated by the proposed action is 9 to 13.5 times the amount considered in the General Permit. This increase in volume from that contemplated in the General Permit has presumably resulted from altered thermal controls for engines and machinery cooling system design control standards.[18] This proposed discharge also invokes 40 CFR

[16] *See* Page B-6 of the ODCE: Table 2-6. Quantities and Discharges in Arctic Alaska (1997-2003).

[17] *See* Table 4, at the end of this report, for a list of waste discharges proposed for discharge under the NPDES General Permit.

[18] Christen Knak, 1990, *Diesel Motor Ship's Engines and Machinery* states on page 393 that "The amount of salt water cooling is adjusted so that it is heated only to approximately 10 °C to 15 °C."

122.28(b)(3)(i)(E), such that the contemplated volumes of discharge are no longer appropriately controlled by the General Permit.

i) <u>Requirements of Clean Water Act Sections 316(a) and (b)</u>

The large magnitude seawater intake for the non-contact cooling water, of between 1.9 to 2.9 million gallons per day (mgd), requires a specific Arctic Ocean site and facility evaluation. This is consistent with the objectives of an NPDES individual permit, which identifies limits on discharges that are a significant contributor of pollutants. Specifically, this is pursuant to the CWA 316(a) requirement:

> **Effluent limitations that will assure protection and propagation of balanced, indigenous population of shellfish, fish, and wildlife**
>
> With respect to any point source otherwise subject to the provisions of section 1311 of this title or section 1316 of this title, whenever the owner or operator of any such source, after opportunity for public hearing, can demonstrate to the satisfaction of the Administrator (or, if appropriate, the State) that any effluent limitation proposed for the control of the thermal component of any discharge from such source will require effluent limitations more stringent than necessary to assure the projection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made**, the Administrator (or, if appropriate, the State) may impose an effluent limitation under such sections for such plant, with respect to the thermal component of such discharge (taking into account the interaction of such thermal component with other pollutants), that will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on that body of water**. [19] (Emphasis added)

Section 316(b) also supports the necessity of an Arctic Ocean site and facility evaluation:

> **Cooling water intake structures**
>
> Any standard established pursuant to section 1311 of this title or section 1316 of this title and applicable to a point source shall **require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact**. (Emphasis added).

c. *Significant Divergence of Proposed NOI from General Permit.*

<u>Table 3</u> below evaluates the six (6) primary issues relating to proposed NOI divergence from the conditions evaluated in the ODCE and GP. These differences render the proposed NOI as inaccurate characterizations unsuitable for coverage under the general permit. The actual discharge being proposed is extensively more polluting, of higher volume and ultimately more

[19] Clean Water Act §1326(a).

environmentally destructive than the NOI acknowledge. The NOI thus considerably exceed the adverse conditions anticipated in the GP and the ODCE.

3. The quantity and nature of the waste proposed for discharge into the Chukchi Sea are potentially harmful to endangered species such as the bowhead whale and to the public health.[20]

As indicated above, the quantities of discharge associated with Shell's 2010 Chukchi Exploration Plan are outside the scope of the general permit. The nature of the waste contained within the discharge is also outside the scope. The toxic effects of metals and their environmental and food chain transport have been the subjects of recent studies in arctic regions. Thus it has been established that anthropogenic contributions of heavy metal contaminants to air, water, soil and food impact the fauna of the Arctic and the consumers of these animals. Most metals can affect multiple organ systems, but frequently each metal has a critical effect seen in a specific organ or tissue.

Trace metals, including toxic metals, occur naturally in the environment and many are essential for life. However, some toxic metals have increased in the biosphere significantly over time. The dose of metal exposure is the amount of metal in an organ manifesting a toxicologic effect. This is a function of time as well as exposure to a metal. A single measurement of a metal in a tissue may be indicative of a recent exposure or of a more chronic, long-term exposure, depending upon the tissue and its particular retention time for that element. This, in turn, is influenced by the biological half-life of the metal. This is important when designing studies dealing with elements in marine mammals. Small sample numbers and single time testing regimes may not provide an accurate representation of the metal in the particular tissue/organism of interest. A well-designed study will cover a variety of organs, tissue types and tissue depths from a variety of age groups over different times of the year and, optimally, will include animals in different reproductive stages. Samples should be gathered from different geographic regions, as well. Antagonistic and synergistic influences of metals on the accumulation and effects of each other must also be taken into account. These are just a few of the many factors that must be considered when making comparisons of toxin levels in marine mammals.

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[20] Prepared by Cheryl Rosa, D.V.M., Ph.D., *Environmental Impact of Industrial Pollutants*, NSB Department of Wildlife Management.

Dr. Cheryl Rosa is a Wildlife Veterinarian and Research Biologist for the NSB Department of Wildlife Management. She has reviewed Shell's disposal plans and has identified a number of concerns related to disposal of industrial pollutants (such as muds and cuttings) in subsistence use areas because they contain heavy metals and other substances which bioaccumulate in subsistence foods which are ultimately eaten by the NSB residents.

Dr. Rosa's doctoral thesis focused on the impacts of industrial toxins on subsistence resources in the Arctic; she specifically studied toxicity impacts and bioaccumulation of toxins such as mercury and cadmium (among other toxins) in the bowhead whale. She has personally examined the health of hundreds of bowhead whales and has provided data from additional peer-reviewed publications on other cetaceans (mysticetes and odontocetes), pinnipeds (seals and walrus) and an ursid (polar bear) that represent the marine mammals of the Arctic. It is these experiences she draws from when summarizing concerns of the local community.

In general, metal concentrations are low in seawater; however, if heavy metals are introduced into the Chukchi Sea, they will become more "bioavailable" to the invertebrates at the base of the Arctic Ocean food web in comparison with warmer ocean areas, because of the amount of organic material that can bind with them and cause them to settle at greater depths. Shell has not provided any toxicology data or analysis to show their proposed discharges will not be toxic to subsistence resources or humans. Shell would need to show that the toxins are either not biologically available to subsistence resources, and that these toxins do not bioaccumulate to a level that his harmful the subsistence resource itself and the humans who consume it.

Phytoplankton and zooplankton are well known to bioaccumulate metals and are the principal prey for baleen whales, some pinniped species, and fish, which, in turn are prey for toothed whales and most pinnipeds. Cadmium accumulates more effectively in the bowhead whale and other baleen whales, whereas mercury tends to increase in beluga.

As the drilling muds are discharged they will be distributed through the water column and suspended for a time, until they finally reach the seabed floor. The marine mammals feeding in this area at the time of discharge will ingest drilling muds that are available in the water column at the time they are moving through. Since drilling muds are typically disposed of in batches, a whale feeding near the drilling ship could be exposed to these drilling muds while feeding or migrating.

Shell has not provided any data to show how much industrial pollution will bioaccumulate in the subsistence resources, nor has Shell provided information on the effects these metals may have on the health of marine species that are consumed by subsistence users.

A brief summary of Dr. Rosa's work on the Bering-Chukchi-Beaufort stock of bowhead whales is provided below. Published information on other Arctic species has also been provided. Dr. Rosa's research and the literature review below show that both cadmium and mercury pollution are present in variable amounts in animals used for subsistence foods. Shell has not provided any scientific evidence or human toxicological data to support the safety of increasing the amount of toxins in the subsistence food sources by introducing additional heavy metals into the Chukchi Sea. It would not be sound scientific practice to introduce such a high volume of discharge, particularly harmful toxins, into the marine environment without understanding the site-specific impact on endangered species, subsistence foods, marine animals and humans.

a. Specific Biological Impacts

i. Cetaceans.

Cetaceans radiate from several distinct evolutionary lines. It stands to reason that these different groups bioaccumulate metals in different ways and exhibit different effects from toxic exposures. In the Arctic, the primary odontocete species studied include the beluga whale *(Delphinapterus leucas)* and the narwhal *(Monodon monoceros)*. These whales occupy the top of the food chain, being mainly piscivorous. The mysticete species whose range is primarily in the Arctic is the bowhead whale *(Balaena mysticetus)*. These whales consume prey on a low trophic level, feeding on the zooplankton, which constitute the base of the arctic food web. Bratton et al.

(1997) and O'Shea and Brownell (1994) found that comparison of available data revealed that, in general, mysticete whales have lower concentrations of metals residues in their tissues than odontocetes, with the exception of cadmium. Other factors which may apply to both groups are evident, such as large body size, unusually low mass-specific metabolic rates, physiological and biochemical adaptations for deep diving, large storage compartments (blood, lipid), and wide amplitudes of seasonal cycles in fat storage and mobilization (O'Hara and O'Shea 1999).

ii. Pinnipeds.

The marine mammals that make up the pinniped groups in the Alaskan Arctic (the ice seals) include the bearded seal, the spotted seal, the ribbon seal, the bearded seal *(Erignathus barbatus),* the ringed seal *(Phoca hispida)* and the walrus (Odobenus rosmarus). Major factors influencing heavy metal contaminant load in these seals include individual species' diet and the region that the species inhabits. Animals feeding in benthic zones (bearded seals) and on the bottom (walrus) are likely to have a greater exposure to metals-containing sediment as compared to seals that feed higher in the water column. Prey choice will have effects as well, for example, species that feed heavily on squid, which are known to contain high levels of cadmium, will most likely have higher levels of cadmium in their livers and kidneys. Prey choice may also exhibit regional and seasonal variability. In addition, many of these seals are apex predators, feeding on a variety of prey species that have the potential to bioaccumulate toxins and thus biomagnify these toxins up the food chain to the seals.

iii. Polar Bears.

Several researchers have investigated trace minerals and metals in polar bears in the Arctic and Greenland, secondary to petroleum and mining development in these regions. Polar bears are apex predators, with diets consisting mainly of seals (predominantly ringed and bearded seals). It has been shown that ringed seals are the predominant food source in the eastern Arctic (bearded seals <3%) and that bearded seals make up a greater percentage of the polar bear diet (13-24%) in the western Arctic. This is significant as the bearded seal has more benthic feeding habits that may affect the types and amounts of accumulated toxins. Bearded seals are thought to accumulate Hg 15 times faster than ringed seals in certain regions of the Arctic. Walruses (bottom feeders) may also be more available as carrion to polar bears in the western Arctic. The possible effect of Hg on bears is of concern, especially in northern Alaskan regions where Hg levels are high, though Lentfer *et al.* captured over 600 polar bears from the region in 1980 and saw no obvious signs of mercury intoxication (Lentfer, 1976). Polar bears serve as a bio-indicator species for arctic development in some regions (i.e. indicators of environmental mercury burden), although overlap of sub-populations and lack of baseline data have made interpretation of these data difficult.

iv. Contaminant Exposure.

The NSB's review of the projected waste streams associated with the 2010 exploration drilling underlying the proposed NOI is attached for your review.[21]

Additionally, the NSB has identified potential acute biological effects associated with the discharges as reported in available literature:

1) Altered benthic communities dominated by short-lived, opportunistic polychaetes.

2) Decreased abundance of typical species (i.e., barnacles) within the mixing zone.

3) Species mortality in discharge zone (e.g. oysters).

Potential chronic effects reported in the literature:

1) Impacts on the surface microlayer surrounding exploration/production platforms;

2) Altered benthic community species composition (plant and animal);

3) Altered behavior and physiology, reduced growth and decreased fecundity of exposed laboratory species;

4) Induced or inhibited enzyme systems and other molecular effects;

5) Reduced immunity to disease and parasites;

6) Histopatholgical lesions and other cellular effects;

7) The potential for tainted flesh in subsistence foods (ie., fishes);

8) Chronic mortality. [22]

All of these effects are proposed to take place where human food migrates and is ultimately harvested.

b. Health Impacts.

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[21] *See* Attachment 3, NSB comments on Shell's 2010 Camden Bay Exploration Plan, included herewith by reference. While the exploration activity reviewed in that proposal is in the Beaufort Sea, the NOIs and discharges are identical.

[22]

Bratton GR, Flory W, Spainhour CB, Haubold EM. Assessment of selected heavy metals in liver, kidney, muscle, blubber, and visceral fat of Eskimo harvested bowhead whales from Alaska's north coast, Final Report (North Slope Borough, Department of Wildlife Management) Barrow, Alaska. 1997; 233 pp.

O'Hara T, O'Shea, TJ. (1999) *In*: Reynolds, J.E. and Rommel, S.A editors. *Biology of Marine Mammals*. Smithsonian Books, Washington, D.C. 2002. 578 pp.

O'Shea TJ, Brownell RL. Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservation implications. Sci Tot Environ 1994; 154: 179-200.

A detailed health impact analysis is not available for this specific proposed action.[23] The NSB however has reviewed international best practices for managing OCS discharges, and found that community concern over potential contamination, coupled with acknowledged data gaps (such as the lack of baseline data regarding current levels of contaminants produced by local oil and gas operations in subsistence species (U.S. DOI BLM 2007), and the absence of any quantitative nutritional data delineating the amount of subsistence foods consumed), creates uncertainty in such assessments. Whalers are meticulous while on the ice during spring whaling in their efforts to prevent even miniscule amounts of contaminants from contacting whales (Lohman 2007, personal communication). Fears about contamination are well-documented causes for decreased participation in subsistence activities and decreased consumption of subsistence foods (Ballew et al., 2004; Poppel et al. 2007). In this case, the recognized data gaps regarding the subsistence consumption contaminant exposure pathway could contribute to these fears and exacerbate the problem. Decreased consumption of subsistence foods would constitute an adverse effect on the nutrition and physical activity of NSB residents. Similarly, decreased consumption of subsistence foods could create an incremental increased risk of problems such as diabetes, obesity, and hypercholesterolemia. As described above, any adverse impact on subsistence would increase stress in communities, which constitutes an adverse effect on public health.

An individual permit would allow for a fuller consideration of Executive Order 12898, disproportionate impacts, as well as CEQ regulations relating to health impact assessment.

3. Other relevant factors - significant difference in the nature of the effluents and the discharges contemplated by the general permit and the threat of disproportionate impact to the Inupiat Native Population of the North Slope.

The following are additional relevant considerations that demonstrate the need for an individual permit under the CWA.

a. Ocean Discharge Criteria for Toxic and Bioaccumulating Chemicals.

Allowance of the proposed five NOI discharges into the Chukchi Sea will result in unreasonable degradation of the environment in violation of CWA 403 - Ocean Discharge Criteria. Specifically, there would be a violation of 40 CFR 125.122 because information of quantities, composition and potential for bioaccumulation or persistence of the pollutants to be discharged has been ignored and omitted in the NOI; and a violation of 40 CFR 125.123, particularly (b) and (c), because EPA cannot issue an authorization to discharge under the NPDES program without knowledge of the magnitude and impact of significant toxic and bioaccumulating discharges.

Drilling fluids, muds and cuttings proposed for discharge under the NOI, and containing large amounts of suspended solids incorporating toxic and bioaccumulating metals and hydrocarbons, are eventually deposited on the seafloor. If approved under the GP, the failure of the NOI to accurately compare compositions and properties to environmental impact criteria, including the EPA sediment criteria used in the GP, will result in ocean dumping violations of 40 CFR 227.5 for prohibited materials.

[23] *But see* Attachment 2, part 3, and Dr. Aaron Wernham's Declaration regarding O & G related health impacts.

Moreover, 40 CFR 227.27 limits the permissible concentration, thus restricting ocean dumping of materials. Particularly, federal regulation ties the permissible limits to bioassays conducted with EPA-approved measures, which include whole effluent testing methods described in the subsection *Required Reports Relied Upon By Discharger are Omitted in NOI.* Accordingly, 40 CFR 227.27 requires:

> § 227.27 Limiting permissible concentration (LPC).
>
> (a) The limiting permissible concentration of the liquid phase of a material is:
>
> (1) That concentration of a constituent which, after allowance for initial mixing as provided in §227.29, does not exceed applicable marine water quality criteria; or, when there are no applicable marine water quality criteria,
>
> (2) That concentration of waste or dredged material in the receiving water which, after allowance for initial mixing, as specified in §227.29, will not exceed a toxicity threshold defined as 0.01 of a concentration shown to be acutely toxic to appropriate sensitive marine organisms in a bioassay carried out in accordance with approved EPA procedures.
>
> (3) When there is reasonable scientific evidence on a specific waste material to justify the use of an application factor other than 0.01 as specified in paragraph (a)(2) of this section, such alternative application factor shall be used in calculating the LPC.
>
> (b) The limiting permissible concentration of the suspended particulate and solid phases of a material means that concentration which will not cause unreasonable acute or chronic toxicity or other sublethal adverse effects based on bioassay results using appropriate sensitive marine organisms in the case of the suspended particulate phase, or appropriate sensitive benthic marine organisms in the case of the solid phase; and which will not cause accumulation of toxic materials in the human food chain. Suspended particulate phase bioaccumulation testing is not required. These bioassays are to be conducted in accordance with procedures approved by EPA, or, in the case of dredged material, approved by EPA and the Corps of Engineers.
>
> (c) Appropriate sensitive marine organisms means at least one species each representative of phytoplankton or zooplankton, crustacean or mollusk, and fish species chosen from among the most sensitive species documented in the scientific literature or accepted by EPA as being reliable test organisms to determine the anticipated impact of the wastes on the ecosystem at the disposal site. Bioassays, except on phytoplankton or zooplankton, shall be run for a minimum of 96 hours under temperature, salinity, and dissolved oxygen conditions representing the extremes of environmental stress at the disposal site. Bioassays on phytoplankton or zooplankton may be run for shorter periods of time as appropriate for the organisms tested at the discretion of EPA, or EPA and the Corps of Engineers, as the case may be.
>
> (d) Appropriate sensitive benthic marine organisms means two or more species that together represent filter-feeding, deposit-feeding, and burrowing characteristics. These organisms shall be chosen from among the species that are most sensitive for each type they represent, and that are documented in the scientific literature and accepted by EPA as being reliable test organisms to determine the anticipated impact on the site.

b. Applicability of NEPA to the Proposed Discharges

As proposed in the NOI, the discharges to do not meet the requirements of the General Permit and must be considered new sources under 40 CFR 6.101. That is: Part 6—Procedures for Implementing the National Environmental Policy Act and Assessing the Environmental Effects

Abroad of EPA Actions. Specifically Subpart A—General Provisions for EPA Actions Subject to NEPA states:

> § 6.101 Applicability.
>
> (a) Subparts A through C of this part apply to the proposed actions of EPA that are subject to NEPA. EPA actions subject to NEPA include the award of wastewater treatment construction grants under Title II of the Clean Water Act, **EPA's issuance of new source National Pollutant Discharge Elimination System (NPDES) permits under section 402 of the Clean Water Act**, certain research and development projects, development and issuance of regulations, EPA actions involving renovations or new construction of facilities, and certain grants awarded for projects authorized by Congress through the Agency's annual Appropriations Act. [Bold added]

According, NEPA assessment is required, at 40 CFR 6.205, where a proposed action is expected to result in environmental impacts:

> § 6.205 Environmental assessments.
>
> (a) The Responsible Official must prepare an environmental assessment (EA) (see 40 CFR 1508.9) for a proposed action that is expected to result in environmental impacts and the significance of the impacts is not known. An EA is not required if the proposed action is categorically excluded, or if the Responsible Official has decided to prepare an EIS. (See 40 CFR 1501.3.)
>
> (b) Types of actions that normally require the preparation of an EA include:

Including

> (2) EPA's issuance of new source NPDES permits under section 402 of the Clean Water Act;

c. Endangered Species Act Section 7 Consultation

The ODCE recognizes the threatened and endangered species in the areas of discharge including the bowhead whale, and spectacled and Steller's eiders.[24] Adverse impacts from discharges potentially resulting in a decline in abundance and/or change in distribution must be addressed under the Endangered Species Act. (ESA) The proposed discharge directly affects large numbers of prey species such as copepods, krill, juvenile fish and other organisms that whales, seals, fish, crustaceans and other animals rely on.

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq) requires federal agencies, in consultation with and with the assistance of the Secretaries of Commerce and Interior, to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of endangered or threatened species or destroy or adversely modify designated critical habitat. The principles, practices, and protocols for section 7 consultations are identified in the ESA, and regulations promulgated in 1986 for implementing section 7 (50 CFR. Part 402), further expound the procedural and substantive requirements for consultation.

d. Site-Specific EPA Temperature Criteria

[24] ODCE, Page 4-2, last bulleted item.

Consistent with the necessity of an individual permit, the EPA *Criteria for Water* (1986) support performing an arctic site-specific evaluation of the thermal discharge stating for:

> Marine Aquatic Life
>
> In order to assure protection of the characteristic indigenous marine community of a water body segment from adverse thermal effects:
>
> a. The maximum acceptable increase in the weekly average temperature resulting from artificial sources is 1.0 C (1.8 F) during all seasons of the year, providing the summer maxima are not exceeded; and
>
> b. Daily temperature cycles characteristic of the water body segment should not be altered in either amplitude or frequency.
>
> Summer thermal maxima, which define the upper thermal limits for the communities of the discharge area, should be established on a site-specific basis.[25]

The temperature increase associated with the thermal discharge in this action is higher (at least 1.8 C), than that contemplated in the foregoing criteria. Site-specific analysis is thus appropriate.

e. Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898 on environmental justice. That Order focused federal agency attention on environmental and human health impacts to communities of color and low-income communities, and required federal agencies to incorporate achieving environmental justice into their missions. Thus, EPA must consider environmental justice when issuing and administering NPDES permits.

The National Environmental Justice Advisory Council ("NEJAC") is a federal advisory committee to EPA that specifically provides advice on environmental justice issues. As a result of its December 2001 meeting, NEJAC issued the report, "Fish Consumption and Environmental Justice." That report states:

[C]ommunities of color, low-income communities, tribes, and other indigenous peoples *depend* on healthy aquatic ecosystems and the fish, aquatic plants, and wildlife that these ecosystems support. While there are important differences among these various affected groups, their members generally depend on the fish, aquatic plants, and wildlife to a greater extent and in different ways than does the general populations. These resources are consumed and used to meet nutritional and economic needs. For some groups, they are also consumed or used for cultural, traditional, or religious purposes. For members of these groups, the conventional understanding of the 'health benefits' or 'economic benefits' of catching, harvesting, preparing, and eating fish, aquatic plants, and wildlife do not adequately capture the significant value these practices have in their lives and the life of their culture.

[25] EPA, 1986, *Criteria for Water*, Page 275 under the Section "Temperature".

"Fish Consumption and Environmental Justice" (as revised in November 2002), p. iv-v (emphasis in original). NEJAC also stated, "The [federal] trust responsibility requires the federal government and its agencies to uphold the highest fiduciary standards when its actions affect the well-being of Alaska Native villages, their property (including subsistence rights), resources, and culture." *Id.* At 132.

The Inupiat people rely on the Chukchi Sea for subsistence foods, which support their traditional way of life. As a result, EPA has a heightened duty to ensure that the proposed discharge protects the habitat and water quality that sustains their subsistence practices.

II. THE INACCURATE AND INCOMPLETE CONTENTS OF THE NOI DO NOT COMPLY WITH THE REQUIREMENTS OF 40 C.F.R. § 122.28(b)(2)(ii) AND THE GENERAL PERMIT.

40 C.F.R. § 122.28(b)(2)(ii) requires that "[t]he contents of the notice of intent shall be specified in the general permit and shall require the submission of information necessary for adequate program implementation, including at a minimum, the legal name and address of the owner or operator, the facility name and address, type of facility or discharges, and the receiving stream(s).

As demonstrated below and more specifically in Appendix A, the NOI fail to provide the information required by 40 C.F.R. § 122.28(b)(2)(ii) and the GP. A number of fundamental problems exist regarding the accuracy and completeness of the NOI. These include impossible exploration timing assumptions that undercut the accuracy of waste flow rates for the drillship. An evaluation of all five (5) NOI wells was carried out in detail for accuracy, omissions and completeness.

Appendix B, also attached, contains an example of omitted line drawing(s) of the waste streams and absent waste source amounts. Appendix B is based on the discharger submitted NOI for the Burger F exploratory well and serves as a direct example of the significant problems associated with the NOI submittals for all five (5) wells.

A. The Reported Duration and Discharge Rates of Exploration Drilling in the NOIs is Impossible in Light of the Actual Time Available for 2010 Exploration Activities.

Exploration duration and availability of the drillship Frontier Discoverer is a major schedule contradiction. This is because the proposed duration of exploration of about 185 days exceeds the actual period during which the drillship is available, which is only about 120 days. This schedule conflict is evaluated in Table 1, which shows that rather than spending 37 days at each well site, the drillship will only spend 24 days at each site. Only 24 days are actually available. This follows from the calculation that only 65% of the proposed time is actually available.[26]

This time conflict results in significant misrepresentation of the materials proposed for discharge relative to GP requirements because the discharge rates for each of the proposed discharge types is significantly increased when the data provided are adjusted to actual times the drillship will be

[26] Available 120 days divided by proposed 185 days equals the fraction 0.65, i.e., 65%.

available at each drill-site. This is compared to the discharge rates reported in the NOI table for each of the five exploration wells. To put it another way, in order to discharge the total volumes reported in the NOI table in the actual amount of time at each drillsite, the discharge rate MUST increase. It means that all the proposed discharge rates are at least 150% of what has been reported in the NOI table for each of the 5 wells. Moreover, the discharge volumes contain large amounts of toxic and bioaccumulating chemicals. So as discharge rate intensity increases, the pollutant load intensity increases.

B. Errors in Discharge Type Water Depths

All five of the NOI for the Chukchi Sea have numerous errors in discharge water depth for the various discharge types. These errors consistently exaggerate dilution in the 100-meter mixing zone[27] identified in the Ocean Discharge Criteria[28] surrounding the drillship Frontier Discoverer and minimize the apparent biological impact of the various discharges.

C. Required Facility Information and Waste Load Quantities Omitted in NOI.

The five NOI for the proposed discharges into the Chukchi Sea are required by the General Permit to provide line drawings, and to construct waste flow balances, containing facility information:[29]

> The line drawing must show flows of discharged waste streams through the facility. Indicate intake sources, operations contributing to the effluent, and treatment units labeled to correspond to the discharges (001 - 014). Construct a flow balance on the line drawing by showing average flows between intakes, operations, treatment units, and outfalls. If a flow balance cannot be determined, provide a pictorial description of the nature and amount of any sources, and any collection or treatment measures.

The NOI contain no line drawings showing waste streams through the facility, which indicate intake sources, operations contributing to the effluent and treatment units. Moreover, no flow balance has been provided on any line drawings showing flows between intakes, operations, treatment units and outfalls. Nor was an accurate description provided of the nature and amount of any sources, nor any collection or treatment measures, with the exception of total discharge volumes in the NOI table. The table provided in each of the NOI included only waste discharge volumes but absolutely no toxic and other waste amounts to be discharged.

D. Required Reports Relied Upon By Discharger are Omitted in NOI.

None of the five (5) NOI for the proposed discharges into the Chukchi Sea provides the necessary reports for special monitoring, biological surveys, and environmental reports as required in the NOI.[30] These are reports the discharger substantially relied upon in assembling

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[27] Baumgartner, *et al.*, 1994, *Dilution Models for Effluent Discharges*, Third Edition.
[28] *See* 40 CFR 125.121(c)).
[29] General Permit AKG280000, Attachment 1 – Notice of Intent Information Sheet, Page A1-3, under "Special Conditions".
[30] *Id.*

the NOI. Missing reports substantially relied upon by the discharger include, but are not limited to;

1) Effluent characterization of drilling muds, fluids and cuttings and ODC model results of mixing zone deposition of suspended solids from the #001 and #013 discharges including pollutant amounts of toxic metals, hydrocarbons and biocides related to sediment criteria supporting the GP and the ODCE.

2) Thermal discharge analysis for NPDES Discharge Number 009 – Non-Contact Cooling Water including the OOC model of the effluent mixing zone and the effluent characterization used to determine the discharge temperature and biocide load. The effect of the thermal discharge on biological indicators is subject to the EPA temperature Criteria for Water[31] but is analyzed nowhere in the NOI reporting.

3) Thermal intake structure analysis and reporting required by the CWA 316(b) to ensure environmental and biological impact is minimized.

4) Whole effluent toxicity (WET) testing and evaluation required by the TSD cited in the General Permit. EPA guidance documents include *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (2002); and *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms* (2002).

[31] EPA, 1986, *Criteria for Water*, Page 275, see under "Temperature" heading.

Table 1. Seven (7) NOI for Discharges to the Beaufort and Chukchi Seas
Proposed Non-Contact Cooling Water Discharges by the Drillship *Frontier Discoverer* for Shell Exploration & Production Company
Starting July 4, 2010 (Chukchi) and July 10, 2010 (Beaufort) through October 31, 2010.

Well Name & No.	Reported Estimated Duration (days)	Reported Total Discharge Amount (bbl/well)	Reported Total Discharge Amount in gallons/well	Reported Average Discharge Rate (bbl/day)	Reported Average Discharge Rate (gallons/day)	Reported Average Discharge Rate in gallons/min	Effective Duration[B,C] Based on Number of Days Available (days)	Effective Discharge Rate (gallons/day)	Effective Discharge Rate (gallons/min)
Chukchi Sea Receiving Waters									
Burger F	37	1,665,000	69,930,000	45,000	1,890,000	1,312.5	24	2,913,750	2,023.4
Burger C	37	1,665,000	69,930,000	45,000	1,890,000	1,312.5	24	2,913,750	2,023.4
Burger J	37	1,665,000	69,930,000	45,000	1,890,000	1,312.5	24	2,913,750	2,023.4
CrackerJack C	37	1,665,000	69,930,000	45,000	1,890,000	1,312.5	24	2,913,750	2,023.4
SW Shoebill C	37	1,665,000	69,930,000	45,000	1,890,000	1,312.5	24	2,913,750	2,023.4
Chukchi Subtotals	185		349,650,000				120		
Adusted Chukchi Subtotals[A]	***111***		***209,790,000***				***72***		
Beaufort Sea Receiving Waters									
Sivulliq N	34	1,530,000	64,260,000	45,000	1,890,000	1,312.5	22	2,913,750	2,023.4
Torpedo H	40	1,800,000	75,600,000	45,000	1,890,000	1,312.5	26	2,913,750	2,023.4
Total Number of Days Reported=	**185**	Total Vol.=	**349,650,000** gallons		Total Number of Days Available= **120**				

[A] Based on only 3 of 5 wells being explored in the summer/fall of 2010.
These adjusted subtotals are used in the calculations for Reported Total Number of Days & Volume Intake/Discharge.

[B] Calculate the Duration Error Factor (actual number of proposed days divided by available days) = (185/120) = 1.54 154%

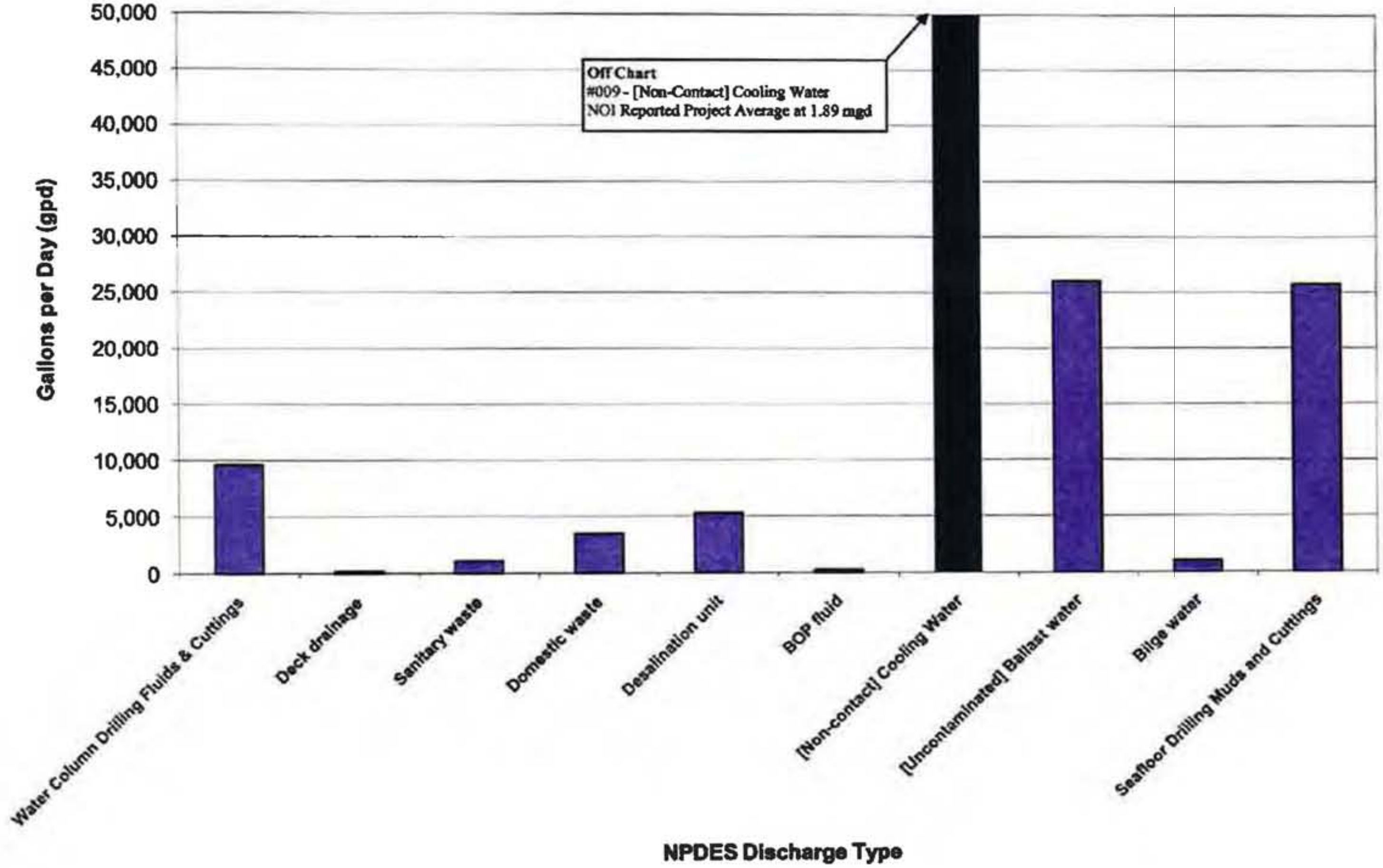
[C] Divide the Reported Estimated Duration days by the Error Factor to get the Effective Duration in days.

one barrel (bbl) = 42 gallons

Actual Number of Days Available

July	28	
August	31	Not subtracting for the number of days required for the whale hunts.
September	30	Not subtracting for the number of days required for the whale hunts.
October	31	
Total Number of Days Available=	120	

Figure 1. Chukchi Sea: Burger F Well - NOI Reported Average Project Discharge Volumes During O&G Exploration (Close-up Scale)
On Gallons-per-Day Unit Basis for Ten (10) of the Proposed Discharge Types



□Table 2. Chukchi Sea: Burger F Well - NPDES Notice of Intent (NOI) to Discharge Reported Project Total and Average Discharge Volumes for Proposed O&G Exploration

On Gallons-Per-Day Unit Basis for Ten (10) of the Proposed Discharge Types

NPDES #	*For Chukchi Sea: Burger F Well* Type of Waste[A]		Reported Total and Average Discharge Volumes in bbl Total	Average	in gallons[B] Total	Average
#001	Water Column Drilling Fluids & Cuttings	Disposal Caisson	7310	229	307,020	9,618
#002	Deck drainage	Disposal Caisson	185	5	7,770	210
#003	Sanitary waste	Disposal Caisson	1000	27	42,000	1,134
#004	Domestic waste	Disposal Caisson	3071	83	128,982	3,486
#005	Desalination unit	Disposal Caisson	4625	125	194,250	5,250
#006	BOP fluid	Seafloor	42	7	1,764	294
#009	[Non-contact] Cooling Water	Surface	1,665,000	45,000	69,930,000	1,890,000
#010	[Uncontaminated] Ballast water	Disposal Caisson	22940	620	963,480	26,040
#011	Bilge water	Disposal Caisson	1000	25	42,000	1,050
#013	Seafloor Drilling Muds and Cuttings	Seafloor	3070	614	128,940	25,788
		Overall Project Total and Average=			71,746,206	1,962,870

[A]Sorted by NPDES Discharge Type and Number

[B]1 barrel (bbl) = 42 gallons

Tab2_Quantities to Chukchi Sea

Table 3. Proposed NOI – Significant Divergence from General Permit AKG280000

ID	Divergence from GP Issue	Description	NPDES Discharge Number Affected
1	Reported Total Project Duration is Physically Impossible.	At least 185 days of operation are proposed in the Chukchi and Beaufort Seas NOI for the drillship Frontier Discoverer. However, only a maximum of 120 days are available in the year 2010 exploration period.	All project average flow rates are affected with an error of at least 150% of NOI reported discharge rates. These rates are directly calculated from the erroneous NOI project durations for each well. This adversely affects the reported discharge rates for #001, #003, #004, #005, #009, #010, #011, and #013. Adverse effects result because more pollutants are being released in a shorter period of time than reported in the NOI.
2	Proposed Discharges of Drilling Muds, Fluids and Cuttings ignore EPA Sediment Criteria for toxic materials.[1]	The discharger ignored EPA sediment criteria used in the GP and ODCE, and relating to discharge of suspended solids waste concentrations of muds and cuttings. The discharger omitted or relied exclusively on sediment criteria not considered in the GP.	Waste discharges from the drilling muds, fluids and cuttings discharge categories #001 and #013 exceed toxic and bioaccumulating pollutant loads considered by EPA in the GP and ODCE. These toxic and bioaccumulating chemicals include metals, hydrocarbons and potentially chlorinated organics. See Trefry and Trocine (2009), *Chemical Assessment in Camden Bay (Sivulliq Prospect and Hammerhead Drill Site), Beaufort Sea, Alaska.*
3	Seawater thermal intake and discharge is excessive ignoring NOAA Fisheries criteria for minimizing intake flow velocities, and other mitigation measures, related to the mortality and survival of Arctic aquatic organisms. Moreover, the discharger ignores EPA water quality criteria for temperature, toxics and bioaccumulating chemicals.	At a magnitude of 2.9 mgd, the Average Daily Flow (ADF) rate is 13.5 times the rate anticipated in the GP and ODCE for non-contact cooling water. At 1.9 mgd, which is the discharge rate reported in the NOI for [non-contact] cooling water, the proposed thermal discharge is 9 times[2] the rate anticipated in the general permit.	#009 – [Non-contact] Cooling Water All other seawater intakes competing for seawater are adversely affected by the excessive operation of the large magnitude thermal intake. These include at least: #001 - Drilling Fluids and Drilling Cuttings; #005 - Desalination Unit Wastes; #010 - [Uncontaminated] Ballast Water; and #013 - Mud, Cuttings, Cement at Seafloor. Reported thermal structure intake velocities exceed recommended conservation measures for fish criteria.[3] The criteria limit intake velocities, among other design considerations, to 0.5 feet per second. However, the discharger reported a value of 0.7 fps without supporting analysis of the fish intake structure.[4] Additionally, the flow rate and reported velocity are actually higher being at least 150% of reported values, i.e., the actual velocity is at least 1.0 fps, exceeding the recommended criteria by a factor of two. Thermal discharge is subject to EPA temperature Criteria.

Table 3 Continues on Next Page.

[1] EPA. 1985, sediment criteria used in GP is from *Assessment of Environmental Fate and Effects of Discharges from Oil and Gas Operations* (EPA 440/4-85/002). 1985.
[2] Arctic Ocean Discharge Criteria Evaluation (ODCE, 2006), Page 2-15, 2nd par., 2nd sentence under section 2.4.4. Non-Contact Cooling Water of the Arctic ODCE for the NPDES permit AKG280000 only anticipated flows up to 0.21 mgd but 1.89 mgd is proposed in the NOI. This results from 1.89 divided by 0.21, i.e., greater flow rate by 1.89/0.21=9 times.
[3] Page 93, Number 2 under Recommended Conservation Measures. NOAA Fisheries. 2009. *Management Plan for Fish Resources of the Arctic Management Area*, North Pacific Fishery Management Council Fisheries.
[4] See drillship Frontier Discoverer discussion on Page 27 of the main report for the Camden Bay Exploration Plan (CBEP), 1st paragraph under the section "Projected Cooling Water Intake".

Table 3. (Continued) **Proposed NOI – Significant Divergence from General Permit AKG280000**

4	Biocides addition of toxic and bioaccumulating chemicals and subsequent discharges exceed conditions anticipated by EPA in the GP and ODCE.	Average daily pollutant load from biocide treatment, for a 2.9 mgd magnitude cooling water (thermal) flow, is 13.5 times the addition anticipated in the GP and ODCE.	Also, for the NOI reported 1.9 mgd discharge rate for the [non-contact] cooling water (NPDES Discharge Number #009), the biocide pollutant load is 9 times[5] the addition anticipated in the general permit. All other discharges receiving biocide treatment are adversely affected by the excessive operation of the large magnitude thermal intake biocide addition. These include at least: #001 - Drilling Fluids and Drilling Cuttings; #010 - [Uncontaminated] Ballast Water; and #013 - Mud, Cuttings, Cement at Seafloor.
5	The NOI do not adhere to the EPA TSD guidance[6] used in the GP for toxic chemical, and other adverse, effects resulting from discharges into the Chukchi Sea	TSD guidance used in developing the GP is ignored in the NOI.[7] There is no NOI information for water quality criteria, reasonable potential analysis, waste load allocation or effluent limitation beyond those evaluated in the ODCE and GP.	All discharge types affected. Particularly: the excessive magnitude of the thermal discharge (#009); expansion of pollutant load of the biocide addition (#001, #009, #010 and #013); and the unanticipated increases in toxic sediment pollutant loads and discharges (#0012 and #013) are well beyond conditions considered in the ODCE and GP
6	Lack of adherence of the NOI to EPA guidance for whole effluent toxicity (WET).[8] The NOI and GP ignore the aggregate effect of the numerous toxic, and adverse, discharges emanating from the drillship *Frontier Discoverer*.	The TSD identified WET as an effluent characterization requirement for assessing the impact of discharges into receiving waters like the Chukchi Sea. The aggregate effect of the 11 proposed discharges was not considered in the NOI	The following toxic discharges act together adversely affecting conditions in the Chukchi Sea: #001, #003, #004, #005, #009, #010, #011, and #013.

[5] Arctic Ocean Discharge Criteria Evaluation (ODCE, 2006), Page 2-15, 2nd par., 2nd sentence under section 2.4.4. Non-Contact Cooling Water of the Arctic ODCE for the NPDES permit AKG280000 only anticipated flows up to 0.21 mgd but 1.89 mgd is proposed in the NOI. This results from 1.89 divided by 0.21, i.e., greater flow by 1.89/0.21=9 times.

[6] EPA TSD, 1991, *Technical Support Document for Water Quality-based Toxics Control*. See General Permit Fact Sheet page 12, II.C.1, under Subsection - Water Quality-based Evaluation, 2nd paragraph.

[7] The NPDES General Permit Fact Sheet (AKG2800000) states: "In determining whether water quality-based limits are needed and developing those limits when necessary, EPA follows guidance in the *Technical Support Document for Water Quality-based Toxics Control (TSD; EPA, 1991)*. The water quality-based analysis consists of four steps: (1) determine the appropriate water quality criteria that apply to each discharge, (2) determine if there is "reasonable potential" for the discharge to exceed the criteria in the receiving water, (3) develop a WLA if there is reasonable potential, and (4) develop effluent limitations based on the WLA."

[8] EPA TSD, Page 4, Section 1.3 Whole Effluent Approach for Aquatic Life Protection states: "The whole effluent approach to toxics control for the protection of aquatic life involves the use of acute and chronic toxicity tests to measure the toxicity of wastewaters. Whole effluent toxicity is a useful parameter for assessing and protecting against impacts upon water quality and designated uses caused by the aggregate toxic effect of the discharge of pollutants [16]. Whole effluent toxicity tests employ the use of standardized, surrogate freshwater or marine (depending upon the mixture of effluent and receiving water) plants, invertebrates, and vertebrates. EPA has published extensive written protocols listing numerous marine and freshwater species for toxicity testing [17, 18, 19]."

List of NOI Proposed Discharge Types

Table 4 lists all the NPDES Discharge Number and Types proposed for release of waste flows into the Chukchi Sea.

Table 4. Proposed Waste Discharges and Types for General Permit **(AKG280000)**

NPDES Discharge Number	Type of Waste
#001	Water Column Drilling Fluids & Cuttings
#002	Deck drainage
#003	Sanitary waste
#004	Domestic waste
#005	Desalination unit
#006	BOP fluid
#009	[Non-contact] Cooling Water
#010	[Uncontaminated] Ballast water
#011	Bilge water
#012	Excess Cement Slurry
#013	Seafloor Drilling Muds and Cuttings

NORWEGIAN ENVIRONMENTAL REGULATION OF OFFSHORE OIL AND GAS ACTIVITIES

Final Draft

Prepared for Mayor Edward S. Itta and
Andy Mack, Government and External Affairs Division
Office of the Mayor
North Slope Borough, Alaska

Daniel F. Fitzgerald
March 20, 2009

TABLE OF CONTENTS

APPENDIX

Political Map of Norway

Purpose of this Report

This report was prepared in response to the North Slope Borough Office of the Mayor's request for an analysis of Norway's regulation of offshore oil and gas activities. Principal concerns are measures relating to environmental protection, including water quality, air quality, noise/industrial disturbance, fisheries protection, and protection of subsistence activities.

I. INTRODUCTION TO THE NORWEGIAN PETROLEUM INDUSTRY

Oil exploration in Norway started in the late 1960s, with production following in 1971. Exploitation of oil and gas resources through nearly 40 years of operation has created value in excess of 6000 billion Norwegian kroner.[1]

Norway is the world's eleventh largest oil producer and sixth largest gas producer. It ranks higher as an exporter: Norway is the world's fifth largest oil exporter and third largest gas exporter. Norway's exports serve mainly European countries, but significant supplies also go to the U.S. and Canada.[2]

The petroleum sector is the largest industry in Norway, accounting for 24% of value creation in the country and 31% of government revenues in 2007. Employment in the sector, however, is less than 1% of the economy's total.[3] There is a general consensus among economists that petroleum has played a key role in Norway's impressive economic development over the last 30 years.[4]

The state is entitled to collect most of the value created from petroleum activities. The revenue stream to government from petroleum activities comes from corporate taxes,[5] CO_2 tax, NO_x tax, area fees,[6] direct ownership in fields on the Norwegian continental shelf through the State's Direct Financial Interest (SDFI),[7] and dividends

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[1] This is equal to U.S. $865,883,817,188 (value measured in current terms and converted with rates in effect December 14, 2008. The "billion" used by the Norwegian government with the kroner figure has nine zeros.) The State has received well over half of this amount. See Facts, The Norwegian Petroleum Sector 2008 at 14.

[2] Organization for Economic Co-operation and Development (OECD) Economic Survey of Norway, 2007, ch.1 annex 1 A1. See also, Facts, The Norwegian Petroleum Sector 2008 at 14. Liquefied natural gas from Snøvit will be exported to the U.S.

[3] Id.

[4] "During the last three decades, Norwegian GDP *per capita* has increased from 90% to 150% of the OECD average. Unemployment has been low except for a short period around 1990. The Norwegian government has considerably increased its net financial assets; erasing a net debt of close to 60% of GDP in the 1970s to build a Government Pension Fund that exceeded 100% of mainland GDP at the end of 2006. Compared to other OECD countries, economic growth has on average been half a percentage point higher annually over the past 30 years and real wage growth much higher." Organization for Economic Co-operation and Development (OECD) Economic Survey of Norway, 2007: The Petroleum Sector and Its Impact.

[5] Due to the extraordinary profitability of petroleum production, a special tax rate of 50% is levied on income from petroleum activities, in addition to the ordinary corporate tax rate of 28%.

[6] The area fee is a policy instrument aimed at fostering efficient exploration of acreage that has been awarded for exploration and development. The goal is to produce the potential resources as quickly as possible but also extend the lifetime of existing fields. Facts, The Norwegian Petroleum Sector 2008 at 25, 34.

[7] SDFI was established in January 1985. It is an arrangement by which the state owns interests in oil and gas fields, pipelines, and onshore facilities. The state pays its share of investment costs and receives a corresponding share of the income from the production license. When awarding acreage, the state can determine how much of the value creation will devolve to the state. If a production license is expected to have low profitability, the state may take a small interest or no interest at all. With more profitable areas, the state is likely to take a larger share. Facts, The Norwegian Petroleum Sector 2008 at 25. SDFI posted record earnings of 160 billion kronor ($22.4 billion) for 2008. Norway '08 oil earnings reach record $22.4B, Scandinavian O&G Magazine, Mar.2, 2009.

from state ownership in StatoilHydro.[8] Direct revenues from the petroleum sector are channeled out of the mainland economy into a sovereign-wealth "pension fund" or spent in the national budget.[9]

Approximately 36% of the expected total resources on the Norwegian continental shelf (NCS) have been extracted already.[10] Petroleum production is expected to increase gradually until 2011 and fall gradually thereafter.[11] Oil production peaked in 2000 and dropped 30% in the following seven years.[12] Gas production continues to rise and is expected to increase to around 130 billion standard cubic meters (scm)[13] early next decade. Gas currently accounts for 35% of the total Norwegian petroleum production and is expected to reach 50% in 2013.

Although new investment and activity on the NCS is high, forecasts indicate Norway's petroleum production will fall markedly over the next two decades.[14] Not surprisingly, industry continues to press for opening more acreage to development. Pressure is growing to open rich commercial fishing zones off the coast of Tromso and the Lofoten Islands (see map page iv).[15] Given the importance of the petroleum industry to Norway's economy, and the current inability to replace produced reserves on the NCS,

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[8] As of 2009, the Norwegian state owns 67% of StatoilHydro. See Norway boosts StatoilHydro stake to 67%, Scandinavian Oil & Gas magazine, Mar. 5, 2009.

[9] OECD Economic Survey of Norway, 2007, ch.1 annex 1 A1. See also, Facts, The Norwegian Petroleum Sector 2008 at 24. See also, Norway '08 oil earnings reach record $22.4B, Scandinavian O&G Magazine, Mar.2, 2009.

[10] Facts, The Norwegian Petroleum Sector 2008 at 7, 15.

[11] OECD Economic Survey of Norway, 2007, ch.1 annex 1 A1.

[12] OECD Economic Survey of Norway, 2007, ch.1 annex 1 A; Facts, The Norwegian Petroleum Sector 2008 at 7. Oil Production has fallen from the peak of 181million scm in 2000 to 128 million scm in 2007.

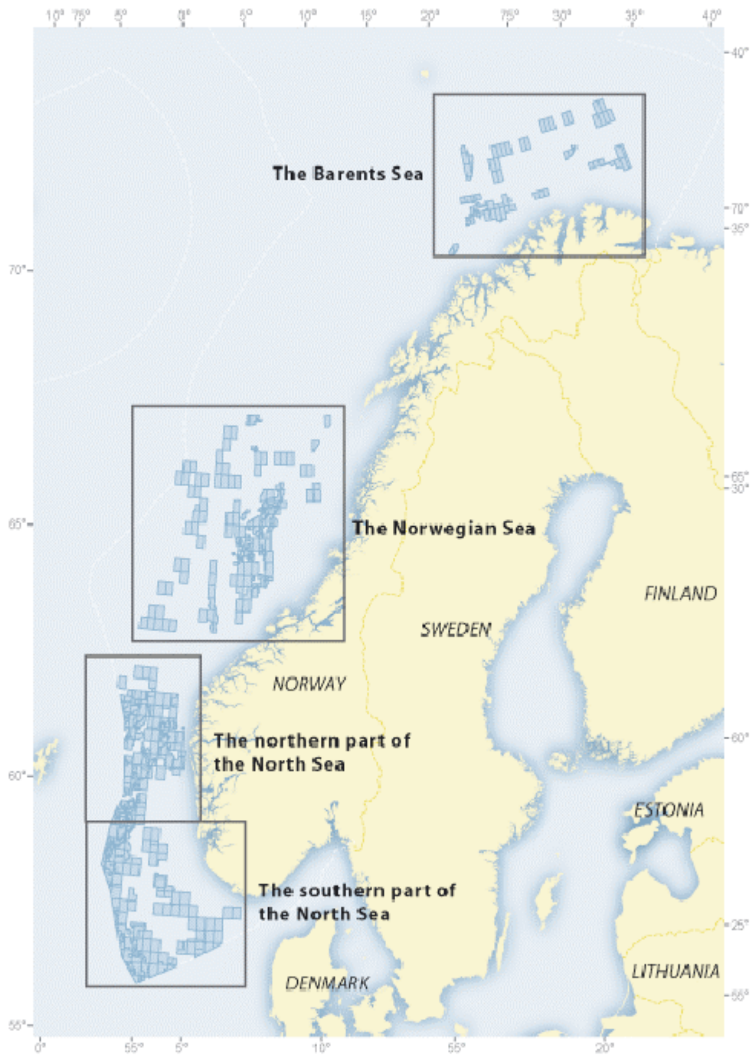
[13] Norwegian sources state oil, condensate, and gas volumes in standard cubic meters ("scm") and liquid natural gas volumes in tons. A measure of total resources is obtained by adding up the energy content of the various petroleum resources and is stated in standard cubic meter oil equivalents ("scm o.e."). One single scm of oil and of condensate both equal 1.0 scm o.e. 1000 scm of gas equals 1.0scm o.e. 1 ton of LNG equals 1.9 scm o.e. Facts, The Norwegian Petroleum Sector 2008 at 229.

[14] U.S. Department of Energy, International Energy Outlook 2007, table G2, pp. 188-89; Facts, The Norwegian Petroleum Sector 2008 at 9, 15.

[15] The Tromso and Lofoten areas are rich in three types of migratory cod and minke whales. The Troms II acreage off Tromso may hold $22 billion in reserves, while the Lofoten area to the south may hold $90 billion worth of oil and gas. These northern regions are currently off limits for oil and gas activities, except for government supervised seismic surveys. See Rich fishery zone could hold $90B in oil, Scandinavian Oil-Gas Magazine, April 28, 2008, available at http://www.scandoil.com/moxie-bm2/news/spot_news/norway-rich-fishery-zone-could-hold-90b-in-oil.shtml. A recent study by KonKraft submitted to the Norwegian Oil & Energy Ministry warns that keeping these areas closed will cause huge losses in investment, production, and expertise in key industry areas. See Open cod banks to boost oilfield spend[sic], Scandinavian Oil-Gas Magazine, December 3, 2008, available at http://www.scandoil.com/moxie-bm2/news/spot_news/norway-open-cod-banks-to-boost-oilfield-spend.shtml; Open to Drilling in cod banks: Norway report, Scandinavian Oil-Gas Magazine, March 6, 2009, available at http://www.scandoil.com/moxie-bm2/news/spot_news/open-to-drilling-in-cod-banks-norway-report.shtml.

politicians will be hard pressed to maintain closures that currently exist for biologically sensitive areas.[16]

Licensed Areas of the Norwegian Continental Shelf



The NCS is divided into three regions: the North Sea, the Norwegian Sea, and the Barents Sea (see map above). Petroleum activities started in the North Sea and have gradually moved north. The expansion of petroleum activities into northern frontier areas has led to a call for integrated management plans for the Norwegian and Barents Seas and

[16] In 2006, only about 12% of the produced petroleum reserves were replaced by new finds on the NCS. Norway's leading petroleum company is also pressed for reserves replacement. In 2008, StatoilHydro replaced only 34% of its produced oil and gas reserves. See StatoilHydro struggles with "reserves cost," Scandinavian Oil & Gas Magazine, Feb. 17, 2009. Exacerbating the problem, independent oil companies are limited in their ability to operate in many countries due to privileges afforded to national oil companies and/or political instability.

areas off the Lofoten Islands. The aim is to establish a framework that balances the interests of the fishing, shipping, and petroleum industries while safeguarding marine ecosystems.[17]

Large areas of the NCS (including all of the northern Barents Sea) have not yet been opened to petroleum activities.[18] The Storting (Norwegian Parliament) decides whether to open such areas to licensing. An impact assessment (similar to an Environmental Impact Statement in the U.S.) would be required prior to such a decision by the Storting. Local authorities and stakeholder organizations also have a say in the matter.[19]

New technologies had to be developed to cope with harsh weather conditions and deep-water setting of the North Sea oilfields. The huge fields on the NCS, combined with the deep water and rugged conditions, called for very expensive infrastructure in the form of huge concrete storage and drilling platforms (the Condeep concept).[20] These huge platforms are not easily moved, which created incentives to develop long-reaching horizontal wells. In recent years, subsea technology has been used to increase the recovery of oil and gas. These subsea installations are tied back to the existing offshore infrastructure, and employ multiphase flow measurement -- the continuous and real-time measurement of flows of water, gas, and oil from a well.[21]

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[17] See Report No. 8 to the Storting (2005-2006): Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands. The Norwegian Government has decided to develop a similar management plan for the Norwegian Sea, which will be presented as a white paper to the parliament in spring 2009. The interests of the Sámi, Norway's only indigenous people, receive brief mention in the Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands. See id. at 43.

[18] In addition to the northern Barents Sea, Troms II, Nordland VII, parts of Nordland VI, and coastal regions off the Nordland coast and Skagerrak are closed to petroleum activities. Facts, The Norwegian Petroleum Sector 2008 at 35.

[19] Facts, The Norwegian Petroleum Sector 2008 at 36.

[20] Condeep (short for concrete deep water structure) refers to a type of gravity base structure for oil platforms developed and fabricated by Norwegian Contractors in Stavanger, Norway. A Condeep usually consists of a base of concrete oil storage tanks that rest on the sea floor and from which one to four concrete shafts rise, typically about 30 meters above sea level. This platform structure was unique in that it was built from reinforced concrete instead of steel, which had been the norm. Following the success of the concrete oil storage tank on the Ekofisk field, Norwegian Contractors introduced the Condeep production platform concept in 1973.

[21] See From Black Gold to Human Gold, A Comparative Case Study of the Transition from a Resource-Based to a Knowledge Economy in Stavanger and Aberdeen, by Sachi Hatakenaka, Petter Westnes, Martin Gjelsvik, Richard K. Lester, MIT IPC Working Paper 06-004, July 15, 2006, at 50-51. See also Sarah Hurst, "VetcoGray brings umbilical subsea technology to life," Petroleum News 12/28/2008 p.8 (noting that Snohvit is currently the world's longest step-out subsea-to-shore development – connecting the gas field 106 miles away to the onshore Melkoya LNG plant – and that tiebacks over 370 miles long may be technically feasible for step-out subsea-to shore gas developments).

II. THE INSTITUTIONAL FRAMEWORK OF NORWAY'S PETROLEUM INDUSTRY

From the outset, national authorities established control over the petroleum industry in order to maximize value for Norway and its citizens. The Norwegian Petroleum Directorate (NPD) has been central to this mission since its formation by the Storting in 1972. In order to advance the interests of society as a whole, the NPD (and other Norwegian authorities) strive to influence companies' decisions through clear-cut legal frameworks.

The current resource management model is built on two principles: predictability and transparency. Predictability allows oil companies to make rational investment decisions. Transparency ensures that state authorities can understand and evaluate the decisions made by industry (e.g., technical solutions related to recovering the resource) and safeguard the overarching goal of maximizing the value of the NCS for Norwegian society as a whole.

Although foreign companies initiated petroleum activities on the NCS, during the 1970s Norway launched three oil companies[22] to establish domestic petroleum expertise and ensure that Norway secured substantial revenues from the sector. As a result of deliberate "Norwegianization" strategies,[23] together with the considerable opportunity for technology development associated with huge fields such as Statfjord, Gullfaks and Troll, Norway today has its own oil companies and oil service/supplier industry. Foreign firms also continue to play a major role on the NCS.

Oil companies are expected to operate in a competitive *and* cooperative framework. Competition fosters maximization of the petroleum resources. So too does cooperation, which can help drive technological innovation. The Norwegian authorities consider close

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[22] At their outset, Statoil was state owned, Norsk Hydro was a state-private company, and Saga Petroleum was fully private. Statoil and Norsk Hydro developed into leading operators. Saga Petroleum was acquired by Norsk Hydro in 1999. Norsk Hydro's petroleum operations were merged with Statoil in 2007 to form StatoilHydro ASA. As of 2009, the Norwegian state owns 67% of StatoilHydro. See Norway boosts StatoilHydro stake to 67%, Scandinavian Oil & Gas magazine, Mar. 5, 2009.

[23] Norwegian authorities at the national, regional, and local levels made concerted and sustained efforts to develop local capabilities in the oil and gas sector. Government policies included the creation of a national oil company (Statoil), the active use of licensing terms and other measures to promote technology transfer from foreign to domestic companies, a localization policy that led to the establishment of major governmental institutions including Statoil and the Norwegian Petroleum Directorate in Stavanger, and the development of local higher education and research capabilities. These policies were instrumental in helping domestic firms in existing industries like construction and shipbuilding enter the oil and gas industry, as well as helping new local firms grow and become competitive internationally. See From Black Gold to Human Gold, A Comparative Case Study of the Transition from a Resource- Based to a Knowledge Economy in Stavanger and Aberdeen, by Sachi Hatakenaka, Petter Westnes, Martin Gjelsvik, Richard K. Lester, MIT IPC Working Paper 06-004, July 15, 2006. See also Facts, The Norwegian Petroleum Sector 2008, ch.8. See also Koncraft Report no. 4: Internationalisation, available at http://www .olf.no/getfile.php/Konkraft/Dokumenter/KonKraft-report%204%20summary.pdf.

cooperation with industry essential to achieving established environmental goals. The "Miljøsok" is a prime example of this cooperative approach.

A. Cooperative Organizations

The **Miljøsok** was a cooperative body initiated by the Ministry of Petroleum and Energy in 1995 that brought together government ministers, petroleum industry executives, and special interest groups such as the Norwegian Fishery Association. Its overarching goal was to reconcile environmental concerns with the need for cost-effective oil and gas exploration. The first phase of Miljøsok produced a report that surveyed the environmental issues the industry faced. The report also presented a set of objectives and targets for industry and the authorities to achieve, stressing the need for mutual and committed effort. Phase two of Miljøsok sought to implement the recommendations from the report. Among other things, Miljøsok successfully initiated a program of measures and technologies for reducing produced water discharges.

Miljøsok ended in 2000, but its recommendations have been followed up by a new collaborative organization, the Environmental Forum.

> **Recommendation:** The NSB should consider whether the creation of an organization like Miljøsok could provide benefits beyond those currently realized through its existing planning and Assembly process. Miljøsok consisted of a Cooperation Forum, a Council, and a Secretariat. The Cooperation Forum was a meeting place for open dialogue between stakeholders on the need for and development of future environmental measures. Representatives from government, industry, research institutions, NGO's, unions, fisheries and other stakeholders participated in the Cooperation Forum. The Council served as the catalyst for activities and recommended policies, guidelines for further action, and the overall agenda of the Forum. Representatives from government and the oil companies served on the Council. The Secretariat was the working body for the Forum and the Council and facilitated communication between the two. Perhaps the key point to remember is that all players in Miljøsok shared the fundamental view that a competitive industry is an environmentally efficient industry.

Another noteworthy collaborative body is **OG21.** In 2001, the Ministry of Petroleum and Energy established a task force to help the petroleum industry formulate a national technology strategy to meet the challenges associated with efficient, safe, and environmentally sustainable petroleum activities. Known as OG21, the task force fosters collaboration among oil companies, universities, research institutes and the supplier industry.

The OG21 strategy focuses on eight core technology areas, one of which is "Environmental technology for the future." Shell is the lead party for this technology target area.[24] It may be worth following the OG21 work on environmental technology to make sure Shell does not disavow technology suitable for the Arctic OCS that it supports using on the NCS. A copy of OG21's most recent strategy statement for "Environmental Technology for the Future" is attached as Appendix 4. Information about other collaborative organizations in the Norwegian petroleum sector is contained in Appendix 2.

Norway's approach to granting licenses also fosters collaboration. Authorities award production licenses to a group of companies instead of just one company. The Ministry of Petroleum and Energy establishes a licensee group, the companies of which must exchange ideas and experience and share the cost and revenues associated with the production license. This licensing system brings together a wide range of expertise and experience in nearly all of the production licenses on the NCS.[25]

B. Environmental Protection and Current Disputes

Environmental protection is now an integral part of Norway's energy policy and management of its petroleum resources. According to the government, a "fundamental precondition for petroleum activities on the Norwegian continental shelf is coexistence with other users of the sea and land areas affected by such activities."[26] To that end, Norway has a strong regulatory framework in place, which is supported by a proactive industry. Norway claims this combination has allowed its petroleum industry to be at the international forefront of both cost efficiency and environmentally friendly exploration and production operations.

Nevertheless, Norway's offshore industry is not free of environmental concerns and disputes. Recent seismic surveys near the Lofoten islands have generated heated opposition from the fishing industry and local politicians who believe that seismic activities are scaring away fish stocks. The mayors of all the townships in the area are reported to be against offshore drilling for oil. Efforts are underway to add Lofoten to UNESCO's list of world heritage sites, which could prohibit drilling in the area once and for all.[27]

Some Norwegian fisherman were officially shut out of fishing grounds (for Greenland halibut) in 2008 due to seismic studies commissioned by the Norwegian

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[24] Other companies involved in the Environmental Technology for the Future strategy group include Chevron, ConocoPhillips, and ExxonMobil.

[25] See Facts, The Norwegian Petroleum Sector 2008, Chapters 2 & 8. Until the late 1990s, the Norwegian government decided which operators should work in each field. One oil company was given the role as the main operator in charge of field development. Arrangements for multiple operator ownership encouraged collaboration (and sometimes conflicts) on strategies, development solutions and technology. Hatakenaka, note 21, at 52. See also Jon R. Hasle et al., Decision on Oil and Gas Exploration in an Arctic Area: Case Study from the Norwegian Barents Sea, section 2.1, Safety Science (2008).

[26] Facts, The Norwegian Petroleum Sector 2008 at 28.

[27] See Sarah Hurst, "Seismic surveys disturb Lofoten fishermen," Petroleum News, July 27, 2008.

Petroleum Directorate.[28] Norwegian newspapers have reported offshore skirmishes between fisherman and seismic vessels reaching new heights, with seismic vessels allegedly trying to run fisherman off the fishing grounds, and fisherman resorting to calling the police.[29] The government may soon require seismic vessels to have satellite tracking equipment onboard "to safeguard against disputes with fishermen."[30] In the Barents Sea, fishermen have threatened civil disobedience around oil installations. The primary source of this dispute is Eni's plan for floating production facilities and loading buoys over the Goliat filed, located off the coast of Finnmark, Norway's northernmost county.[31]

StatoilHydro's image as an environmentally sensitive company has also suffered in recent years. In December 2007, the second largest oil spill in Norway's history occurred at the North Sea Statfjord oilfield, located some 125 miles from the Norwegian coast.[32] Approximately 1.2 million gallons of oil were spilled into the sea when a tanker's loading hose ruptured.[33] Investigation revealed that a similar incident on StatoilHydro's Gulfaks field in 2004 had not been adequately addressed.[34] In February 2008, StatoilHydro announced its intent to participate in Russia's Shtokman gas field in the environmentally sensitive Barents Sea. Russia has suggested powering Shtokman operations from a floating nuclear power plant.[35] StatoilHydro's participation in Alaska Arctic leasing and Alberta's oil sands has also drawn fire.[36]

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[28] The NPD is responsible for seismic studies in the area pursuant to the Integrated Management Plan for the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands. NPD did not inform the fisherman of the seismic work until shortly before the fishing season, after fisherman had invested significant time and money. NPD then handled the situation poorly, abruptly closing the fishing grounds and offering compensation to the fishermen. Information provided to author by Helge Soras (ENI Norway), October 2008.

[29] See Tensions rise between fishing and oil industries, Aftenposten, Feb. 2, 2008; Minister to calm fishermen over seismic, Scandanavian Oil & Gas Magazine, Feb. 13, 2008.

[30] See Reservoir size to limit license, Scandinavian Oil-Gas Magazine Online, Nov. 26, 2008, available at http://www.scandoil.com/moxie-bm2/news/spot_news/reservoir-size-to-limit-license-norway.shtml.

[31] See Fisheries getting critical towards Big Oil, Barents Observer, Feb.22, 2008.

[32] See Large Oil Spill near North Sea oil platform: Norway, available at http://afp.google.com/article/ALeqM5gKH21ZKRRYqBvIHSIQ-IBK51G_Fg.

[33] By way of comparison, the GC-2 spill on the North Slope in March 2006 was estimated at 200,000 gallons. See BP: Learning from oil spill lessons, Petroleum News, May 14, 2006. The Exxon Valdez oil spill was estimated at 10.8 million gallons on the low end, and as high as 38 million gallons. Riki Ott, Not One Drop (Chelsea Green Publishing 2008) at 45 and 288 at note 45.

[34] Statfjord Oil Spill Investigation Report Submitted to PSA Norway, Rigzone, February 2, 2008.

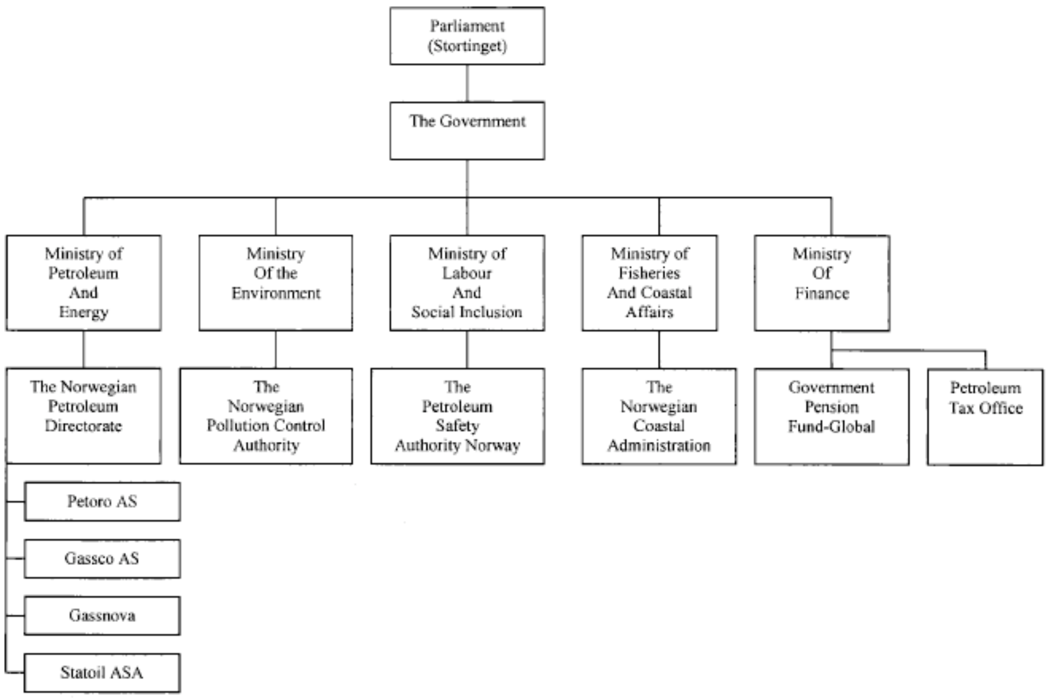
[35] See "Russia brings nuclear power into oil, gas projects," Petroleum News, Dec. 28, 2008. For safety and environmental impacts associated with floating nuclear power plants, see W.J.F. Standring, Floating nuclear power plants: Potential implications for radioactive pollution of the northern marine environment, Marine Pollution Bulletin, Vol, 58, Issue 2, Feb. 2009 at 174-178, and Dowdall M & Standring W.J.F., Floating Nuclear Power Plants and Associated Technologies in the Northern Areas, StrålevernRapport 2008:15 Østerås: Norwegian Radiation Protection Authority, 2008.

[36] See "StatoilHydro upsets environmentalists," again, Aftenposten, Feb. 11, 2008.

C. Government Authority Over Petroleum Activities In Norway

The Storting (Norwegian Parliament) has the overarching power over petroleum activities. It can pass legislation, adopt propositions, and discuss and respond to white papers relating to petroleum activities. Major development projects must be discussed and approved by the Storting.[37] The Storting also supervises the government.[38]

The government holds the executive power over petroleum policy. This power is divided among several ministries, with subordinate directorates and agencies as follows:



The three agencies most relevant to the issues in this report are:

The Norwegian Petroleum Directorate (NPD) The NPD was established to secure the optimal resource utilization on the NCS. It exercises wide authority in connection with exploration for and exploitation of petroleum deposits. The NPD has authority to issue regulations, perform safety evaluations, and make decisions according to rules and regulations for petroleum activities. The NPD supervises regulatory compliance by all licensees of the NCS.

NPD is also responsible for providing all participants in the petroleum industry with guidance and information. It maintains a trustworthy information base and makes

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[37] For example, the Storting recently enacted decisions to launch large investment projects in Snøhvit, Ormen Lange, and Langeled.

[38] Norway is a constitutional monarchy with a parliamentary system of government. The "government" is formed by the majority or a coalition of parties in parliament and headed by a Prime Minister. The King's power is mostly symbolic.

information concerning the petroleum activities available to industry, the media, and society at large.[39] The NPD also stimulates innovation by setting ambitious targets for the future development of the oil and gas industry, including new targets for additional recovery of oil (requiring new technologies for improved recovery), high levels of exploration, and reduced unit costs.

The NPD is administratively subordinate to the Ministry of Petroleum and Energy. It functions as an advisor to the Ministry of Petroleum and Energy (for energy issues) and the Ministry of Labor (for safety issues). The NPD plays a coordinating role in relation to the Norwegian Pollution Control Authority, and with the Ministry of Finance and the Ministry of Petroleum and Energy in regard to collecting the CO_2 tax.[40]

The Norwegian Pollution Control Authority (SFT) is an agency subordinate to the Ministry of Environment. It has primary responsibility for oil pollution response and regulating discharges into the sea of oil and chemicals from drilling and production activities. Discharge permits must be approved by SFT.

The Norwegian Pollution Control Authority sets the requirements for monitoring air and water pollution and is responsible for enforcing the Pollution Control Act.[41] It also provides the Ministry of the Environment with advice, guidelines, and technical documentation.

The Norwegian Pollution Control Authority coordinates Norway's involvement in the Arctic Monitoring and Assessment Program (AMAP), a working group under the auspices of the Arctic Council. The primary function of AMAP is to advise the governments of the eight Arctic countries (Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden, and the United States) on matters relating to threats to the Arctic region from pollution and related issues.

The Petroleum Safety Authority Norway (PSA) has regulatory responsibility for technical and operational safety, emergency preparedness, and the work environment in the petroleum sector. Its regulatory role covers all phases of the petroleum activities, from planning and design through construction and operation to decommissioning and removal. As used here, "safety" includes three broad categories of potential loss: human life, health, and welfare; the natural environment; and financial investment and operational regularity. The PSA is subordinate to the Ministry of Labor and Social Inclusion.

More information about the Norwegian ministries, directorates, and agencies is contained in Appendix 1.

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[39] UNEP, Offshore Oil & Gas Forum, Environmental Regulations for Norwegian Offshore Oil & Gas Industry, http://www.oilandgasforum.net/management/regula/norwayprof.htm.
[40] UNEP, Offshore Oil & Gas Forum, Environmental Regulations for Norwegian Offshore Oil & Gas Industry, http://www.oilandgasforum.net/management/regula/norwayprof.htm.
[41] Act No. 6 of 13 March 1981 concerning waste and protection against pollution) See section III B, below.

D. The Norwegian Licensing System

The proprietary right to subsea petroleum deposits on the NCS is vested with the state. The Petroleum Act and its attendant regulations authorize the award of licenses necessary to explore for, produce, and transport petroleum.[42] Before such activities take place, the area in question must have been opened for petroleum activity by the Norwegian parliament.

An impact assessment must be completed before an area can be opened for petroleum exploration and production. The impact assessment must describe the development's expected social, economic, and environmental impacts, including transboundary environmental effects.[43]

Oil companies can nominate blocks they wanted included in a particular licensing round. The decision on which blocks to include in a licensing round is made by the Ministry of Petroleum and Energy after consultation with the Ministries of Environment and Fisheries.

Licenses are issued by the Norwegian Petroleum Directorate to operators prior to various stages of the exploration and production cycle, including exploration, exploration drilling, manned underwater operations, putting facilities into service, major rebuilding of facilities or changes in the purpose of operation, disposal/removal/relocation of facilities, and removal of vessels important to safety. An application to obtain the NPD's "consent to proceed" must contain information on the planned activities, choice of technical solutions, implementation of management systems, exceptions from regulations that may affect safety, and measures taken to balance any departures from safety regulations.[44]

The Ministry of Petroleum's announcement of a licensing round will include conditions related to fishery issues and other environmental concerns. These conditions may be block specific or generally applicable to all blocks in the licensing round. Recent examples include requirements to map coral reefs within a block and abide by "zero discharge to the sea" rules. [45] A license award will confirm conditions stated in the

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[42] Act of 29 November 1996 No. 72 relating to petroleum activities.

[43] A 1997 revision to the Petroleum Act imposed a requirement for Regional Environmental Impact Assessments (REIA). Statoil has overseen the REIAs for the North Sea and Norwegian Sea. Project specific EIA's are still required but their regional impacts can be based on the REIA, saving time and money for operators. See Sigurd Juel Kinn, Regional Environmental Impact Assessment – Experiences from the Norwegian Petroleum Activity, in Proceedings from the 3rd Nordic/SEA Conference, 22-23 November 1999.

[44] Regulations and conditions of licensing are located on the NPD website at http://www.npd.no/norsk/regel/con_reg_start_eng.htm.

[45] Jon R. Hasle et al., Decision on Oil and Gas Exploration in an Arctic Area: Case Study from the Norwegian Barents Sea, Safety Science (2008). Zero discharge to the sea is discussed in section IV D, below.

licensing round announcement. Licenses can also supplement the provisions of the Petroleum Act by specifying detailed terms governing each license.[46]

E. Decommissioning Of Offshore Petroleum Installations

Domestic and international law applies to decommissioning.[47] As for domestic law, The Petroleum Act requires that a decommissioning plan for an installation must be developed and submitted 2 to 5 years before the use of the installation comes to an end. The decommissioning plan requires a plan for the disposal of the installation and an environmental impact assessment.[48] The Ministry of Petroleum and Energy is responsible for approving decommissioning plans. To date, most plans have required all facilities be removed and transported to shore. However, some concrete substructures have been allowed to be left in place.[49] If facilities are left in place, the licensees and owners remain liable for any damage or inconvenience in connection with the facility, unless the Ministry of Petroleum agrees otherwise.[50] Licensees and owners can remain jointly responsible for carrying out decommissioning plans even if the license has been transferred.[51]

Caution: Although beyond the scope of this report, it should be noted that decommissioning has important environmental ramifications. If OCS development proceeds in the Arctic OCS, the NSB should take a closer look at the legal and environmental issues associated with decommissioning -- and the possibility that industry attempts to leave installations in the ocean.[52]

III. NORWAY'S LEGAL FRAMEWORK REGULATING ENVIRONMENTAL ASPECTS OF PETROLEUM ACTIVITIES

A. Introduction to Norway's Legal Framework

Norway's legal framework consists of Acts, Regulations, and Guidelines. Acts are the main legislation, analogous to statutes in the U.S. legal system. Regulations are promulgated by various agencies, pursuant to Acts. Regulations provide more detail to Acts, which tend to be relatively short and simple compared to much American federal

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[46] See also note 25 and accompanying text for information on how Norway's licensing system foments cooperation among operators. Note that the Norwegian state is a license partner through the State's Direct Financial Interest (SDFI). Jon R. Hasle et al., Decision on Oil and Gas Exploration in an Arctic Area: Case Study from the Norwegian Barents Sea, Safety Science (2008). SDFI is described in note 7, above.

[47] Norway's international obligations concerning decommissioning and disposal would be governed under the OSPAR Convention. See section V C, below. OSPAR Decision 98/3 sets forth guidelines for disposal alternatives for various types of installations.

[48] Petroleum Act § 5-1.

[49] Facts, The Norwegian Petroleum Sector 2008, ch.7.

[50] Petroleum Act § 5-4.

[51] Petroleum Act § 5-4. Transfer of licenses requires approval of The Ministry of Petroleum and Energy. Petroleum Act § 10-12.

[52] See, e.g., Rachael E. Salcido, Enduring Optimism: Examining the Rig-to Reef Bargain, 32 Ecology L. Q. 863 (2005).

legislation. There are five sets of regulations that are relevant to environmental matters relating to petroleum activities:

- Framework Regulations (relate to health, safety and the environment),
- Management regulations (contain overarching requirements for management concerning HSE, risk reduction, management elements, resources and processes, analyses and measuring, follow-up and improvement),
- Information Duty regulations (set requirements concerning information that must be provided or made available to regulators, e.g., applications for consent, notifications, and reporting),
- Facilities regulations (regulate the design and outfitting of petroleum facilities, e.g., safety functions and loads, materials, work areas, physical barriers, emergency preparedness), and
- Activities regulations (regulate the conduct of various activities and set requirements for, *inter alia*, planning, the work environment, and the external environment. Chapter X of the Activities regulations contains many of the most germane regulations. Requirements concerning environmental monitoring are listed in an appendix that forms part of the regulations.).

Guidelines are also promulgated at the agency level. Guidelines are not legally binding per se but provide additional explanation for interpreting and applying regulations. Guidelines may also provide information about the overarching legislation. In the HSE field, guidelines may propose solutions for satisfying a regulatory requirement. If a company adopts the proposed solution, the regulatory requirement is deemed fulfilled. If an alternative solution is adopted, the company must be able to document that its fulfillment of the requirement is as good as or better than the solution recommended in the guideline.[53]

The laws most germane to the scope of this report will be discussed below.

B. The Pollution Control Act[54]

The Pollution Control Act sought to create one legal framework for all types of pollution and waste. The purpose of the Act is to protect the environment against pollution and to reduce existing pollution and waste. But environmental protection is not the only relevant consideration. The Act ensures only that the "quality of the environment

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[53] See http://www.ptil.no/guidelines/category218.html; http://www.ptil.no/regultaions/the-continetal-shelf-article4246-87.html.

[54] Act of 13 March 1981 No.6 concerning protection against pollution and concerning waste (the Pollution Control Act), most recently amended by Act of 12 June 1996 No. 36 (available online at http://www.regjeringen.no/nb/dokumentarkiv/Regjeringen-Brundtland-III/Miljoverndepartementet/260597/260604/t-1300_pollution_control_act.html?id=260605).

is satisfactory."[55] Satisfactory environmental quality is based on a balance of interests, including costs associated with any measures and other economic considerations. The Act is administered by the Norwegian Pollution Control Authority ("SFT").

The Pollution Control Act is a typical enabling act, which means that detailed controls on particular sources of pollution are outlined in discharge permits and regulations issued by the pollution control authorities. The main rule of the Act provides merely that pollution is forbidden unless it is specifically permitted by law, regulations, or individual permits.[56] Almost all pollution activity in Norway is regulated through individual permits or licenses issued by the Norwegian Pollution Control Authority or county environmental agencies. Section 4 of the Act specifies how it applies to activities on the Norwegian Continental Shelf.

C. The Product Control Act[57]

The Product Control Act was passed in 1976 and is administered by the Norwegian Pollution Control Authority. Its main purpose is to prevent products from causing damage to health or the environment in the form of ecosystem disturbance, pollution, waste, noise or the like.[58]

The Product Control Act imposes two primary duties: the duty of care, and the duty of substitution. The duty of care requires all to exercise caution in order to prevent products (including chemicals) from damaging health or the environment.[59] The duty of substitution requires anyone who uses products that contain chemical substances that can cause damage to health or the environment to consider whether alternatives exist that entail less risk of such impacts, and to choose such alternatives if this can be done without unreasonable cost and inconvenience.[60] The duty of substitution has figured prominently in Norway's efforts to reduce environmentally harmful discharges to the sea.[61]

D. The Petroleum Activities Act[62]

The Petroleum Activities Act requires that resource management of petroleum resources shall be carried out with a long-term perspective for the benefit of Norwegian society as a whole. The Act provides general rules for licensing, production, safety, liability for pollution, and management of the State's Direct Financial Interest (SDFI) in petroleum activities.[63]

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[55] Pollution Control Act § 1.
[56] Pollution Control Act § 7. Pollution is broadly defined in section 6 of the Act.
[57] Act of 11 June 1976 No.79 relating to the control of products and consumer services.
[58] Product Control Act §1.
[59] Product Control Act §3.
[60] Product Control Act §3a.
[61] See section IV D, below.
[62] Act of 29 November 1996 No. 72 relating to petroleum activities.
[63] See footnote 7 for more on the SDFI.

The Petroleum Activities Act strictly regulates flaring, which contributes to a low level of flaring on the Norwegian Continental Shelf compared to other countries.[64]

E. CO_2 Tax Act[65]

Carbon dioxide is a greenhouse gas that contributes to global warming. High concentrations of CO_2 in the atmosphere also result in more CO_2 dissolved into water, which increases ocean acidification. The petroleum sector is responsible for 31% of all CO_2 emissions in Norway. Carbon dioxide emissions associated with Norway's offshore oil and gas industry result mainly from combustion associated with power generation at offshore facilities (90%) and flaring (7%).

The use of gas, oil, and diesel in connection with petroleum operations on the NCS has been subject to the CO_2 Tax Act since January 1991.[66] The Norwegian oil and gas industry is the only business sector in Norway (and the world) to purchase quotas for all its emissions.[67]

The CO_2 tax has been effective to improve energy efficiency and incentivize major projects, such as carbon capture and sequestration associated with the Sleipner Vest gas field in North Sea.[68] Improved energy efficiency lead to a reduction in CO_2 emissions per produced oil equivalent from 1991 to 1997. Unfortunately, the trend since 1997 has been mainly one of gradual increase in total emissions and emissions of taxable CO_2 per produced unit. Factors leading to increasing CO_2 emissions include:

- decreasing reservoir pressure on the NCS, which increases energy use for gas compression
- more fields have entered a mature phase, which results in more water in the well stream and requires more energy for the process facility
- the movement of production activity northward, and consequently longer distances for gas transportation (treatment and transport of produced gas requires more energy than liquid production).[69]

Despite these factors, CO_2 emissions on the Norwegian continental shelf are low compared to most other producing countries.[70] Norway's investment in environmental

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[64] Facts, The Norwegian Petroleum Sector 2008 at 66.

[65] Act of 21 December 1990 No. 72 relating to tax on discharge of CO_2 in the petroleum activities on the continental shelf, last amended by Act 20 December 1996 no. 100.

[66] In most cases, emissions to air are calculated on the basis of the volume of fuel consumed at a facility. As of 1 January 2008, the CO_2 tax is NOK 0.45 per liter of oil and standard cubic meter (scm) of burned gas (or approximately NOK 184/ton CO_2. Facts, The Norwegian Petroleum Sector 2008, ch. 9.

[67] OLF 2007 Environmental Report, §2.2.

[68] See section III F and V D, below, for more on carbon capture and sequestration.

[69] Facts, The Norwegian Petroleum Sector 2008, ch. 9.

[70] Norway's emissions per produced unit in 2006 were approximately 47 kg per scm oil equivalent. The international average for the same year was approximately 120 kg per scm per oil equivalent. Facts, The Norwegian Petroleum Sector 2008 at 73.

technology has contributed to reducing greenhouse gas emissions per produced unit from the NCS to one-third of the international average.[71]

F. Other Measures For Reducing CO_2 Emissions

In addition to the CO_2 tax, Norway has employed a variety of other measures to reduce CO_2 emissions. If production in the Arctic OCS occurs, the NSB may want to consider whether any of these measures are feasible and desirable:

- **Combined cycle power plants –** heat from turbine exhaust gas is used to produce steam, which in turn is used to generate electric power. Combined cycle power is currently in use on three fields on the NCS. [Susan Harvey advises that most North Slope operators use waste heat recovery units whenever technically feasible.]

- **Carbon Capture and Sequestration (CCS) –** CO_2 can be injected and stored in depleted oil and gas reservoirs or in other geologic formations. Norway has been a leader in developing carbon capture and sequestration technology.[72] Since 1996, Norway has stored millions of tons of CO_2 in the (subsea) Utsira formation in connection with processing gas from the Sleipner field in the North Sea. Separation and storage of CO_2 in connection with the Snøvit field (located in the Barents Sea) began in 2008. At the onshore LNG-plant on Melkøya, CO_2 is separated from the natural gas and piped back to the field, where the CO_2 is reinjected and stored in the Tubåen formation, 2600 meters beneath the seabed. When Snøvit reaches full capacity, it is expected that 700,000 tons of CO_2 will be stored annually.

  Discussion of the pros and cons of subsea carbon sequestration is beyond the scope of this report.[73] Note that subsea sequestration of CO_2 is subject to international rules under the OSPAR Convention and the London Dumping Convention.[74]

- **Systematic study of energy efficiency and energy management for offshore activities.** In 2004 industry worked with government authorities to study the potential for more efficient energy supply and use in offshore activities. The Norwegian Oil Industry Association is developing guidelines for establishing and implementing energy management.[75]

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[71] OLF 2007 Environmental Report, §2.2.
[72] See Klaas van Alphen et al., The performance of the Norwegian carbon dioxide, capture and storage innovation system, Energy Policy, vol. 37, issue 1, January 2009 at 43-55.
[73] The safety of carbon sequestration is not without controversy. In addition to safety issues, CCS may not deliver the environmental benefits that are commonly presumed. According to a study in the International Journal of Greenhouse Gas Control, a complete environmental analysis should consider that carbon sequestration would generate additional pollutants because it will require 30% more energy, new chemical reactions, and new equipment. See Carbon Sequestration Frustration, Science News, August 13, 2008.
[74] See Section V C & D, below.
[75] Facts, The Norwegian Petroleum Sector 2008 at 74-75.

- The Petroleum Act and Activities Regulations reduce CO_2 emissions by **banning flaring beyond what is necessary for safe operations**, absent consent from the Ministry of Petroleum and Energy.[76] The same general rule applies to formation testing, although there is often no other option than flaring available due to safety considerations and the type of test and rig in question. Norway has seen extensive use of mini drill stem tests without discharges. In some cases, however, a mini drill stem test does not provide sufficient information.[77]
- **Use of CO_2 to enhance oil recovery**. In March 2006, Shell and Statoil signed an agreement to develop the world's largest project using CO_2 to increase oil recovery. The project involved a gas-fired power plant and methanol production facility at Tjeldbergodden (in mid-Norway) that would provide CO_2 to the Draugen and Heidrun offshore oil and gas fields. According to Statoil and Shell, power from the plant would be provided to onshore users as well as the offshore facilities, enabling near zero CO_2 and nitrogen oxide (NO_x) emissions from these facilities. In 2007, the companies announced the project was technically feasible but not commercially viable at then current oil prices.[78] **[**Susan Harvey advises that CO_2 miscible flooding has been studied for several North Slope fields.]

G. Greenhouse Gas Emissions Trading Act

The Greenhouse Gas Emissions Trading Act went into effect January 2005 and was revised in 2007.[79] The Act creates a national emission allowance system that requires facilities subject to emissions capping to apply for permits and CO_2 allowances. Detailed regulations describe how the facilities are to calculate and report their emissions to the Norwegian Pollution Control Authority. The regulations are consistent with the UN Framework Convention on Climate Change (FCCC) guidelines for registering greenhouse gas emissions.[80] The SFT is responsible for verifying that emissions inventories meet the requirements stated in the regulations.

The Greenhouse Gas Emissions Trading Act generally follows the EU Emissions Trading Directive. The Norwegian Emission Trading Scheme will be part of the EU's

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[76] Petroleum Act § 4.4; Activities Regulation § 60. The Ministry of Petroleum and Energy also regulates flaring in more detail through production licenses. Since January 2008, flaring is also regulated by the Greenhouse Gas Emissions Trading Act, discussed in section III G, below.

[77] When operators apply for a discharge permit for an exploration well, emissions to air from well testing are included together with emissions from power generation and chemical discharges. Information provided by Ann Mari Vik, Senior Advisor Norwegian Pollution Control Authority, November 13, 2008. Susan Harvey advises that Alaska also limits flaring to safety and emergency situations, except well test flaring at an exploration site, where there is no other option.

[78] Statoil and Shell decide against carbon capture project, Energy Business Review, July 2, 2007, available at http://www.energy-business-review.com/article_news.asp?guid=93A4AF76-7450-4BE1-A08D-43F82D75DBAA; Facts, The Norwegian Petroleum Sector 2008 at 74.

[79] Act of 17 December 2004 No.99 relating to greenhouse gas emission allowance trading and the duty to surrender emission allowances.

[80] See section V A, below, for discussion of the UN Framework Convention on Climate Change.

Emission Trading Scheme from 2008 to 2012. An important difference, however, is that in the Norwegian system the offshore sector has to purchase all its quotas.[81]

H. NO_x Tax[82]

NO_x causes a wide variety of health and environmental impacts, including contributing to the formation of ground-level smog, acid rain, and water quality deterioration (including eutrophication and acidification). NO_x reacts with ammonia, moisture, and other compounds to form nitric acid and related particles. Human health concerns include damage to lung tissue and premature death. Small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease such as emphysema and bronchitis, and aggravate existing heart disease. In the air, NO_x reacts readily with common organic chemicals and ozone to form a wide variety of toxic chemicals, some of which may cause biological mutations.[83]

As with CO_2, NO_x emissions associated with Norway's petroleum industry result mainly from combustion associated with power generation at the offshore facilities and flaring. The petroleum sector is responsible for 24% of all NO_x emissions in Norway. The trend for NO_x emissions in the petroleum sector has been one of modest increase, due mainly to increased activity and hence a need for more energy.[84]

In order to fulfill its obligations under the Gothenburg Protocol,[85] Norway imposed a tax on NO_x emissions. A tax of 15 NOK per kilo of NO_x[86] took effect on 1 January 2007.[87] The tax applies to, *inter alia*, offshore and onshore flaring, engines with a total

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[81] See Greenhouse gas emission trends and projections in Europe 2007 – Country profile for Norway, available at http://reports.eea.europa.eu/eea_report_2007_5/en/Norway.pdf. For a more thorough explanation of Norway's Greenhouse Gas emissions Trading Act, see Av Audun Rosland, Fifteen percent of Norway's emissions in emissions trading, available at http://www.cicero.uio.no/fulltext/index.aspx?id=3628&lang=no.

[82] Tax on emissions of NO_x 2008, Circular No. 14/2008 S (31 January 2008), available at http://www.toll.no/upload/Dokumenter/avgiftsrundskriv/2008_NO_x_EN.pdf.

[83] Health and Environmental Impacts From NO_x, U.S. EPA, available at http://www.epa.gov/air/urbanair/nox/hlth.html.

[84] Facts, The Norwegian Petroleum Sector 2008 at 75.

[85] See section V B, below.

[86] 15 Norwegian Kronor equaled $2.18 on December 11, 2008, so the tax then equaled about one dollar per pound of NO_x.

[87] By way of comparison, the U.S. EPA imposes fees on emissions to air on the OCS pursuant to 40 CFR 55.10. For sources located within 25 miles of a State's seaward boundaries, EPA implements the State's regulations. If a State's regulations impose emissions fees, then EPA imposes those emissions fees on sources located within 25 miles of a State's seaward boundaries. The State of Alaska's schedule of emissions fees is set out at 18 AAC 400 – 499. For example, for an oil and gas operation that emits more than 250 tons per year of any one pollutant, the annual fee to emit pollution would be $33.37 per ton emitted considering individual pollutants emitted in quantities greater than 10 tons. 18 AAC 50.410(b)(3)(A). The Fee to Process a Construction Permit Application is set case-by-case per negotiated service agreement. 18 AAC 50.403(2). The Annual Fee to Support Issuance of Operating Permit would be $4,548 ($1,633+ $2,915). 18 AAC 50.400(a)(1). Beyond the first 25 miles of the OCS, EPA implements its own regulations. In contrast to Alaska's regulations, the EPA imposes no Fee to Emit Pollution and no Fee to Process a Construction Permit Application. EPA does have an Annual Fee to Administer the Operating Permit Program, set at $45.25 per ton emitted. See http://www.epa.gov/air/oaqps/permits/

rating of more than 750 hp, and energy production from engines, boilers, and turbines with a total effect of more than 10 MW. Although the NO_x tax targets mainly domestic emissions from large land-based plants and operations on the continental shelf, shipping companies are also subject to the tax for ships sailing between Norwegian ports (including Svalbard/Spitsbergen). No tax is paid for routes directly to or from a foreign port to a Norwegian port.

Emissions during petroleum production are also regulated by terms stipulated in the PDO/PIO[88] approval process. Emission permits for NO_x can also be granted under the Pollution Control Act.[89]

In May 2008, the Ministry of the Environment signed an agreement with 14 Norwegian business organizations to replace the NO_x tax with a NO_x fund.[90] Businesses participating in this plan will pay into a NO_x fund instead of the state NO_x tax.[91] The sums collected (expected to be around NOK 500 million annually) will be used to fund or subsidize projects aimed at reducing NO_x emissions. The overall objective is to reduce NO_x emissions as efficiently as possible, in order to contribute to fulfilling Norway's commitments under the Gothenburg Protocol. The parties will decide in 2010 whether to extend the agreement beyond its scheduled termination date of 31 December 2010.[92]

Caution: While flexible pollution reduction approaches such as the NO_x fund may be efficient and perhaps beneficial at a national level, the NSB should be wary if similar approaches are attempted in the U.S. The result may be high emissions being allowed offshore the NSB in exchange for reductions in emissions elsewhere that are less expensive for industry to achieve.

I. Other Measures For Reducing NO_x Emissions

Since emissions of NO_x are closely connected with CO_2, most of the measures for reducing CO_2 (discussed above) also contribute to reducing NO_x. According to the Norwegian Ministry of Petroleum and Energy, low–NO_x technology installed on machinery running at high efficiency results in significant environmental benefits.[93]

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pdfs/fee71_2009.pdf. For additional background on fees, see the 1991 EPA OCS proposed rulemaking (56 FR No. 234 at 63783, 12/5/1991) and the final 1992 EPA OCS rulemaking (57 FR No. 173 40792, 9/4/1992).

[88] Plan for Development and Operation (PDO); Plan for Installation and Operation (PIO).

[89] Facts, The Norwegian Petroleum Sector 2008 at 68.

[90] Environmental Agreement concerning reduction of NO_x emissions (14 May 2008), available at http:// www.nho. no/getfile.php/EnvironmentalAgreement.pdf.

[91] The duty to pay into the NO_x fund will be 4 NOK/kg NO_x for onshore industry and the maritime sector and 11 NOK/kg NO_x for the offshore oil and gas sector. See http://www.nho.no/category.php?category ID=476.

[92] For more on the Environmental Agreement concerning reduction of NO_x emissions, see http://www .nho.no/ category.php?categoryID=476.

[93] Facts, The Norwegian Petroleum Sector 2008 at 75.

Susan Harvey has advised that the NSB already insists on low–NO_x burners and did so in connection with Shell's OCS air permit.[94]

J. Non-Methane Volatile Organic Compounds (nmVOCs)[95]

Emissions of nmVOCs contribute to the greenhouse effect because CO_2 and ground-level ozone are formed when nmVOCs react with air in the atmosphere. Ground-level ozone is generally considered "bad" ozone.[96] Ground-level ozone is the primary constituent of smog. Sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air. Breathing ozone can reduce lung function, inflame the linings of the lungs, and trigger other health problems such as chest pain, coughing, throat irritation, and congestion. It can exacerbate bronchitis, emphysema, and asthma. Repeated exposure may permanently scar lung tissue. Ground-level ozone also damages vegetation and ecosystems.[97]

The petroleum sector accounts for 41% of the nmVOC emissions in Norway. Most of these emissions originate from offshore storage and loading of crude oil. Norway's Ministry of Petroleum and Energy believes that technology currently available can reduce emissions from loading crude oil by approximately 70%.[98]

The phase-in of emission reducing technology in recent years has lead to a steady decline in nmVOC emissions from Norway' petroleum sector. However, several newer fields using floating storage facilities have relatively higher emissions of nmVOCs. This is because floating storage facilities allow emissions between production and storage that do not occur in fields where oil is stored at the base of the platform.[99]

In 1996, recovery facilities for nmVOC were installed at the Sture crude oil terminal at Stura, Norway. Since January 2003, all tankers calling at the Sture terminal have been required to be fitted with the equipment necessary for recovering nmVOC. Ships without such equipment are normally denied access to the facility.[100]

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[94] NO_x emissions might also be reduced by injection of water or steam into the combustion chamber. This technology is not currently allowed on the NCS. Among other challenges, it requires large amounts of clean water. Susan Harvey advises that this technology is not technically feasible for Arctic operations.

[95] NMVOC is a generic term for a variety of chemical compounds, such as benzene, ethanol, formaldehyde, cyclohexane, 1,1,1-trichloroethane or acetone. NMVOCs are similar to VOCs, but with methane excluded.

[96] "Good" ozone occurs naturally in the stratosphere approximately 10 to 30 miles above the earth's surface and forms a layer that protects life on earth from the sun's harmful rays. See http://www.epa.gov/ground levelozone/.

[97] See http://www.epa.gov/air/oaqps/gooduphigh/bad.html#7.

[98] Since 2001, discharges of nmVOC associated with offshore loading and storage of crude oil have been regulated by discharge permits issued under the Pollution Control Act. Emission permits require oil to be stored and loaded using best available emissions–reducing technology (BAT). In 2002, operators on the NCS with buoy loading facilities formed a joint venture to coordinate the phase-in of the BAT. By the end of 2005, nmVOC-reducing technology had been installed on 13 buoy loaders and two ships. NmVoc emissions were reduced by 40,000 tons. Facts, The Norwegian Petroleum Sector 2008, ch.9.

[99] Facts, The Norwegian Petroleum Sector 2008 at 76.

[100] Facts, The Norwegian Petroleum Sector 2008, ch.9.

Most of the Norwegian concerns addressed in this section currently are not present on the NSB, as there are no loading terminals and all transport is by pipeline. Should this situation change, the NSB will want to review existing regulations and the best available emissions–reducing technology.[101]

K. Norway's Regulation Of Seismic Activities

Permission to carry out surveys on the Norwegian continental shelf can be granted in an exploration permit or within a production license.[102] Exploration permits are currently granted for one year at a time, while production licenses are granted for up to ten years (for the initial period).

Before a survey is initiated, the licensees submit notification about their plans for seismic data acquisition to the NPD, the Directorate of Fisheries, the Institute of Marine Research, and the Ministry of Defense. The NPD coordinates this work. The consultation bodies give technical advice, based in part on the expected fishery activities in relation to the proposed survey.

Based on the consultation submissions, the NPD will make a recommendation to the licensee. Typically the NPD will recommend that the licensee follow the recommendations made by the consultation bodies. If a consultation submission is negative regarding a specific activity, the NPD will contact the licensee to attempt to adapt the activity to the recommendations made by the consultation bodies. If the NPD decides to recommend an activity in spite of submissions from consultation bodies, a copy of the NPD's recommendation will be sent to the consultation body in question, as well as to the Ministry of Petroleum and Energy. These recommendations set forth how the NPD expects the survey to take place, particularly in relation to fishery activities that might be underway during the seismic data acquisition, in order to avoid conflict situations. Licensees are informed that ongoing fishery activities have general priority.[103] After the procedure has been completed, the NPD announces the planned activity, stating the area involved and the expected time intervals for seismic work.

The petroleum regulations also require that a fishery expert be on board during seismic data acquisition. The job of the fishery expert is to assist with conflict avoidance concerning the seismic vessel and the fisheries.[104] As of 1 June 2009, fishery experts will have to pass a course designed to enhance their competence in areas such as knowledge of regulations, conflict management, reporting, and startle effect associated with survey

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[101] Susan Harvey advises that federal regulations adopted in the 1990s resulted in vapor control at the Valdez Marine Terminal.
[102] Cf. The Petroleum Act, §§ 2-1 and 3-3.
[103] But see section II B, above, concerning conflict between fisheries and seismic surveys.
[104] Seismic acquisition on the Norwegian shelf – the NPD's role in the process, June 10, 2008, available at http://www.npd.no/English/Aktuelt/Nyheter/2008_10_6_Seismikk+på+norsk+sokkel.htm.

activity. The NPD and Directorate of fisheries are responsible for implementing the courses.[105]

L. Regulations And Guidelines

Norwegian regulations and guidelines pertaining to the petroleum industry are numerous. Some of the most important are:

- Discharge of oil-contaminated drill cuttings from petroleum activity on the continental shelf (June 1991)
- Measurement of petroleum for fiscal purposes and for calculation of CO_2 tax (November 2001)
- Petroleum Activities (June 1997 No 653)
- Health, environment and safety in the petroleum activities (September 2001)
- Management in the petroleum activities (September 2001)
- Conduct of activities in the petroleum activities (September 2001)
- Material and information in the petroleum activities (September 2001)
- Design and outfitting of facilities etc. in the petroleum activities (September 2001)
- Notification of acute pollution or the risk of acute pollution (July 1992)
- Safe practice in exploration drilling for petroleum deposits on Spitzbergen (March 1988)
- Supervisory activities (in regard to safety) in petroleum activities on the Norwegian continental shelf (June 1985)

IV. NORWAY'S REGULATION OF EMISSIONS AND DISCHARGES

A. Introduction To Norway's Regulation Of Emissions And Discharges

The various phases of petroleum activities generate different types of emissions and discharges. Exploration activity entails discharge of drill cuttings and emissions to air from energy production. During the production phase there are discharges to sea (produced water containing residues of oil and chemicals) and emissions to air, primarily carbon dioxide and nitrogen oxides from energy production and flaring, and non-methane volatile organic compounds (nmVOC) from storage and loading of crude oil. There is also a risk of acute oil spills during exploration and production phases.

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[105] <u>See</u> Historic Course Starts, 23 February 2009, available on NPD website, http://www.npd.no/English /Aktuelt /Nyheter/Historisk+kursstart.htm?tip=true.

Emissions from petroleum activities in Norway are regulated primarily by the Petroleum Act, the CO_2 Tax Act, the Greenhouse Gas Emission Trading Act, and the Pollution Control Act.[106] Discharges of oil and chemicals are regulated at the national level through the permit system under the Pollution Control Act, and internationally through the OSPAR Convention.[107]

Companies must apply for discharge permits from the Norwegian Pollution Control Authority in order to discharge oil and chemicals into the sea. The Norwegian Pollution Control Authority grants discharge permits pursuant to the Pollution Control Act. That Act also obligates operating companies to establish contingency measures to counteract acute pollution. Municipal and national emergency response plans are also in place.

Norwegian authorities enforce strict environmental and safety requirements regarding the selection of chemicals. Operators must apply for discharge permits for all planned operations that involve discharges. There are detailed requirements regarding testing the environmental properties (biodegradation, potential for bio-accumulation, and acute toxicity) of chemicals to be used, even if an operator does not plan to discharge the chemicals. Operators are required to phase out the most environmentally hazardous chemicals. When operators use a new chemical, it must be accompanied by a Harmonized Offshore Chemicals Notification Format (HOCNF) form.[108]

The Norwegian Pollution Control Authority (SFT) requires operators to record their discharges. Produced water discharges must be measured daily, and operators must demonstrate that they are in compliance with their discharge permits.

B. Measuring And Reporting Discharges And Emissions

Emissions to air are generally calculated on the basis of the volume of fuel gas and diesel consumed at the facility.[109] Oil discharges are calculated by measuring the volume of produced water discharged to sea, followed by an analysis of the oil content in the water. Discharge of chemicals is calculated based on the quantity that is used relative to the quantity that is recovered.

There are a number of requirements for operators to provide environmental data, including annual reports, which give detailed information regarding discharges into the

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[106] Petroleum facilities on land are subject to the same laws and regulations as other land-based industry. Facilities located on land or at sea within the baselines are also subject to the Planning and Building Act. Facts, The Norwegian Petroleum Sector 2008 at 66.

[107] The OSPAR Convention is discussed in section V C, below.

[108] The purpose of the Harmonised Offshore Chemical Notification Format is to provide authorities with data and information about chemicals to be used and discharged offshore and to enable the authorities to take appropriate regulatory action in accordance with the scope of the applicable OSPAR Decision on a Harmonised Mandatory Control System for the Use and Reduction of Offshore Chemicals. See section V C, below.

[109] The emission factors are based on measurements from suppliers or standard figures developed by the industry itself, through the Norwegian Oil Industry Association (OLF), or using field-specific measurements.

sea and emissions to air. Industry monitors the environmental impact from drilling and production. According to the Norwegian Oil Industry Association (OLF), industry usually produces environmental performance reports with more data than the regulators required.[110]

The Norwegian Pollution Control Authority, the Norwegian Petroleum Directorate, and the Norwegian Oil Industry Association (OLF) have established a joint database to report discharges to sea and emissions to air from the petroleum activities. Since 2004, all operators on the Norwegian continental shelf report emission/discharge data directly in this database. This allows industry and regulators to more easily analyze historical emissions to air and discharges to the sea.[111]

Recommendation: The NSB should consider further study of the Norwegian joint database with a view toward establishing a similar (and hopefully even better) mechanism for acquiring and analyzing discharge data in the Arctic. The NSB should define a system that would serve its needs and then advocate for its establishment.

C. Environmental Monitoring

Environmental monitoring is required under Section 52 of the Regulations Relating to the Conduct of Activities in the Petroleum Activities.[112] Independent experts evaluate reports from the monitoring. The expert evaluations are available by request to the Norwegian Pollution Control Authority.[113]

1. Sediment Monitoring

Environmental monitoring is divided into sediment monitoring and water column monitoring. Sediment monitoring of individual fields has occurred since 1982. A more sophisticated regional approach, with harmonized acquisition and analysis methods, has been employed since 1996. Under this approach, the NCS is divided into 11 regions for sediment monitoring. Samples are collected in every area every third year using core samplers and grab sampling. The samples are analyzed for various heavy metals and oil compounds. The biodiversity of benthos (seabed animals) is also monitored.[114] Even industry admits that "[c]ontamination and impacts near installations are unavoidable and

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[110] OLF produces annually an Environmental Report that outlines the industry's emissions, trends, and prognoses. It reports atmospheric emissions, discharges to the sea, accidental spills, chemical discharges, waste emissions, and disposal of installations. It also presents the results of research studies and projects. OLF coordinates research and analytical reports, but the ultimate responsibility for implementing emissions reductions and other environmental improvement measures rests with individual operating companies.
[111] Facts, The Norwegian Petroleum Sector 2008 at 71.
[112] The specifics are set forth in Appendix 1 to the Activities Regulations, however these are not yet available in English.
[113] See hhtp://www.sft.no/artikkel___40389.aspx.
[114] Data from the monitoring is also used in connection with Norway's reporting requirements under OSPAR. See section V C, below.

continue to be measured," and that minor fauna effects have been proven at 50 meters from discharge points. [115]

The report "Offshore sediment monitoring on the Norwegian shelf" provides an assessment of ten years of regional monitoring from 1996 to 2006. Despite some environmental improvements due to operators switching from oil-based drilling fluids to water-based fluids, some regions have not improved and have, in fact, seen an increase in impacts and contamination. The study also notes that knowledge limitations regarding Arctic fauna may impede accurate monitoring of petroleum activities. Furthermore, impact models developed for the North and Norwegian Seas may not translate to the Arctic because faunal communities appear to respond to oil differently in the Arctic than in regions further south.[116] In light of these findings, Shell's reliance on studies from temperate waters to justify its planned discharges in the Arctic OCS seems patently unreasonable.

2. Water Column Monitoring

Water column monitoring can be used to study the effects of offshore discharges on organisms living in the water column. Organisms living in the water column around offshore oil and gas facilities are exposed to chemicals predominately through the discharge of produced water, which provides a constant source of contaminants to the marine environment.

The amount and composition of produced water varies from field to field, but usually it is a mixture of:

- formation water contained naturally in the reservoir,
- injected water used for secondary oil recovery, and
- chemicals added during production.

Produced water typically contains dissolved inorganic salts, minerals, and heavy metals together with dissolved and dispersed oil components and other organic compounds. Specific chemical compositions vary between reservoirs and even within a single reservoir over the course of production. As oil content in reservoirs decreases, the need to inject water increases, leading in turn to an increase in produced water discharges.

Some of the chemicals in produced water are known to biaccumulate and to be toxic to organisms in receiving waters. Studies in the North Sea have found toxic chemicals are detectable several kilometers away from production platforms.[117] Recent studies confirm that exposure to produced water alters immune function in the blue

[115] OLF, 2007 Environmental Report §2.3.
[116] Offshore sediment monitoring on the Norwegian Shelf, A Regional Approach 1996-2006, attached as Appendix 5.
[117] Water Column Monitoring 2006, Report AM 2006/013, attached as Appendix 7.

mussel (Mytilus edulis).[118] Similarly, exposure to oil has been shown to affect immune function in the Arctic Scallop (Chlamys islandica) and may have consequences for disease resistance and hence survival.[119]

Water column monitoring started on a research basis in 1993 and has been required by the Norwegian Pollution Control Authority since 1999.[120] The water column monitoring program is split into two sections: condition monitoring and regional impact monitoring.

Condition monitoring takes place every third year and covers the whole of the NCS. It is intended to determine whether fish from Norwegian waters are affected by pollution from offshore petroleum activities. According to OLF, "condition monitoring has not proven any oil components in fish used for consumption. However, a heightened level of certain biomarkers in haddock caught near oil installations has been identified."[121] The 2005 Water Column Monitoring Summary report prepared by OLF summarizes the monitoring in the Norwegian sector of the North Sea during 1997-2004.[122]

Regional impact monitoring addresses the fate and effect of produced water discharges in selected regions and is carried out on an annual basis. Caged fish and blue mussels are exposed to produced water in open seas.[123] The regional impact monitoring program for 2006 assessed the extent to which discharges from ConocoPhillips's Ekofisk field affect organisms living in the water column. Moderate negative effects were observed in organisms exposed to produced water.[124]

D. Zero Discharge To The Sea

1. Development Of The Zero Discharge Concept

Norway's zero discharge policy evolved from general political goals rather than a set of specific legal requirements. The concept of "zero discharge to the sea" was first mentioned in Storting White Paper No. 58 (1996–1997) Environmental Policy for a Sustainable Development – Joint Efforts for the Future.[125] The original zero discharge goals focused on two primary targets: oil in produced water and chemicals. All new

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[118] M.L. Hannam et al., Immune modulation in the blue mussel *Mytilus edulis* exposed to North Sea produced water, Environmental Pollution, Dec. 31, 2008, corrected proof available online Feb 12, 2009

[119] Marie L. Hannam et al., Immune function in the Arctic Scallop, *Chlamys islandica*, following dispersed oil exposure, Aquatic Toxicology, Jan. 10, 2009.

[120] To compare monitoring requirements under U.S. law, see the Arctic NPDES General permit, section II A (p. 12), II B (p.15), Tables 1-16 (pp. 20-36), and section III, (p.37).

[121] OLF, 2007 Environmental Report §2.3.

[122] See Appendix 6.

[123] According to the Norwegian Pollution Control Authority, these water quality monitoring methods are still under development. See hhtp://www.sft.no/artikkel___40389.aspx.

[124] See Appendix 7.

[125] Storting White Papers are aimed at the governmental bodies that will implement the guidelines and goals stated in the White Papers. Amendments of laws such as the Pollution Control Act or the Product Control Act are typically required to transform the policy statements of White Papers into binding legal obligations.

fields had to avoid environmentally harmful discharges; existing fields had to meet the zero discharge goals by 2005. Activities related to exploration drilling were not included in the original zero discharge goals, but were added later pursuant to a 2001 White Paper.[126] As this evolution indicates, the zero discharge concept has been subject to ongoing interpretation and development.[127]

It is important to note that the zero discharge concept was not intended to be implemented literally such that *all discharges* would be prohibited. Different types of discharges are treated differently, and factors such as environmental harm, cost, technological feasibility, and field specific factors can justify minimizing rather than eliminating discharges. The overarching goal was to reach zero *environmentally harmful discharges*. In 1999 the Environmental Impact Factor (EIF) risk assessment tool was established for evaluating planned discharges to the sea. The EIF holds that environmental harm occurs when the chemical concentration in the sea exceeds the "no effect" limit.[128]

The goals proposed in the various White Papers were converted into more specific measures for implementation by the Zero Discharge Group, a collaborative group with representatives from SFT, NPD, and OLF.[129] The legal basis for the zero discharge program is grounded in the Pollution Control Act and Product Control Act, as well as regulations under these statutes, particularly the Activities Regulations.

Several definitions are necessary to understand Norway's classification scheme and the manner in which Norwegian sources discuss the zero discharge program:

> **Environmentally hazardous substances** are substances or groups of substances that have defined intrinsic properties such as acute toxicity, persistence, and/or are

[126] This is according to Ingunn Nilssen, Senior Scientist, Department of Industry, Section for the Oil and Gas Industry of the SFT. See Zero Discharges to the Sea from Petroleum Activity on the Norwegian Continental Shelf, Exploration & Production: The Oil & Gas Review - 2003, Volume 2 at 2. I have been unable to verify this with the English language version of White Paper No. 24 (2000-01), The Government's Environmental Policy and the State of the Environment, available on the Ministry of Environment's website. English versions of the older White papers can be imprecise.

[127] The zero discharge objective was enhanced in White Paper No. 12 (2001-2002) Protecting the Riches of the Sea, which emphasized that the zero discharge goals apply to oil, naturally occurring substances in produced water, and added chemicals. Other documents relevant to the zero discharge work include White Paper No. 38 (2001-2002) On the Oil and Gas Activities; White Paper No 25 (2002-2003) The Government's Environmental Policy and the State of the Environment in Norway; The zero discharge report (November 1998)(A collaboration between OLF and SFT following up on Storting White Paper No.58 (1996-1997), and Coexistence between fisheries, aquaculture, oil activities, shipping and environmental interests, Final report from the Environmental Forum's working group on fisheries/oil (2002). The latest White Paper, The Government's Environmental Policy and the State of the Environment in Norway (spring 2007) is not yet available in English.

[128] OLF Fact Sheet, Zero Discharge. The EIF is also used to evaluate the components of produced water and to find the optimum solution for each field, whether that be reinjection or cleaning. Id. See also Emissions to Water, StatoilHydro, available at http://www. statoilhydro.com/en/environmentsociety environment/pages/dischargeswater.aspx..

[129] See Zero discharges to the sea from the petroleum activities, Status and recommendations 2003, Report by the Zero Discharge Group.

likely to bioaccumulate. The most hazardous substances are called "priority hazardous substances." Priority hazardous substances were variously targeted for elimination or substantial reduction by 2000, 2005, and 2010. Norway has substantially reduced emissions of several substances on the list. The current priority list includes about 30 substances or groups of substances.[130]

Note that "priority hazardous substances" are *not* limited to substances used in the petroleum industry. International agreements call for the phase out or restriction on the use of many of these substances.

Environmentally harmful discharges/ Discharges that cause environmentally adverse effects are phrases used when discussing the potential harm of a specific discharge. The potential for environmental harm is evaluated by using risk assessment models and depends on factors such as properties and volume of the substance discharged, as well as the time and place of the discharge. An "environmentally harmful discharge" can result from discharge of a hazardous substance, but it can also result from the discharge of intrinsically harmless substances that nevertheless cause adverse environmental effects (e.g., smothering corals by covering them with cuttings).

Potentially environmentally hazardous substances refers to substances or groups of substances that are not listed on the authorities' list of chemicals for priority action, but for which there is reason to believe that they are environmentally hazardous in relation to quantitative test criteria. The substances are evaluated on the basis of the precautionary principle.[131]

Chemicals refers to substances and mixtures of substances that are added in connection with activities in the petroleum industry.

Chemical substances refers to both chemicals and naturally occurring substances.

Contaminants in chemicals refers to environmentally hazardous substances that have not been added deliberately, but which occur naturally in low concentrations in chemicals. These are not pollutants in the sense of the Pollution Control Act,

[130] The chemicals selected for priority action were first identified in Storting White Paper No. 58 (1996–1997) Environmental Policy for a Sustainable Development – Joint Efforts for the Future. This list is updated regularly. The current priority list contains about 30 substances and is posted on the website State of Environment Norway, available at http://www.environment.no/Tema /Kjemikalier/Kjemikalielister /Prioritetslisten/.

Criteria for defining the types of substances to be given priority attention (beyond those on the priority list) were set forth in White Paper No. 25 (2002-2003), The Government's Environmental Policy and the State of the Environment in Norway. These include substances that exhibit low biodegradability, that bioaccumulate, and that have a serious long-term impact on health or are highly toxic to the environment. Emissions of such substances are to substantially reduced by 2010. List of Priority Substances, Norwegian Pollution Control Authority, 7/3/2008.

[131] See footnote 174 for a definition of the precautionary principle.

but rather undesirable substances that can accompany chemicals (such as heavy metals in barite).

Zero discharge of environmentally hazardous substances means no discharge of environmentally hazardous substances, whether they are chemicals, contaminants in chemicals, oil, or naturally occurring substances.[132]

2. Classification of Chemicals

The Norwegian Pollution Control Authority divides the chemicals into four groups -- black, red, yellow and green -- according to their intrinsic properties. The black and red groups both contain environmentally hazardous chemicals; the most hazardous substances are in the black category. More specifically, substances are categorized as follows:

a) **Black** category consists of chemicals on the following lists:

- Prioritized list in White Paper No. 21 (2004-2005)
- OSPAR List of Chemicals for Priority Action
- Substances with the following ecotoxicological properties:
  - Substances that have both a low biodegradability (BOD_{28} <20%) and a high bioaccumulation potential (log P_{ow} •5)
  - Substances that have both a low biodegradability (BOD28<20%) and a high acute toxicity (EC50 or LC50•10 mg/l)
  - Substances that are detrimental in a mutagenic or reproductive way

Discharge of Black category chemicals is generally not permitted.

b) **Red** category consists of substances with the following ecotoxicological properties:

- Inorganic substances that are acutely toxic (EC50 or LC50• 1 mg/l)
- Organic substances with a low biodegradability (BOD28<20%)
- Substances that meet two of the three following criteria:
  - Biodegradability equivalent to BOD28<60%
  - Bioaccumulation potential equivalent to log Pow•3 and molecular weight < 700, or
  - Acute toxicity of EC_{50} or LC_{50}•10 mg/l[133]

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[132] See Zero discharges to the sea from the petroleum activities, Status and recommendations 2003, Report by the Zero Discharge Group at 2.2.

[133] Regulations Relating to Conduct of Activities in the Petroleum Activities (The Activities Regulations), § 56b.

Red category chemicals are to be phased out and replaced with less hazardous substances. Discharge of red category chemicals requires permission, which typically will be given only if necessary for technical or safety reasons.

c) **Yellow** category is something of a catchall. Based on ecotoxicological properties, yellow chemicals would not be categorized as red or black, nor are they defined as PLONOR substances (chemicals considered to Pose Little Or No Risk to the marine environment).[134]

Discharge of Yellow category chemicals requires permission. Permits typically are granted since the chemicals are viewed as having acceptable environmental properties.

d) **Green** category consists of substances on the OSPAR PLONOR list (chemicals considered to Pose Little Or No Risk to the marine environment).[135]

Green category chemicals may be discharged without permission.[136]

3. Discharge Of Cuttings, Sand, And Solid Particles

Cuttings from drilling and well activities, sand and other solid particles shall not be discharged to sea if the oil content of formation oil, other oil or base fluid in organic drilling fluid is more than ten grams per kilogram of dry matter. Operators must obtain permits to inject material such as cuttings, sand, and solid particles.[137]

4. Permitting And Implementation Of The Zero Discharge Goals

The Pollution Control Authority has permitting authority under Chapter three of the Pollution Control Act. With the exception of green category chemicals, operators must obtain permits to use, discharge, or inject chemicals or water containing chemicals.

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[134] Regulations Relating to Conduct of Activities in the Petroleum Activities (The Activities Regulations), § 56b. The latest update of this list can be found on OSPAR's website under the Offshore Oil and Gas Industry, Decisions, Recommendations and other Agreements.

[135] Regulations Relating to Conduct of Activities in the Petroleum Activities (The Activities Regulations), § 56b.

[136] See Appendix 2 to the Activities Regulations: Conditions for the Use and Discharge of Offshore Chemicals, Table 1 (attached here as Appendix 8). An overview of the type of chemicals and corresponding requirements with regard to discharge permits and eco-toxicological documentation (in the form of HOCFN) is included in Appendix 8.

[137] Regulations Relating to Conduct of Activities in the Petroleum Activities (The Activities Regulations), § 59. See also Appendix 2 to the Activities Regulations: Conditions for the Use and Discharge of Offshore Chemicals, section 9 (attached here as Appendix 8).

Operators must ensure that the chemicals they use have been tested with regard to eco-toxicological properties.[138]

Operators must use chemicals containing as little contamination from other substances as possible. Operators are also directed to choose chemicals that, according to mandated environmental evaluations, pose the lowest risk of harming the environment.[139] Operators have an independent responsibility to identify chemicals that are potentially environmentally hazardous and that should therefore be substituted.[140]

Operators must state their plans for substituting red and black chemicals in their annual reports to the authorities.[141] Chemicals in the red and black category can only be used if they are necessary for technical and safety reasons.[142] Operators are under an overarching duty to reduce as much as possible the use and discharge of chemicals.[143] Unused chemicals cannot be discharged to sea.[144]

5. Summary Of The Zero Discharge "Rules"

At some risk of incompleteness, the zero discharge rules will now be summarized. First, note that today there are two sets of rules: general zero-discharge rules that apply to most of the NCS, and a stricter set of rules that apply to the Barents Sea-Lofoten area (discussed below in section IV D 5 b). Note also that "rules" in some instance might be better understood as goals or targets. Finally, the literature sometimes organizes the rules on the basis of "chemicals" and "other substances," while other times the divide is made between "environmentally hazardous substances" and "other substances." Given the nebulous nature of the zero discharge policy, the fact that so much environmental progress has been accomplished under it speaks highly of the cooperative relationship between government and industry in Norway.

a. **The General Zero-Discharge Rules** (applicable to most of the NCS)

The general zero-discharge rules are often divided between: 1) chemicals used in offshore processes, and 2) oil and other naturally occurring substances brought up with the oil and gas.

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[138] Regulations Relating to Conduct of Activities in the Petroleum Activities (The Activities Regulations), § 56a.
[139] Regulations Relating to Conduct of Activities in the Petroleum Activities (The Activities Regulations), § 56c.
[140] Details regarding the prioritization of chemicals to be substituted are set forth in Appendix 2 to the Activities Regulations (attached here as Appendix 8).
[141] These reports exist only in Norwegian. Per email from Ann Mari Vik Green (Senior advisor, Norwegian Pollution Control Authority) to author, July 14, 2008.
[142] Regulations Relating to Conduct of Activities in the Petroleum Activities (The Activities Regulations), § 56d.
[143] Regulations Relating to Conduct of Activities in the Petroleum Activities (The Activities Regulations), § 57.
[144] Id.

1) Restrictions On The Use Of Chemicals

- No discharge of environmentally hazardous chemicals (black and red categories).
- No discharge of other chemicals (yellow and green categories) if they can harm the environment.
- No discharge, or minimization of discharges, of environmentally hazardous contaminants in chemicals.

2) Restrictions On Other Substances

- No discharge (or minimization of discharges) of naturally occurring environmentally hazardous substances that are also “priority substances” (as defined in White Papers).
- No discharge (or minimization of discharges) of drill cuttings that can cause environmental harm.
- No discharge (or minimization of discharges) of oil components that are not environmentally hazardous but can cause environmental harm.
- No discharge (or minimization of discharges) of other substances that can cause environmental harm.[145]

b. Zero Discharge Rules for the Barents Sea-Lofoten Islands

The Barents Sea is one of Europe’s last large, relatively undisturbed marine environments. It supports rich biological diversity, including rich fisheries, numerous colonies of seabirds, deepwater coral reefs, and marine mammals such as walrus, seals, bowhead whales, and polar bears. Unfortunately, 30% of the undiscovered Norwegian petroleum resources are expected to be in the Barents Sea.[146]

Seismic surveys and exploration drilling began in the Barents Sea-Lofoten area in 1980. Some 65 exploration and appraisal wells have been drilled in the area, but the Snøvit gas and condensate field, northwest of Hammerfest, is the only year-round petroleum activity in these Norwegian waters. Additional Norwegian fields, however, will be produced,[147] as will Russian fields in the Barents Sea, such as Shtokman, the world’s largest offshore gas reserve.

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[145] OLF Fact Sheet – Zero discharges; Facts, The Norwegian Petroleum Sector 2008 at 70; Report to the Storting No. 8 (2005-2006), Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands at 64.

[146] Jon R. Hasle et al., Decision on Oil and Gas Exploration in an Arctic Area: Case Study from the Norwegian Barents Sea, Safety Science (2008). See notes 10-16 and accompanying text for the pressures building to find and tap these resources.

[147] StatoilHydro has received approval from Norway’s Pollution Control Authority to drill an appraisal well at the Nucula oil and gas discovery in the Barents Sea. It will be drilled with Transocean's semi-submersible rig Polar Pioneer, which has drilled other Norwegian Barents Sea exploration wells and has

Exploration activity in the Norwegian Arctic came to an abrupt halt in 2001. In the face of scientific dispute over the effects of produced water components on fish reproduction, the government ordered a regional environmental and socio-economic impact assessment for petroleum activity in the Lofoten and Barents Sea area. The impact assessment was based on a stricter "zero-discharge" regime. The authorities and oil companies recognized that adopting stricter discharge rules was the only politically feasible way to complete the impact assessment and get the region reopened to petroleum activities without too many years delay.[148]

The upshot was that Norway imposed stricter requirements on petroleum activities in the Barents Sea and Lofoten area. These requirements were set forth in a 2004 White Paper[149] and reaffirmed in the 2006 White Paper establishing a region-wide, ecosystem based management plan for the Barents Sea.[150] In 2010, the government will reevaluate these stricter standards and also decide whether more acreage in the area will be opened for petroleum activities.

The requirements for petroleum activities in the Barents Sea are as follows:

- No discharge of produced water during normal operations. Injection or another suitable technology must be used.
- In cases of operational deviation, no more than 5% of produced water can be discharged, provided it is first treated using the best available technology to remove environmentally hazardous substances.
- No discharge of drill cuttings and drilling muds. Drill cuttings and muds must be reinjected or taken to shore for treatment/disposal (Except: Drill cuttings from the top hole section of the well (i.e. the section of the well drilled prior to installation of a blowout preventor and conductor casing) may be discharged *provided*:

    1. they do not contain environmentally hazardous substances or other substances that may have a negative impact on the environment

    2. such discharges are allowed only where damage to vulnerable components of the environment is unlikely (based on thorough environmental assessments); and

    3. the operator obtains a permit for such discharge.

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been modified to satisfy Norwegian criteria for zero-discharge operations. See StatoilHydro allowed to drill near coast, Petroleum News, October 12, 2008.

[148] Jon R. Hasle et al., Decision on Oil and Gas Exploration in an Arctic Area: Case Study from the Norwegian Barents Sea, Safety Science (2008).

[149] Report to the Storting No. 38 (2003-2004), On the Petroleum Activities.

[150] Report to the Storting No. 8 (2005-2006), Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands.

- "Sealed" drilling rigs are required to avoid discharge of drainage water and minor accidental discharges to the sea.[151]
- No discharge to sea in connection with well testing.
- A number of areas identified as valuable and vulnerable from an environmental and resource point of view have been placed off limits to petroleum activities, including the ***marginal ice zone*** and ***polar front***.[152]
- No petroleum activities within 35 km (21.75 mi.) of many portions of the coast.
- No new petroleum activities in the zone 35-50 km (21.75 – 31 mi.) from the coast, except where production licenses had been issued in the 19th licensing round (2006) or earlier.
- Where petroleum activities are allowed, they must not damage vulnerable flora and fauna. Areas that could be affected must be surveyed before any activities are started.
- Licensees are not allowed to engage in year-round operations unless they can substantiate that their operations will meet the zero discharge requirements.
- Oil spill response measures must be at least as effective as on other parts of the NCS.[153]

In addition to the restrictions above, preventative measures have been undertaken to increase safety at sea and oil spill preparedness in the Barents Sea. These include:

- Establishing new mandatory shipping lanes for high-risk transportation at around 30 nautical miles from land.
- A sea traffic control center for Northern Norway was established in 2007 at Vardo.

The government has also pledged to continue its work on maritime safety and oil spill response as set forth in a 2005 white paper.[154]

6. Success Of The Zero Discharge Policy

Discharges of environmentally hazardous chemical additives on the NCS have been reduced by more than 99% over the ten-year period 1997-2007.[155] The small amount of

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[151] Jon R. Hasle et al., Decision on Oil and Gas Exploration in an Arctic Area: Case Study from the Norwegian Barents Sea, Safety Science (2008).

[152] These restrictions will be reevaluated in 2010 in connection with the revision of the management plan for the area.

[153] OLF Fact Sheet – Zero discharges; Facts, The Norwegian Petroleum Sector 2008 at 70; Report to the Storting No. 8 (2005-2006), Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands, ch. 5 & 10.

[154] See Report No. 14 to the Storting (2004-2005). See also Report No. 8 to the Storting, Integrated Management Plan for the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands, part 10.2.

black and red category chemicals still being used is driven by safety concerns, but substitution efforts will continue.[156] It should be noted that the replacement of such chemicals has generally been cost effective.[157]

Most chemical discharges are associated with drilling, so discharge volumes will vary with the amount of drilling activity. Chemicals that are not discharged are dissolved in the oil, deposited subsurface, or handled as hazardous waste.[158] Norway considers its zero discharge targets to have been achieved for environmentally hazardous chemical additives.[159]

The goals for naturally occurring substances have not been reached to the same degree as for chemical additives. Produced water (which contains residues of oil and added chemicals, as well as naturally occurring chemical substances) is the greatest environmental challenge on the NCS. Norway has many aging fields, and the amount of produced water increases as fields mature. Norway also aggressively pursues increased oil recovery, which increases the amount of produced water.[160]

Reinjection of produced water, cleaning, and process optimizations have been the most economically efficient means to reduce pollution from produced water on the NCS. C-tour and Epcon are the most commonly used cleaning technologies and have reduced the amount of dispersed oil to 1.5 to 2 mg/l on some facilities, well below the 30mg/l limit set by domestic and international law.[161]

StatoilHydro reports that the environmental impact from its platforms, measured in terms of the EIF, fell by more than 80% between 2000 and 2006, and discharges of oil have been halved. Its average concentration of oil in discharged water is 25mg/l, 5mg/l below the legal limit.[162]

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155 Discharges of black chemicals have dropped from 228 tons in 1997 to one ton in 2007, while discharges of red chemicals dropped from 3933 tons to 23 tons during the same period. The trend continues: from 2006 to 2007 black chemicals were reduced from three tons to one, while red chemicals went down from 39 to 23 tons. OLF's Environmental Report 2007.

156 Per email from Ann Mari Vik Green (Senior advisor, Norwegian Pollution Control Authority) to author, July 14, 2008; OLJEINDUSTRIEN, May 2008, available at http://www.olf.no/?53157.pdf. 99% of the chemicals used on the NCS are from the green and yellow categories (believed to have little or no environmental impact), Facts, The Norwegian Petroleum Sector 2008 at 77.

157 Facts, The Norwegian Petroleum Sector 2008 at 71.

158 Facts, The Norwegian Petroleum Sector 2008 at 78.

159 Facts, The Norwegian Petroleum Sector 2008 at 71. The status of the Zero Discharge work was last evaluated in 2006. This report by SFT to the Ministry of Environment is available only in Norwegian. The report states that from 2000 – 2005 discharges of black and red category chemicals were reduced by 93% and 89%, respectively. Discharges have been reduced further since then. Safety concerns are said to be the reason black and red chemicals continue to be used at all.

160 The average recovery factor on the NCS is 46%, the highest national rate for offshore production. Norwegian Continental Shelf, No.2, 2008 at 9.

161 Facts, The Norwegian Petroleum Sector 2008 ch.9; OLF 2007 Environmental Report. See also section V C, below.

162 StatoilHydro, Emissions to Water, available at http://www.statoilhydro.com/en/environmentsociety/environment/pages/dischargeswater.aspx.

In 2009, the Pollution Control Authority will evaluate the degree to which the zero discharge targets for oil and naturally occurring substances have been reached and the need for further measures.

V. INTERNATIONAL LAW

Certain aspects of Norway's petroleum industry are subject to international law. Of particular interest, given the scope of this report, are international obligations relating to limitations on emissions and discharges. A brief synopsis of the key aspects of applicable international law follows. A complete report of the international law that applies to Norway's offshore oil and gas industry is beyond the scope of the current work.

With regard to air emissions, Norway has signed internationally binding agreements on emissions of NO_x (Nitrogen Oxides) under the Sofia Agreement, VOC (Volatile Organic Compounds) under the Geneva Agreement, and chlorofluorocarbons (CFCs) and halons[163] under the Montreal Protocol on Substances that Deplete the Ozone Layer. The Sofia and Geneva Agreements are two of the five elements of the 1979 Convention on Long-Range Transboundary Air Pollution. Norway has also committed to certain reductions in greenhouse gas emissions as a party to the 1992 Framework Convention on Climate Change (FCCC) and Kyoto Protocol. The OSPAR Convention plays a significant role governing Norway's international obligations with regard to discharges to the sea. These international agreements are discussed in more detail below.

The effect of international agreements on the petroleum sector will depend on the treaty language and how national obligations are distributed within Norway. For example, under the Kyoto Protocol, Norway can meet its obligations by reducing emissions in Norway or in other countries by the use of international emission trading, the Clean Development Mechanism, or joint implementation. States generally use these types of mechanisms (where allowed) when the cost of making reductions abroad is lower than making the reductions at home. Thus, even if the U.S. were to join the progressive part of the international community that is working to roll back greenhouse gas emissions, accepting international obligations will not necessarily result in a direct reduction in emissions on the NSB or OCS.

A. Kyoto Protocol To The United Nations Framework Convention On Climate Change[164]

The 1992 Framework Convention on Climate Change (FCCC) is a treaty requiring parties to provide national inventories of sources and sinks of greenhouse gases (GHG),

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[163] Halons are fully halogenated chemicals that have relatively long lifetimes in the atmosphere. Halons break down in the stratosphere and release reactive bromine that is extremely damaging to ozone. Reactions involving bromine are estimated to be responsible for 25% of the chemical destruction of ozone over Antarctica and 50% over the Arctic. The ozone depleting potential of halons is 10 times greater than that of chlorofluorocarbons (CFCs). Halons are used as fire fighting agents and have been installed on some offshore platforms.

[164] UN Doc. FCCC/CP/1997/L7/Add.1 (Dec. 10, 1997).

and regular reports on policies and measures that limit emissions of GHGs and enhance the sinks for them. The FCCC itself does not contain explicit targets and timetables for stabilizing atmospheric concentrations of greenhouse gases.[165]

The Kyoto Protocol to the FCCC is an additional treaty that seeks to achieve reductions in GHGs by providing legally binding, individualized emissions targets for countries listed in Annex I of the FCCC (so-called "Annex I countries"), which are predominately OECD members, some Eastern European countries, and some former republics of the Soviet Union. The targets are to be met over a 5-year period running from 2008 to 2012.[166]

In accord with the Kyoto Protocol, Norway has agreed that its average emissions for 2008- 2012 shall not increase by more than 1% compared to its emissions in 1990. At current emission levels, this will require a reduction of approximately 7%, because Norway's carbon emissions increased by almost 8% between 1990 and 2006.[167]

Despite its Kyoto obligations, Norway's greenhouse gas emissions have never been higher. Following two years of decreases, emissions of GHG increased by almost 3% in 2007. The increase is mainly due to CO_2 emissions from excessive flaring at the new LNG plant at Melkøya outside Hammerfest.[168] Emissions from other parts of the petroleum industry continued to decrease in 2007 due to lower production of crude oil. Nevertheless, GHG emissions from the petroleum industry almost doubled from 1990 to 2007.[169]

In 2007, the Norwegian government committed to overachieving its Kyoto obligations by 10%, and in 2008 it announced a commitment to achieve a carbon neutral economy by 2050. These targets will have to be met largely through the use of Kyoto mechanisms (international emission trading, the Clean Development Mechanism, or joint implementation), given the expansion of Norway's oil and gas industry and the proliferation of gas and diesel-powered generators needed to power it.[170]

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[165] The FCCC entered into force March 21, 1993. The U.S. and nearly every state in the world is a party to the treaty. For more on the FCCC, see Daniel Bodansky, The United Nations Framework Convention on Climate Change: A Commentary, 18 Yale J. Intl. L. 451 (1993).

[166] The Kyoto Protocol to the FCCC was adopted in 1997 and entered into force in 2005. Although a signatory to the Kyoto Protocol, the U.S. has not ratified it and therefore is not bound by it. For more on the Kyoto Protocol, see Clare Breidenich et al., Current Development: The Kyoto Protocol to the Framework Convention on Climate Change, 92 Am. J. Intl. L. 322 (1998).

[167] Facts, The Norwegian Petroleum Sector 2008, ch.9.

[168] Technical difficulties at the LNG plant at Melkøya (off of Hammerfest) lead to high levels of flaring. The Melkøya plant processes the wellstrem from the Snohvit field, located 100 miles offshore.

[169] Statistics Norway, available at http://www.ssb.no/english/subjects/01/04/10/klimagassn_en/. Other sources state that the Norwegian petroleum sector's carbon dioxide "equivalent" emissions have grown 91.6 % since 1990. See Norway: oil, gas drive country off Kyoto course, Scandinavian Oil-Gas Magazine, Feb. 9, 2009.

[170] Facts, The Norwegian Petroleum Sector 2008, ch.9; Greenhouse gas emission trends and projections in Europe 2007 – Country profile for Norway, available at http://reports.eea.europa.eu/ eea_report_2007_5/ en/Norway.pdf.

B. The 1979 Convention On Long-Range Transboundary Air Pollution[171]

Norway is a party to the 1979 Convention on Long-Range Transboundary Air Pollution (LRTAP), which entered into force in March 1983.[172] In general, the treaty seeks to reduce and prevent air pollution, including but not limited to transboundary air pollution. The problem of transboundary acid rain was the main reason for concluding the LRTAP, but the goals have been extended by eight protocols.

The Convention together with its eight protocols set targets for the reduction of specific emissions, prescribe stringent emission limit values for emission sources, propose concrete pollution reduction measures, and establish requirements regarding the submission of data on emissions of a number of air pollutants. The most recent protocol (and most relevant to the present report) is the 1999 Gothenburg Protocol.[173]

The Gothenburg Protocol sets 2010 emission ceilings for four pollutants: sulfur dioxide, nitrogen oxides, volatile organic compounds, and ammonia. Parties whose emissions have a more severe environmental or health impact and whose emissions are relatively cheap to reduce will have to make the biggest cuts. Under the Gothenburg Protocol, Norway must reduce its NO_x emissions to 156,000 tons by 2010, a 27% reduction from its 1990 emission levels.

C. OSPAR (Oslo-Paris Convention) -The Convention For The Protection Of The Marine Environment Of The North-East Atlantic

The 1992 OSPAR Convention guides international cooperation on the protection of the marine environment of the North-East Atlantic. It combined and updated the 1972 Oslo Convention on dumping waste at sea and the 1974 Paris Convention on land-based sources of marine pollution with the intention of providing a comprehensive and simplified approach to addressing all sources of pollution that might affect the North-East Atlantic. Among other things, the Convention:

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[171] T.I.A.S. No. 10541, reprinted in 18 I.L/M. 1442 (1979).

[172] The U.S. has acceded to the LRTAP and its protocols by executive agreements rather than by treaty making under Article II, section 2 of the Constitution.

[173] The other seven protocols are: 1) the 1998 Protocol on Persistent Organic Pollutants (POPs)(entered into force on 23 October 2003); 2) the 1998 Protocol on Heavy Metals (entered into force on 29 December 2003); 3) the 1994 Protocol on Further Reduction of Sulfur Emissions (entered into force 5 August 1998); 4) the 1991 Protocol concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (entered into force 29 September 1997); 5) the 1988 Protocol concerning the Control of Nitrogen Oxides or their Transboundary Fluxes (entered into force 14 February 1991); 6) the 1985 Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent (entered into force 2 September 1987); 7) the 1984 Protocol on Long-term Financing of the Cooperative Program for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) (entered into force 28 January 1988).

1. requires the application of:
   a) the precautionary principle;[174]
   b) the polluter pays principle;[175]
   c) best available techniques (BAT) and best environmental practice (BEP), including clean technology;[176]
2. provides for a Commission that can adopt binding decisions;
3. provides for the participation of observers, including non-governmental organizations, in the work of the Commission;
4. establishes rights of access to information about the maritime area of the Convention.

Work under the Convention is managed by the OSPAR Commission, made up of representatives of the Governments of 15 Contracting Parties and the European Commission, representing the European Community.[177] The work under the Convention applies an ecosystem approach and is organized under six strategies: 1) Biodiversity and Ecosystem, 2) Eutrophication, 3) Hazardous Substances Strategy, 4) Offshore Industry Strategy, 5) Radioactive Substances Strategy, and 6) the Strategy for the Joint Assessment and Monitoring Program, which assesses the status of the marine environment and the benefits thereto resulting from implementation of the strategies.

The objective of the Offshore Oil and Gas Industry Strategy is "to prevent and eliminate pollution from offshore sources and to protect the OSPAR maritime area against the adverse effects of offshore activities so as to safeguard human health and conserve the marine ecosystems. When practical, marine areas which have been adversely affected shall be restored."[178] The Offshore Oil and Gas Industry Strategy

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[174] The OSPAR Commission defines the precautionary principle as requiring preventive measures to be taken when there are reasonable grounds for concern that human activities may bring about hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a causal relationship. A lack of full scientific evidence must not postpone action to protect the marine environment. The precautionary principle anticipates that delaying action would in the longer term prove more costly to society and nature and would compromise the needs of future generations. See http://www.ospar.org/content/content.asp?menu=00320109000065_000000_000000.

[175] The polluter pays principle is one of the guiding principles of the OSPAR Convention and requires that the costs of pollution prevention, control, and reduction measures must be borne by the polluter. The polluter pays principle is mainly implemented by means of command-and-control approaches but can also be applied via market-based mechanisms, encouraging the development and introduction of environmentally sound technologies and products.

[176] As defined in Appendix 1 of the OSPAR Convention, BAT "means the latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste." BEP is defined as "the application of the most appropriate combination of environmental control measures and strategies." BAT and BEP for a particular source will change over time in light of technological advances, economic and social factors, and changes in scientific knowledge and understanding.

[177] Norway is a party to the Convention; the United States is not.

[178] OSPAR Commission, Offshore Oil and Gas Industry strategy statement.

develops and implements programs that address all phases of offshore activities, including offshore installations, discharges, carbon capture and storage, and offshore chemicals.

With regard to chemicals, OSPAR has adopted a harmonized mandatory control system for use and reduction of discharges of offshore chemicals. This system promotes a shift toward the use of less hazardous (or preferably non-hazardous substances). Chemical suppliers must provide national authorities with data and information according to the Harmonized Offshore Chemical Notification Format (HOCFN). Chemicals are ranked according to their hazardous qualities, which allows operators selecting chemicals and regulators issuing permits to make informed decisions.

Each signatory state has its own regulatory scheme to implement OSPAR policies. The Norwegian Pollution Control Authority (with the assistance of consulting companies) manages the approval process for the HOCFN in Norway. Chemicals used in the offshore industry are evaluated at the component level and given a color classification appropriate to its environmental footprint, (*i.e.* black, red, yellow, or green).[179] This information is entered in a central database to which operators have access.

The OSPAR Convention also regulates discharges into the sea. As of January 2007, the maximum allowable level for oil content in water discharged into the sea is 30mg/l. Norway's domestic law incorporates the limits set forth in the OSPAR Convention.

In 2007, the OSPAR Commission adopted amendments to the Annexes to the Convention to allow storage of CO_2 in subsea geologic structures.[180] The changes will enter into force when at least seven of the parties to the Convention have ratified the resolution. The Commission has also adopted a decision to legally rule out placement of CO_2 into the water-column and on the seabed, because of the potential negative effects.

In addition to directing its own work, the OSPAR Commission also cooperates with other international organizations to develop measures to prevent and eliminate pollution from offshore sources. The OSPAR Commission has leant its regional seas perspective to international efforts such as the 1996 Protocol to the London Dumping Convention[181] and the European Union's REACH Regulation (for Offshore Chemicals). The OSPAR Commission has also contributed to international efforts at regulating subsea carbon sequestration under recent amendments to the 1996 London Protocol.[182]

The OSPAR Convention allows the oil-producing states of Western Europe to work more like a single country for the purposes of controlling offshore pollution. Detailed implementation of the OSPAR regulations is still governed by national laws and European Union directives (with the exception of Norway, which is not an EU member

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[179] See section IV. D. 2, above.
[180] Resolution from summer 2007.
[181] See section V D, below.
[182] Id.

but has, in general, stricter environmental regulations). The OSPAR Convention may warrant further study to determine whether it should serve as a model for increasing international protection of the Arctic marine environment.

D. London Dumping Convention

The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972, commonly called the "London Convention," has provided the basic global framework for controlling the deliberate disposal of wastes at sea since its entry into force in 1975. It generally applies to deliberate disposal from vessels, but also aircraft, platforms, and other manmade structures. Dumping generally does not include discharges from land-based sources of marine pollution, such as pipes and outfalls. Nor does it include normal operational discharges from vessels, offshore drilling operations, or disposal arising from or related to the exploration, exploitation, or associated offshore processing of seabed mineral resources. The International Maritime Organization (IMO), a specialized agency of the United Nations, serves as Secretariat for the Convention.

In simple terms, the London Convention follows a "blacklist/graylist" approach to regulation, with dumping of blacklisted materials (Annex I) not allowed unless they are present only as trace contaminants or will be rapidly rendered harmless. Graylisted materials (Annex II) pose less risk to the environment and may be dumped so long as special care is taken with regard to factors such as site selection, monitoring, and other mitigation measures. National authorities in contracting states must control dumping consistently with the provisions of the Convention, which is done through a permit system.[183] Annex III sets forth environmental protection criteria that national authorities must consider when issuing permits.

The 1996 London Protocol supersedes the 1972 Convention for all states that join the 1996 Protocol.[184] The 1996 Protocol adopts the precautionary principle[185] and a more stringent legal framework for preventing ocean waste disposal than its predecessor. Whereas the London Convention legitimized waste disposal at sea by allowing all materials not listed to be disposed of, the 1996 Protocol adopts the opposite approach, banning all forms of disposal unless specifically allowed. The list of possibly acceptable waste, the so-called "reverse list," includes, *inter alia*, vessels and platforms; inert, inorganic geological material (e.g., mining wastes); and organic material of natural origin.

As of February 2007, the 1996 Protocol permits injection and storage of CO_2 in subsea geologic formations. This is the first international law explicitly addressing carbon

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[183] In the U.S., the London Convention is implemented through Title I of the Marine Protection, Research and Sanctuaries Act (MPRSA). The MPRSA provides that implementing regulations are to apply binding requirements of London Convention to the extent this would not relax the standards of the MPRSA.
[184] The London Protocol entered into force on 24 March 2006 and has currently 32 State Parties. Norway is a party to both the London Convention and the 1996 Protocol. The United States is a party to the London Convention but has not ratified the 1996 Protocol.
[185] See note 174 for the OSPAR Commission's definition of the precautionary principle.

sequestration in international waters. Under the new amendment to the 1996 Protocol, carbon dioxide streams from carbon dioxide capture processes for sequestration can be stored if they meet three criteria: (1) disposal is into a sub-seabed geological formation; (2) the carbon dioxide stream is of high purity containing only incidental amounts of associated substances; and (3) no wastes or other matter are added for the purpose of disposing of those wastes or other matter.[186]

The addition of carbon capture and sequestration (CCS) activities to the 1996 Protocol is particularly relevant in Norway. The Sleipner field is the longest running, large-scale CCS project in the world. Carbon dioxide is captured from an offshore natural gas processing platform in the North Sea and injected into the Utsira formation deep under the ocean floor.[187] When Sleipner came on stream, the 1996 Protocol was not yet in effect. While the London Convention appears to prohibit sub-seabed storage of carbon dioxide generated from land-based sources, the project was permitted under an exemption that allows carbon dioxide storage in sub-seabed formations as long as the carbon dioxide originates from the processing of mineral resources under the seabed. In Sleipner, the carbon dioxide is a byproduct of the natural gas operation and therefore falls within the exemption.[188] Separation and storage of CO_2 is also taking place in connection with the Snøvit field.[189]

VI. NORWAY'S INVOLVEMENT IN INTERNATIONAL COLLABORATION

Norwegian authorities actively participate in international fora that focus on matters relating to health, safety, and environment in offshore activities. A number of these are described in Appendix 3.

VII. NORWAY'S INVOLVEMENT WITH BILATERAL COLLABORATION

Norway's Petroleum Safety Authority collaborates with other Northern European offshore regulators to exchange knowledge and experience and facilitate internationalization of the industry.

A. Bilateral Collaboration With The UK

Norwegian and U.K. regulators signed a framework agreement on cross-boundary petroleum collaboration in 2005. The framework provides a basis for the British Health and Safety Executive and Norway's PSA to reach more specific agreements on safety and the working environment.

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[186] The 1996 Protocol and London Convention's jurisdiction extends to all waters except internal waters (i.e. waters inland from territorial waters).

[187] StatoilHydro extracts CO_2 from Sleipner Vest production for storage 1,000 meters beneath the seabed, rather than releasing it to the air. More than 10 million tons of CO_2 have been sequestered since fall 1996. Seismic data confirms that the carbon dioxide is being contained in the structure as planned. See New seismic data from the Utsira formation confirms greenhouse store staying sealed, Scandinavian Oil & Gas Magazine, Mar. 9, 2009.

[188] See Article III (c) of the London Convention and Article I 4.3 of the London Protocol.

[189] See section III F, above.

Agreements have been reached for the Blane and Enoch boundary fields and the Langeled South gas pipeline. These accords regulate the exchange of safety-related information as well as the supervision of operators, fields, and installations. Similar agreements have been reached concerning other fields and transport systems crossing the UK-Norwegian boundary. Norwegian and British regulators regularly conduct joint audits and supervision of industry participants. A special working group meets twice a year to exchange information on legislation and regulatory strategy and developments in the two countries and larger EU area.

B. Bilateral Collaboration With Russia In The Far North

Russia faces major challenges developing its oil and gas in the far north. Norway seeks to assist Russia with its far north petroleum operations not only for the economic benefits that may inure by having Norwegian companies involved in Russian fields, but also to protect the Barents Sea environment. To this end, Norwegian regulators have cooperated with Russian authorities for a number of years, which has helped to build good relations and contribute to an exchange of safety-related experience. Norway is currently working to develop HSE standards that will apply to both the Norwegian and Russian sectors of the Barents Sea.[190]

VIII. PROTECTION OF INDIGENOUS SUBSISTENCE ACTIVITIES

The Sámi are the indigenous people of Northern Europe. The vast majority of Sami live in Norway (60,000 – 100,000) with smaller numbers in Sweden (15,000-25,000), Finland (6,400), and Russia (2,000). Their ancestral lands, known as Sápmi, span the northern portion of the three Nordic countries and the Kola Peninsula in Russia.

Of the four states home to Sámi, Norway arguably has been the most progressive in supporting Sámi culture. The Sámi received Constitutional recognition in 1988,[191] and the Sámi Parliament was established the following year.[192] Norway was the first state in the world to ratify the International Labour Organization Convention No. 169 concerning Indigenous and Tribal Peoples in Independent Countries.[193]

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[190] Petroleum Safety Authority report," Safety –Status & Signals 2008-2009" at 41.

[191] Article 110a of Norway's Constitution provides: "It is the responsibility of the authorities of the State to create conditions enabling the Sámi people to preserve and develop its language, culture and way of life." Two other constitutional provisions can be relevant to Sámi (and other Norwegian citizens') rights that may be threatened by resource development projects: § 100b relating to environmental issues, and § 100c relating to human rights. See generally, Ola Mestad, Rights to Public Participation in Norwegian Mining, Energy, and Resource Development, chapter contained in Human Rights in Natural Resource Development, Donald Zillman, Alastair Lucas, and George Pring (eds.) (Oxford 2002).

[192] Provision for the Sámi Parliament was made in the Sámi Act of 12 June 1987. The amount of responsibility assigned to the Sámi Parliament by the Norwegian government is rather limited and focuses primarily on cultural affairs.

[193] ILO Convention 169 is one of the key instruments in the body of international law relating to indigenous peoples. Adopted in 1989, the Convention has been ratified by only 20 of the ILO's 182 member states. Although its provisions are directed at states, not private actors, the convention is often used a reference point by stakeholders. The U.S. is a member of the ILO but has not ratified Convention 169.

Traditional Sámi livelihoods include reindeer and sheep herding, fur trapping, and fishing. Fishing is said to be the oldest Sámi industry, and it can be divided between sea fishing and inland fishing. While inland fishing is practiced throughout Sápmi, Sámi sea fishing is carried only in Norway and Russia.[194]

Coast Sámis are a branch of Sámi who have been living along the fjords of the Barents Sea for thousands of years.[195] In Norway, Coast Sámi mainly use small boats to fish for cod and other available fish and crabs in coastal fjords. To date, Norway's Sámi have not had substantial direct conflicts related to oil and gas activity, primarily because most activity has taken place offshore in areas where the Sámi do not fish. Industrial over-fishing, which has left some fjords nearly devoid of fish, has been a greater problem for Sámi fisheries than has oil and gas activities.[196]

While it is clear that oil and gas activities can have a number of impacts on the Sámi, the Government has been reluctant to include the Sámi Parliament of Norway in related policy processes.[197] The government contends that it has no duty to consult with regard to activities taking place beyond the boundaries the traditional Sámi homeland.[198] If a large project were proposed that would have direct coastal and land impacts, Sámi interests would be considered in an environmental assessment according to general Norwegian law.

Government efforts to protect what we might consider analogous to subsistence activities have been modest. Fisheries depletion led the government to establish a commission to examine Sámi rights to fish in the waters of Finnmark, Norway's northernmost county. In February 2008, the Coastal Fisheries Committee for Finnmark proposed legal reform for small-scale coastal fisheries. In short, the committee found that the Sámi have special fishing rights based in international human rights law but proposed that these rights should be applied to all coastal people in Sámi areas of

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[194] Lars-Nila Lasko et al., The Sámi People and the Northern Sea Route: Juridical, Social and Cultural Concerns.

[195] Steinar Pedersen, Formalizing Indigenous Fishing Rights, Samudra Report No. 51.

[196] Information provided to author by John B. Henriksen, Chairperson-Rapporteur of the UN Human Rights Council's Expert Mechanism on the Rights of Indigenous Peoples. There are exceptions of course. Development of the Goliat oil field is expected to impact fisheries and reindeer herding. See Ingunn Ims Vistnes et al., Utbygging og drift av Goliat oljefelt Konsekvensutredning Sámiske forhold, Northern Research Institute (Sept. 2008).

[197] For example, the interests of the Sámi receive only brief mention in the Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands. See Report No. 8 to the Storting (2005-2006): Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands at 43.

[198] Id. The duty to consult with the Sámi arises mainly from international law (mainly articles 6, 15, 16 of the ILO Convention No. 169 and the UN Human Rights Council's jurisprudence related to article 27 of the International Covenant on Civil and Political Rights. In addition, the Government and the Sámi Parliament have entered into an agreement concerning consultations. However, this agreement does not have clear legal significance, and it is unfortunately frequently violated.

Finnmark without regard to ethnicity.[199] The committee's proposals are undergoing public comment and are not yet before the Storting.

Reindeer herding receives some special protection under Norwegian law, the details of which are beyond the scope of this report. In simple terms, The Reindeer Herding Act of 1978 and customary national law (based on protracted traditional use of land or water areas), protect Sámi reindeer herding as a *right to use* land and resources. Due to its nomadic nature, reindeer herding is not regarded as intensive enough to establish any *ownership rights* under Norwegian law. Reindeer herding rights also contain a number of utilization rights, including the right to hunt, trap, and fish in connection with the reindeer herding.[200]

The Sámi right to use lands and resources for reindeer herding purposes is not absolute -- it has to compete with other activities, including industrial activities. Reindeer herding rights can be expropriated for the benefit of competing activities if those are deemed being of greater benefit for the society at large.

The Sámi in Norway are generally not involved with whaling, and consequently there are no special legal protections for the Sámi in this regard. In recent years, Norwegian whalers have taken less than half of the quota of 1,052 minke whales set by the Norway's Fisheries and Coastal Affairs Ministry. I have found no reports of conflicts between the petroleum industry and Norwegian whalers. This is likely because most Norwegian whaling takes place in areas where O & G activities are not present.

IX. CONCLUSION

This report has sought to answer the questions presented with sufficient detail to provide the Mayor and his staff with a solid basis for understanding Norway's environmental regulation of offshore oil and gas activities. Much more could be written on most of the issues discussed herein. Please let me know if there are any topics about which you wish to know more.

Looking forward, the NSB may want to stay abreast of issues of international law relating to the Arctic. It is likely that the Senate will ratify the U.N. Convention on the Law of the Sea (UNCLOS). Accession to that treaty will likely create a flurry of activity as the federal government leverages treaty provisions to protect and advance national interests in the Arctic. The NSB will have to remain vigilant to make sure its interests are not overlooked or sacrificed in the name of the "national interest."

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[199] Steinar Pedersen, Formalizing Indigenous Fishing Rights, Samudra Report No. 51. It is proposed that fishery rights in the fjords should be exclusive rights for the people living along the shores of the fjord concerned (Sámi and non-Sámi). Outside the fjords and within Norway's territorial seawaters, it is proposed that that people from Finnmark should have the same fishery rights as non-Finnmark fishermen.

[200] Information provided to author by John B. Henriksen, Chairperson-Rapporteur of the UN Human Rights Council's Expert Mechanism on the Rights of Indigenous Peoples. See also Elisabeth Einarsbol, Reindeer husbandry rights in Norway (2005), available at http://www.galdu.org/web/index.php?artihkkal =259&giella1=eng.

While UNCLOS will likely be the cornerstone of the legal regime applicable to the Arctic, there is certainly room for further development of multilateral environmental agreements. A regional sea agreement, similar to OSPAR (discussed above in section V C) may be an effective way to enhance environmental governance of the Arctic and maximize protection of the marine environment. The NSB may benefit by staying abreast of such developments and advocating on their behalf, where appropriate. In this connection, a more detailed study of the OSPAR Convention and Commission may be warranted. Having key personnel continue to be involved in the work of the Arctic Council through the Inuit Circumpolar Council's status as an Arctic Council Permanent Participant may become increasingly important a the rush for Arctic resources accelerates.

The mandate for this report did not call for an analysis of shipping issues. It should be noted, however, that shipping presents a major threat to the Arctic marine environment. Shipping will surge not only with the increase in O&G activity, but also due to the quest for other resources (such as minerals and fisheries), the opening of new navigational routes (due to climate change), and increased military presence in the Arctic. Unfortunately, the Arctic is underprepared for vessel accidents and spills.[201] The work of the International Maritime Organization (IMO) will be critical if the Arctic nations are to meet the challenges presented by increased shipping in the Arctic. The NSB should maintain careful monitoring of the IMO's work, as well as the federal departments that will be involved in developing maritime transportation policy in the Arctic.[202] Other work to monitor and participate in includes the Arctic Council's Protection of the Arctic Marine Environment (PAME) Working Group, which is preparing an Arctic Marine Shipping Assessment (AMSA), currently in draft form.[203]

An increase in shipping activity, whether associated with OCS oil and gas operations or otherwise, will likely pose direct threats to subsistence activities and wildlife even if tremendous progress is made in enhancing shipping safety. The best protection available for these NSB interests may be the creation of one or more Marine Protected Areas (MPA). A MPA is "any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein."[204] Started by Executive Order during the Clinton Administration, the ultimate goal of the MPA program is to develop a large national system of state and federal MPAs. Section 4(f) of the Clinton Executive Order required the EPA to propose new regulations that ensure additional protections for MPAs. More protective regulations proposed during the

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[201] Open the Arctic Seas, Envisioning Disasters and Framing Solutions (Jan. 2009), available online at http://www.crrc.unh.edu/workshops/arctic_spill_summit/index.htm.

[202] These departments include State, Defense, Transportation, Commerce, and Homeland Security. See generally, National Security Presidential Directive 68/ Homeland Security Presidential Directive 25 (9 Jan. 2009) (aka U.S. Arctic Region Policy 2009).

[203] The AMSA definition of "Arctic" includes marine waters of the North Pacific along the Great Circle Shipping Route and an "over-the-top" shipping route traversing the Alaskan Beaufort and Chukchi Seas, Bering Strait, and the western Bering Sea.

[204] Executive Order No. 13158 for Marine Protected Areas, 65 Fed. Reg. 34,909 (May 26, 2000).

Clinton administration were recalled when the Bush Administration came into office.[205] With the Obama administration now in place, the NSB may want to consider the political feasibility of creating new Ocean Discharge Criteria[206] and MPAs for the Arctic.

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[205] The regulations at issue here are the Federal Ocean Discharge Criteria, also known as section 403 of the Clean Water Act. The Ocean Discharge Criteria are intended to provide an evaluation of the ecological risks and impacts associated with discharges to the marine environment and a level of protection to marine ecosystems beyond the technology- and water quality-based requirements of a typical NPDES permit. Section 403 requirements can include ambient monitoring programs to determine degradation of marine waters, alternative assessments to further evaluate the consequences of various disposal options, and pollution prevention techniques designed to further reduce the quantities of pollutants requiring disposal. Office of Wetlands, Oceans, and Watersheds, U.S. EPA, Ocean Discharge Criteria, http://www.epa.gov/owow/oceans/regulatory/403.html.

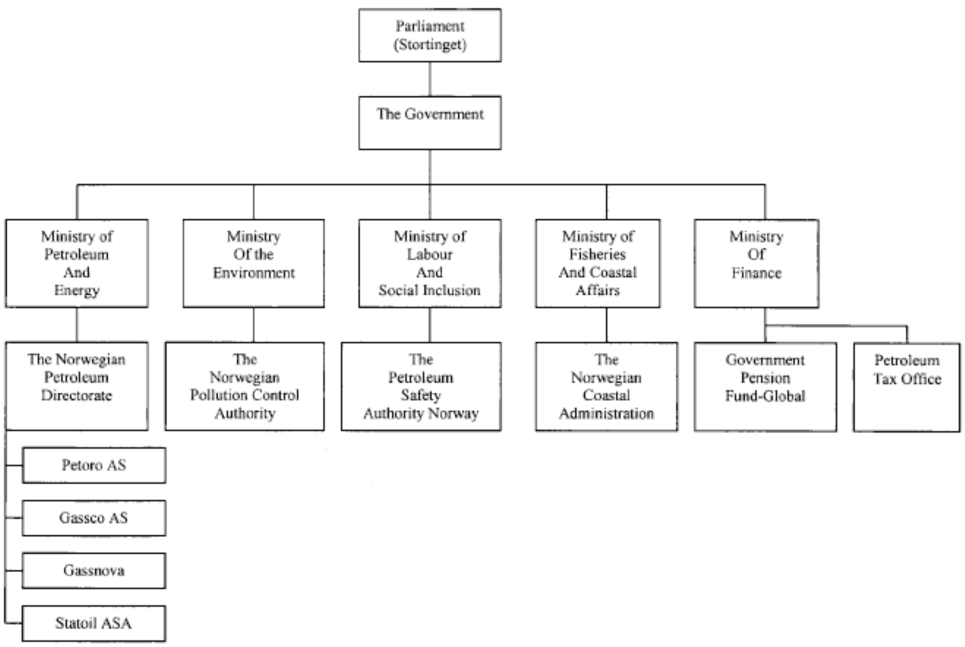
[206] See note 205, above.

APPENDIX

Appendix 1. Government Authority over Petroleum Activities in Norway

The Storting (Norwegian Parliament) has the overarching power over petroleum activities. It can pass legislation, adopt propositions, and discuss and respond to white papers relating to petroleum activities. Major development projects must be discussed and approved by the Storting. The Storting also supervises the government.

The government holds the executive power over petroleum policy. This power is divided among several ministries, with subordinate directorates and agencies as follows:



The Ministry of Petroleum and Energy is responsible for overall management of the petroleum sector. This includes ensuring that petroleum activities are carried out in accordance with the mandates from the Storting and the government. The Ministry of Petroleum and Energy also has responsibility for monitoring the state-owned corporations, Petoro AS, Gassco AS and Gassnova, and the partly state-owned StatoilHydro ASA.

The Norwegian Petroleum Directorate (NPD) was established to secure the optimal resource utilization on the NCS. It exercises wide authority in connection with exploration for and exploitation of petroleum deposits. The NPD has authority to issue regulations, perform safety evaluations, and make decisions according to rules and regulations for petroleum activities. The NPD supervises regulatory compliance by all licensees of the NCS.

NPD is also responsible for providing all participants in the petroleum industry with guidance and information. It maintains a trustworthy information base and makes information concerning the petroleum activities available to the industry, the media, and to society at large. The NPD also stimulates innovation by setting ambitious targets for the future development of the oil and gas industry, including new targets for additional recovery of oil (requiring new technologies for improved recovery) high levels of exploration, and reduced unit costs.

The NPD is administratively subordinate to the Ministry of Petroleum and Energy. It functions as an advisor to the Ministry of Petroleum and Energy (for energy issues) and the Ministry of Labor (for safety issues). The NPD plays a coordinating role in relation to the Norwegian Pollution Control Authority and with the Ministry of Finance and the Ministry of Petroleum and Energy in regard to collecting the CO_2 tax.

The Ministry of the Environment holds overall responsibility for management of environmental affairs in Norway.

The Norwegian Pollution Control Authority (SFT) is an agency subordinate to the Ministry of Environment. It has primary responsibility for oil pollution response and regulating discharges into the sea of oil and chemicals from drilling and production activities. Discharge permits must be approved by SFT.

The Norwegian Pollution Control Authority sets the requirements for monitoring air and water pollution and is responsible for enforcing the Pollution Control Act. It also provides the Ministry of the Environment with advice, guidelines, and technical documentation.

The Norwegian Pollution Control Authority coordinates Norway's involvement in the Arctic Monitoring and Assessment Program (AMAP), a working group under the auspices of the Arctic Council. The primary function of AMAP is to advise the governments of the eight Arctic countries (Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden and the United States) on matters relating to threats to the Arctic region from pollution and related issues.

The Ministry of Fisheries and Coastal Affairs is responsible for sea transport infrastructure and emergency preparedness for pollution incidents in Norwegian waters.

The Norwegian Coastal Administration is responsible for national oil spill contingency measures. It reports to the Ministry of Fisheries and Coastal Affairs.

The Ministry of Labor and Social Inclusion holds overall responsibility for the work environment, including health and safety and measures.

The Petroleum Safety Authority Norway (PSA) has regulatory responsibility for technical and operational safety, emergency preparedness, and the work environment in the petroleum sector. Its regulatory role covers all phases of the petroleum activities, from planning and design through construction and operation to decommissioning and removal. As used here, “safety” includes three broad categories of potential loss: human life, health and welfare; the natural environment; and financial investment and operational regularity. The PSA is subordinate to the Ministry of Labor and Social Inclusion.

The Ministry of Finance holds overall responsibility for ensuring that the state collects taxes, fees, and other revenues from the petroleum sector. The Ministry of Finance is also responsible for administration of the Government Pension Fund – Global (formerly known as the Government Petroleum Fund).

The Petroleum Tax Office is part of the Norwegian Tax Administration, which is subordinate to the Ministry of Finance. The main function of the Petroleum Tax Office is to ensure correct assessment and collection of the taxes and fees applicable to the petroleum sector.

Petoro AS is a state-owned corporation that is responsible for the State’s Direct Financial Interest (SDFI).

Gassco AS is a state-owned corporation responsible for the transport of natural gas from the Norwegian continental shelf.

Gassnova is an administrative agency with the task of promoting and supporting innovation and development of environmentally friendly gas power technology.

StatoilHydro ASA is a fully integrated petroleum company and the largest operator on the Norwegian Continental Shelf. Since its founding in 1972, Statoil has been a main instrument through which Norway has implemented its petroleum policies, including the focused strategy of exploiting new technology. The state currently owns 67% of StatoilHydro ASA.

Since the mid-1990s, Statoil has made efforts to become a global player. It is present in 27 countries and an operator or partner in ten. It is a leaseholder in the Chukchi OCS.

Appendix 2. Collaborative Organizations Related to the Norwegian Petroleum Industry

The **Miljøsok** was a cooperative body initiated by the Ministry of Petroleum and Energy in 1995 that brought together government ministers, top executives in the petroleum industry, and special interest groups such as the Norwegian Fishery Association. Its overarching goal was to reconcile the need for cost-effective oil and gas exploration with environmental concerns. The first phase of Miljøsok resulted in an extensive report that surveyed the environmental issues the industry faced. The report also presented a set of objectives and targets for industry and the authorities to achieve, stressing the need for mutual and committed effort. Phase two of Miljøsok aimed to implement the recommendations from the report. Among other things, Miljøsok successfully initiated a program of measures and technologies for reducing produced water discharges.

Miljøsok ended in 2000, but its recommendations have been followed up by a new collaborative organization, the Environmental Forum.

Miljøsok consisted of a Cooperation Forum, a Council, and a Secretariat. The Cooperation Forum was a meeting place for open dialogue between stakeholders on the need for and development of future environmental measures. Representatives from government, industry, research institutions, NGO's, unions, fisheries and other stakeholders participated in the Cooperation Forum. The Council served as the catalyst for activities and recommended policies, guidelines for further action, and the overall agenda of the Forum. Representatives from government and the oil companies served on the Council. The Secretariat was the working body for the Forum and the Council and facilitated communication between the two. Perhaps the key point to remember is that all players in Miljøsok shared the fundamental view that a competitive industry is an environmentally efficient industry.

The **Topplederforum** (Senior Management Forum) was established in 2000, under the leadership of the Ministry of Petroleum and Energy. The Senior Management Forum is composed of 37 senior managers from oil companies, the supply industry, labor organizations, research institutes, and government authorities. The Senior Management Forum is chaired by the Minister of Petroleum and Energy, however, no formal decisions on oil and gas policy are made in the Forum. The Forum’s goal is to improve the competitiveness of the Norwegian Continental Shelf as well as the competitive strength of the Norwegian supply industry, both at home and abroad. Proposals include projects and working processes related to the cost level on the NCS, as well as improved cooperation within the sector.

INTSOK (Norwegian Oil and Gas Partners) is a foundation established in 1997 by government authorities in partnership with industry. With approximately 150 members, INTSOK supports and promotes Norwegian petroleum industry internationally. The goal is to increase the export of products and services.

Petrad is a non-profit Norwegian government foundation that seeks to facilitate knowledge and experience transfer to the management of national oil companies and petroleum authorities in emerging economies. Established in 1989, Petrad organizes courses and seminars on a wide variety of topics relating to the management and administration of petroleum resources.

OG21 In 2001, the Ministry of Petroleum and Energy established a task force to help the petroleum industry formulate a national technology strategy to meet the challenges associated with efficient, safe, and environmentally sustainable petroleum activities. Known as OG21, the task force fosters collaboration among oil companies, universities, research institutes and the supplier industry.

The OG21 strategy focuses on eight core technology areas:

• Environmental technology for the future

• Exploration and reservoir characterization

• Enhanced recovery

• Cost effective drilling and intervention

• Integrated operations and RTRM (Real time reservoir management)

• Subsea processing and transportation

• Deep water and subsea production technology

• Gas technology

Shell is the lead party for the "Environmental technology for the future" target area. Other companies involved in the Environmental Technology for the Future strategy group include Chevron, ConocoPhillips, and ExxonMobil. A copy of OG21's most recent strategy statement for Environmental Technology for the Future is attached as Appendix 4.

Norway's Involvement In International Collaboration

Norwegian agencies actively participate in many international fora that focus on matters of safety in offshore activities. Some of these of these are:

A. **NSOAF** The North Sea Offshore Authorities' Forum (NSOAF) brings together safety regulators from the various countries involved in North Sea petroleum activities. Its stated goal is to pursue continuous improvement in health, safety and the environment in North Sea petroleum activities. This work primarily takes place through three permanent working groups: the HS&E working group, the working group for safety training, and the working group on drilling.

B. **IRF** The International Regulators' Forum (IRF) was established in 1994 to promote a common understanding of issues related to safety, health, and the environment. Regulators from Australia, Brazil, Canada, the Netherlands, New Zealand, Norway, the UK and the USA participate in the organization. IRF has appointed working groups to focus on issues of shared interest such as assessing whether common criteria can be defined for reporting offshore incidents and studying common international challenges related to cranes and lifting operations. Every second or third year, IRF organizes a conference for safety regulators and industry delegates to discuss relevant issues and possible solutions to them.

C. **ICRARD** The International Committee on Regulatory Research and Development (ICRARD) serves as an arena for information sharing and experience transfer relating to HSE research in the petroleum industry. The organization was formed in 1994 by authorities from the U.S., Canada, the U.K. and Norway; authorities from Brazil, Mexico, the Netherlands, Australia and New Zealand have since joined.

ICRARD's main purpose is to disseminate knowledge of HSE work being done so that similar activities do not unnecessarily copied in other countries. ICRARD's website provides an efficient way to obtain an overview of the research taking place in each country, along with contact information for related agencies and research communities.

D. **OMHEC** The Offshore Mechanical Handling Equipment Committee (OMHEC) is dedicated to improving safety in crane and lifting operations. Norway's Petroleum Safety Authority, together with government agencies in other North Sea countries work to develop guidance documents for use by industry.

E. **EDTC** Norway's PSA is also an active member of the European Diving Technology Committee, which aims to establish educational qualifications of diving personnel.

Appendix 3. OG21 Technology Strategy for "Environmental Technology for the Future" (lead party: Shell)

Appendix 4. Offshore sediment monitoring on the Norwegian Shelf, A Regional Approach 1996-2006

Appendix 5. **Water Column Monitoring Summary report 2005 (**prepared by OLF)
http://www.olf.no/miljoerapporter/water-column-monitoring-summary-report-2005-article1941-1334.html

Appendix 6. Water Column Monitoring 2006, Report AM 2006/013

Appendix 8

Appendix 2 to the Activities Regulations (Conditions for the Use and Discharge of Offshore Chemicals)

HARVEY CONSULTING, LLC.

Oil & Gas, Environmental, Regulatory Compliance, and Training

June 16, 2009

Harold Curran
Chief Administrative Officer
North Slope Borough Mayor's Office
PO Box 69
Barrow, Alaska 99723

Re: Review of Shell Exploration and Production Company's August 2008 Analysis of the Pros and Cons of Zero Discharge of Muds and Cuttings During Exploration Drilling in the Alaska Beaufort Sea Outer Continental Shelf, and Shell's May 2009 Supplemental Information on Annular Injection and Barents Sea Exploration Permits.

Mr. Curran:

This paper summarizes my September 2008 review of Shell Exploration and Production Company's (Shell's) August 2008 report entitled: Analysis of the Pros and Cons of Zero Discharge of Muds and Cuttings During Exploration Drilling in the Alaska Beaufort Sea Outer Continental Shelf (Shell's August 2008 report). Shell's August 2008 report was submitted in response to North Slope Borough (NSB) Mayor Itta's request for Shell to meet a zero waste discharge standard while conducting exploratory drilling and production operations in arctic waters. This paper was updated in June 2009 to include Shell's May 2009 Supplemental Information on Annular Injection.

Overall

Shell's August 2008 report concluded that the most cost-effective and environmentally sound solution is to dispose offshore exploration drilling wastes directly into the Beaufort Sea. Shell rejects the use of Cuttings Re-Injection (CRI) waste disposal technology to dispose of waste at its offshore exploration drilling location, citing cost and technical challenges. Shell rejects transportation of exploratory drilling waste to an onshore waste disposal well, asserting cost and environmental reasons. However, no technical or economic case studies of actual projects are cited in support of these conclusions. Likewise, Shell did not provide arctic data nor cite any studies

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addressing the adverse impacts to subsistence activities and resources for its preferred marine disposal alternative.

Yet, numerous technical reports are available in the Society of Petroleum Engineering literature,[1] validating Cuttings Re-Injection (CRI) technology and the use of subsurface waste disposal in general as cost effective, technically viable, and environmentally sound methods for offshore exploration operations. Published literature also confirms that transportation of offshore exploration wastes to shore-based disposal facilities is common practice world-wide. Barents Sea exploration well permits provided by Shell in May 2009 confirm that Norway requires muds, cutting and some other exploration wastes to be transported to shore for disposal or injected on-site into the exploration well (with the exception of top-hole cuttings);[2] further supporting the NSB's position that offshore disposal of exploration waste is not best international practice.

Shell's proposed Outer Continental Shelf (OCS) exploration operations in Alaska have several viable options for waste handling: (1) annular injection into the same well while drilling, (2) temporary storage of wastes and subsequent disposal into that same well prior to abandonment, (3) transportation of wastes to the nearest onshore treatment facility or (4) a combination of these alternatives. While Shell does not currently own shore-based waste facilities, its stated intent for long-term operations in Alaska makes this a viable investment opportunity. Alternatively, existing operators in the general vicinity have established fee-based agreements for the use of waste disposal facilities.

1. Offshore Cuttings Re-Injection (CRI) is a viable solution

Shell's August 2008 report concludes that Cuttings Re-Injection (CRI) technology is not a feasible waste management option for its proposed offshore exploration activities. However, published literature cited throughout this report demonstrates that, since the early 1990s, offshore oil and gas exploration operators and contractors have made substantial progress developing CRI technology to achieve environmentally sound, technically feasible and cost-effective methods for handling offshore exploratory drilling wastes. CRI technology has been developed for both offshore exploration and production operations.

A bit of history is provided below on CRI technology to highlight the technical progress made over the last 15 years.

Cuttings Re-Injection (CRI) technology was originally developed in the early 1980's to clean up growing stockpiles of drilling waste stored or buried onshore in large disposal pits and handle new oil-based drilling waste. Onshore space limitations were less challenging and a single dedicated disposal well was used to dispose of waste from multiple wells and operations.

Later, CRI technology was expanded to offshore applications. National and international regulations prohibiting disposal of oil-based muds and cuttings into marine waters provided the primary motivation for developing new offshore waste management technology. Additionally, some operators elected to use CRI technology to achieve voluntary zero-discharge goals including disposal of water-based muds and cuttings, and other drilling waste.

[1] www.spe.org
[2] Norwegian Pollution Control Authority (SFT) Permits for the Barents Sea, translated by Shell into English for the Nucula Exploration Well 7125/4-2 SFT Permit and Obesum Exploration Wells 7223/5-1 S and 7223/5-1 SFT Permit.

For decades offshore exploration operators have been required to collect oily waste and haul it back to a shore-based waste management facility for long-term treatment and disposal. Motivated by economics, operators have sought methods to reduce the cost of transportation, treatment and disposal of oily wastes.

By the late 1990s and into the 2000s several operators and contractors successfully miniaturized onshore CRI technology to fit on offshore platforms and Mobile Offshore Drilling Units (MODUs). CRI units were initially installed on production platforms, but were later installed on exploration drilling units to save cost.

M-I Swaco, a leading consultant and CRI service provider, summarizes this history:

> *Injection of drilling and other associated E&P [exploration and production] wastes through hydraulic fracturing has been successful and has led to the adoption of the technique as a routine disposal method. Drill cuttings re-injection (CRI) operations started in the late 1980s with small volumes of drill cuttings slurry through either tubular or annular injections. However, as more experience was gained through these smaller volume waste disposal operations, the scale of drill cuttings injection operations increased dramatically. For example, in terms of disposal volumes, CRI operations have advanced from thousands of barrels of slurry per well to millions of barrels by 2002.* ***<u>CRI operations started from onshore to offshore fixed platforms to deepwater mobile offshore drilling modules</u>****. It has been operated worldwide within very different drilling operations.*[3] *[emphasis added]*

Offshore CRI technology requires the installation of tanks, pumps, and grinding equipment, and some type of disposal well to provide for underground waste injection. CRI equipment grinds up waste into small particles, which are then mixed with water and other liquid waste to create a slurry. Waste slurry is pumped underground into the annulus of a well or into a dedicated disposal well.

Waste is injected at high pressure into an approved subsurface disposal formation, well below any drinking water source. While muds and cuttings comprise the vast majority of drilling waste, offshore exploration operations also produce a number of other human and industrial wastes that can be commingled and disposed of in injection facilities. Waste may include muds, cuttings, industrial waste water, storm water, domestic waste or fluids produced during well testing.

Operators drilling more than one well in an area typically find drilling a dedicated injection well to be the most cost effective alternative because the cost of the disposal well is amortized over several wells.

Operators have also proven the efficacy of injecting waste into the annular wellbore space. The drilling waste from the top segment of the well can be temporarily stored until the well is drilled deep enough and casing is set for annular injection into that same well.

If a single exploration well is drilled, waste can be injected into the annulus of that same well. If more than one exploration well is drilled in an area, the first well's waste may be temporarily stored or transported to shore for disposal. This waste, and waste from successive wells, can then be injected into the first well. The Department of Energy's report on slurry injection technology summarizes the process:

> *Oil and gas wells are constructed with multiple layers of pipe known as casing. A well is not drilled from top to bottom at the same diameter but rather in a series of segments. The top segment is drilled starting at the surface and has the largest diameter hole. After a suitable depth has been drilled, the hole is lined with casing that is slightly smaller than the diameter of the hole, and cement is pumped into the space between the wall of the*

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[3] Guo, Q., SPE, Geehan, T., SPE, Ovalle, A., SPE, M-I SWACO, "Increased Assurance of Drill Cuttings Re-injection – Challenges, Recent Advances and Case Studies," International Association of Drilling Contractors (IADC) and Society of Petroleum Engineers (SPE) Paper 87972, presented at the IADC/SPE, Asia Pacific Drilling Technology Conference and Exhibition held in Kuala Lumpur, Malaysia, September 2004.

drilled hole and the outside of the casing. Next, a smaller diameter hole is drilled to a lower depth, and another casing string is installed to that depth and cemented. This process may be repeated several more times. The final number of casing strings depends on the total depth of the well and the sensitivity of the formation through which the well passes.

The two <u>common</u> forms of slurry injection are annular injection and injection into a disposal well. Annular injection introduces the waste slurry through the space between two casing strings (known as the annulus). At the lower end of the outermost casing string, the slurry enters the formation. The disposal well alternative involves injection to either a section of the drilled hole that is below all casing strings, or to a section of the casing that has been perforated with a series of holes at the depth of an injection formation.[4] [emphasis added]

If, for some reason, underground injection is not possible at an offshore location, a CRI unit can grind and create a slurry that can be pumped to a vessel for transportation to a shore-based disposal well, or placed in an offshore barge for temporary storage. CRI units can be purchased and installed by the operator, or rented and operated by specialized service companies. Later, that stored slurry can be pumped back into an exploration well prior to plugging and abandoning the well. While offshore CRI technology was originally developed to manage oily waste, some countries have demanded operators use this new technology to achieve zero-discharge, as an alternative to dumping wastes overboard. Some communities have questioned the environmental impacts of water-based and synthetic muds and have recommended disposal wells as a preferred disposal method for other exploration wastes such as industrial waste water, storm water, and domestic waste.

Barents Sea exploration well permits provided by Shell, confirm that Norway requires muds and cuttings to be transported to shore for treatment even if water based mud is used. Norway may allow cuttings from the top-hole section of the well to be discharged, but only after trawl and fauna baseline studies are completed to verify top-hole discharge is the best environmental disposal option.[5] Even though the Barents Sea exploration wells were located <u>29-102 miles offshore</u>, and in approximately 1000 feet of water, the Norwegian Pollution Control Authority (SFT) confirmed that transportation of drilling muds and cuttings waste to shore or wellbore re-injection is an economic and environmentally preferable option for exploration wells.[6] While Shell has maintained that back-hauling waste to shore is not environmentally preferable in the Beaufort Sea for shorter offshore distances, the Barents Sea exploration permits demonstrate that injection or backhauling of most muds and cuttings is technical and economically feasible for even longer distances.

Shell's August 2008 report stops short of recent technology developments. Shell's preferred waste disposal method (offshore dumping) is the same method it used over 25 years ago, when it last drilled exploration wells in the Beaufort Sea. Shell's August 2008 report does not provide rationale for maintaining the status quo in light of substantial improvements in waste management technology since the early 1980s.

More recently, in a 1995 paper Shell writes:

The paper concludes that CRI is a practical solution to the tightening governmental legislation on discharges to the sea…CRI is a field proven technique of oily cuttings disposal: it is currently used by several operators, notably

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[4] Argonne National Laboratory, "An Introduction to Slurry Injection Technology for Disposal of Drilling Wastes," Publication prepared for the U.S. Department of Energy, September 2003.

[5] Norwegian Pollution Control Authority (SFT) Permits for the Barents Sea, translated by Shell into English for the Nucula Exploration Well 7125/4-2 SFT Permit and Obesum Exploration Wells 7223/5-1 S and 7223/5-1 SFT Permit.

[6] Shell has questioned whether a zero-discharge requirement is technically and economically feasible during <u>exploration</u> operations, but has orally agreed that during the development phase (development drilling and production operations) it would be technically and economically feasible.

offshore USA and in the Norwegian sector of the North Sea, and this experience was incorporated in the Brent project.[7]

This paper cites specific case examples and studies to demonstrate proven CRI technology exists for offshore exploratory drilling operations. In several cases cited in this paper, Shell is either part owner in a field where offshore waste handling has been demonstrated or has invested in technology to develop offshore waste disposal methods that are now proven.

2. Offshore Cuttings Re-Injection (CRI) technology is proven for Mobile Offshore Drilling Units (MODU)

Shell's August 2008 report at p.12 concludes CRI technology is not feasible for a Mobile Offshore Drilling Unit (MODU):

> *It is not technologically possible to reinject used drilling mud and cuttings underground during exploratory drilling from a floating vessel such as the Kulluk. CRI technology has been applied primarily from bottom-founded installations and there has only been one experimental effort at injecting from a floating vessel. The water depth capability of bottom-founded drilling units is limited to 25 to 80 feet and therefore this type of unit cannot be used at the Sivulliq location due to depth of water.*

Yet, published literature shows CRI technology has been developed for MODU operations.

In 1992 BP successfully completed a cuttings reinjection trial project from a mobile offshore drilling unit.[8] More than ten years ago, in 1998, Statoil conducted a long-term cuttings reinjection operation into a subsea annulus from a mobile offshore drilling unit at the Åsgard Field.[9] By 2000, Statoil had completed over a dozen subsea cuttings reinjection operations at the Åsgard Field in 1,500 feet of water.[10]

Waste was injected into the annulus of either the well being drilled or a previously drilled well. Horsk Hydro has proven the feasibility of re-injecting cuttings from a mobile offshore drilling unit in 1,100 feet of water.[11]

Advantek International published a 2003 paper that verifies CRI is a technically viable method used by operators worldwide on mobile offshore drilling units. The report cites numerous case studies and concludes:

> *…Drill cuttings injection (DCI) has been applied in the North Sea (Vallhal, Ekofisk, Ula, Gyda, Clyde), the North Slope in Alaska (Prudhoe, Endicott), the Gulf of Mexico (Ewing Bank, Fushon), Canada (Panuke), Venezuela (Pedernalis) and many other parts of the world (Azerbaijan, Bolivia, Indonesia, Trinidad, etc.)… Drill cuttings injection operations have been applied since early 1980s and these operations have varied from small volume operations such as annular injections to large volume centralized DCI facilities; from fixed platforms to subsea wells via mobile offshore drilling module units….It has been applied in many parts of the*

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[7] Van Gils, J.M.I, Thornton, J.T.O., Kece, M., Bennett, W., Yule, G.K., Shell UK E&P, "Cuttings Re-injection on Mature Platforms: a Case History," SPE Paper 29377, presented at the SPE/IADC Drilling Conference held in Amsterdam, 1995.
[8] Minton, R.C., SPE, and Secoy, B., BP Exploration Operating Co. Ltd., "Annular Re-injection of Drilling Wastes," SPE Paper 25042, presented at the 1992 European Petroleum Conference held in Cannes, France, November 1992.
[9] Saasen, A., Bale, A., Corneliussen, R., and Kristiansen, P.B., Statoil , Oftedal, B., Procon Drilling Services, "The First Cuttings Injection Operation Worldwide in a Subsea Annulus: Equipment and Operational Experience," SPE Paper 48985, presented at the 1998 SPE Annual Technical Conference and Exhibition in New Orleans, Louisiana, September 1998.
[10] Saasen, A., SPE, Tran, T.N., Joranson, H., SPE, Meyer, E., Gabrielsen, G., and Tronstad, A.E., Statoil, "Subsea Re-injection of Drilled Cuttings- Operational Experience," SPE Paper 67733, presented at the 2001 SPE/IADC Annual Drilling Conference held in Amsterdam, The Netherlands, February-March 2001.
[11] Abou-Sayed, A.S., Guo, Q., SPE, Advantek International, "Drilling and Production Waste Injection in Subsea Operations- Challenges and Recommendations," SPE Offshore Technology Conference Paper 14288, presented at the 2002 Offshore Technology Conference in Houston Texas, May 2002.

world and operational experience has proven that it is an environmentally safe long-term solution for E&P [Exploration and Production] waste management"[12] *[emphasis added]*

Shell's conclusion, that CRI technology has not been developed for MODUs is inaccurate.

Upon challenge, Shell's May 2009 additional information now confirms technology has been developed to allow CRI into the annulus of a newly-drilled subsea well.[13] Shell no longer disputes that CRI technology exists for offshore mobile drilling units, but rather raises risk and safety questions about potential use on its Alaska rigs. Shell concludes that CRI technology cannot be used on its Alaska rigs, because CRI technology for MODUs still lacks the capability to allow the drill rig to rapidly secure the well and escape the site under emergency conditions. Shell argues that:

> *"Since we will be working in ice, it must also have some type of seal and disconnect capability that will allow us to escape the dill site quickly in case of an emergency. To our knowledge, that capability does not exist and would require considerable time and regulatory approval to develop."* [14]

Yet, Shell's May 2009 claim that CRI technology for MODUs does not included fail-safe well closure capability is not supported by the literature. Case-in-point, BP's CRI technology for MODUs, developed back in 1992, underwent an extensive safety review to ensure that the formation could be isolated either during a pressure control incident or while abandoning or suspending the well.[15] As part of the CRI technology design for MODUs, BP added two failsafe valves on the subsea permanent guide base. In 1992, the American Bureau of Shipping (ABS) concluded that BP's CRI design complied with the Department of Energy (DOE) guidance for offshore installations[16] and issued a "certificate of conformity."

While additional Minerals Management Service (MMS) safety review may be required for use of CRI technology in the Alaska OCS, that review will be expedited by the previous international safety review and approval processes already taken place.

3. Offshore Cuttings Re-Injection (CRI) Technology can be accomplished through a subsea wellhead

Shell's August 2008 report at p.12 concludes that CRI is not possible through a subsea wellhead.

> *<u>The main challenge is that the wellheads and associated Blowout Preventers (BOPs) used with floating vessels such as the Kulluk are located on the seafloor and are not capable of accepting ground-up mud and cuttings while drilling an exploratory well.</u> The subsea BOP equipment is designed to reliably seal off the well and the marine riser has the ability to be rapidly disconnected to permit the drilling unit to quickly move off the well site in case of ice encroachment or an extreme weather event. The subsea wellhead and BOP system can be left in the mud-line cellar (excavated below the seafloor to protect wellhead equipment from ice keels) and can be reconnected to the drilling unit when conditions improve. In bottom-founded mobile exploratory drilling units, the wellhead and BOP equipment are installed at the surface – directly beneath the floor of the rig derrick and protected within the base of the structure – so no subsea BOP equipment is required. Surface wellhead equipment contains a system of valves and sealing elements that allow access to the casing annuli in the well, thus permitting injection of drilling mud and cuttings as a disposal option in some instances. [emphasis added]*

However, more than 15 years ago, in 1993, BP conducted a cuttings re-injection trial at its Clyde Field **<u>through a subsea wellhead</u>**, proving the feasibility of injecting drilling waste from a mobile

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[12] Guo, Q., SPE, Abou-Sayed, A.S., SPE, Advantek International Corp., "Worldwide Drill Cuttings Injection Permitting Requirements and Guidelines," SPE Paper 80587, presented at the SPE/EPA/DOE Exploration and Production Environmental Conference held in San Antonio, Texas, March 2003.
[13] May 2009 e-mail correspondence from Phil Dreyer, Shell to Harold Curran, NSB.
[14] May 2009 e-mail correspondence from Phil Dreyer, Shell to Harold Curran, NSB.
[15] Minton, R.C., SPE, and Secoy, B., BP Exploration Operating Co. Ltd., "Annular Re-injection of Drilling Wastes," SPE Paper 25042, presented at the 1992 European Petroleum Conference held in Cannes, France, November 1992.
[16] Offshore Installations: Guidance on Design, Construction and Certification. Section 43- Well Control Equipment.

offshore drilling unit while a well is being drilled.[17] This project was supported by 15 companies, **<u>including Shell</u>**, Statoil, Mobil, Texaco, BP, among others. BP's patented Universal Subsea Wellhead, designed for deep water application, as well as for use in shallow water and high fatigue environments, and associated guide base, was modified to allow for drill cuttings injection.[18]

The report explained:

> *A number of options for disposal are being developed but one that appears particularly attractive is the grinding and slurrying of oily cuttings. The resultant fluid is used to induce fractures in the sub-surface formation within which its permanent disposal is achieved. This process has been utilized successfully onshore in Alaska and from fixed platforms offshore in the Gulf of Mexico, the Norwegian North Sea and on the UKCS.*
>
> *In each case the wellheads have been easily accessible, providing simple access to the well or annulus for injection. For subsea wells drilled from a floating exploration drilling vessel, access to the annulus is much more complex, requiring modification to both the permanent guide based (PGB) and the subsea wellhead.*
>
> *<u>This paper is a report of a successful field trial of one such subsea system where the permanent guide base (PGB) and subsea wellhead have been modified to allow access to an appropriate annulus for slurry injection</u>.[19] [emphasis added]*

The field trial:

> *…<u>clearly proved the feasibility of cutting injection from a floating vessel drilling on an exploration well</u>. This project has taken some 18 months to execute and involved 15 companies working together with a common aim.[20] [emphasis added]*

4. Waste disposal by annular injection is feasible

Annular injection is the process of injecting waste slurry through the space between two well casing strings (known as the annulus). At the lower end of the outermost casing string, the slurry enters the formation.[21]

In a 2003 report prepared for the U.S. Department of Energy (DOE), the author attributes the slow transition to annular injection as a best practice to the fact that the EPA and many states still allow drilling waste to be buried in onshore pits and dumped offshore.[22] The DOE report concludes that while regulatory agencies support annular injection as a best waste management practice, many companies will not invest in this technology until required. Shell's May 2009 supplemental information reaffirms this problem. Shell argues that because there is no prior precedent for annular CRI in the arctic, Shell should be allowed to continue to discharge waste into the Beaufort Sea. Shell states:

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[17] Furguson, G.C., Minton, R.C., BP Exploration, Cow, S., Drill-Quip (Europe) Ltd., and Secoy, B.W., Thule Rigtech, "Subsea Cuttings Injection Guide Base Trial," SPE Paper 26681 presented at the 1993 Offshore European Conference held in Aberdeen, Scotland, September 1993.
[18] Hopper, H.P., UK Patent 2239471, Subsea Well Injection System, July 11, 1989.
[19] Furguson, G.C., Minton, R.C., BP Exploration, Cow, S., Drill-Quip (Europe) Ltd., and Secoy, B.W., Thule Rigtech, "Subsea Cuttings Injection Guide Base Trial," SPE Paper 26681 presented at the 1993 Offshore European Conference held in Aberdeen, Scotland, September 1993.
[20] Furguson, G.C., Minton, R.C., BP Exploration, Cow, S., Drill-Quip (Europe) Ltd., and Secoy, B.W., Thule Rigtech, "Subsea Cuttings Injection Guide Base Trial," SPE Paper 26681 presented at the 1993 Offshore European Conference held in Aberdeen, Scotland, September 1993.
[21] Fact Sheet-Slurry Injection of Drilling Wastes, http://web.ead.anl.gov/dwm/techdesc/slurry/index.cfm, September 2008.
[22] Puder, M.G., Bryson, B., Veil, J.A., Argonne National Laboratory, "Compendium of Regulatory Requirements Governing Underground Injection of Drilling Wastes," Prepared for the U.S. Department of Energy, February 2003.

Water-based mud and cuttings from all previously drilled wells in the Chukchi, US Beaufort and Canadian Beaufort Seas have been discharged into the sea, so there is not prior precedent for annual CRI in the Arctic.[23]

Shell's conclusion that there is no precedence for CRI use in the Beaufort Sea is incorrect. As explained in Section 7 of this paper, several Beaufort Sea operators have either used CRI technology or transported waste back to shore for treatment.

The DOE report points to the need for regulatory and financial incentives to move toward more environmentally sound technical solutions, such as annular injection. The report cites a case in Kazakhstan, where underground injection of drilling waste is required because the Kazakhstan Petroleum Law outlaws offshore and onshore burial of offshore-generated E&P wastes.

Shell points to the lack of a dedicated injection well during exploration operations as a limiting factor for its Beaufort Sea exploration campaign, however, Shell itself reported the efficacy of injecting waste into the annulus of the same well while drilling it in 1997 at Shell Expro's Brent field in the northern part of the North Sea:

*The casing design of a well recently drilled on the Brent Delta platform was modified to allow injection into the Hutton sands at 3,000 ft. through the 13-3/8 x 20" casing annulus. Injection proved to be very successful and was achieved with only moderate injection pressures (+/- 600 psi). In this well, <u>the cuttings generated whilst drilling the 12-1/4" hole section were injected into the previous annulus (i.e. **drilling and disposal in the same well**</u>)[emphasis added].*[24]

Other reports make similar findings. A 2002 report entitled, "Drill Cuttings Injection: A Review of Major Operations and Technical Issues," concludes:

Annulus injection is more common offshore, where cuttings are injected into either an uphole annulus of the well being drilled, or into an annulus of a nearby well.[25]

BP's 1993 paper on "Annular Reinjection of Drilling Wastes" concludes:

Annular reinjection offers a cost-effective disposal mechanism for oily cuttings and associated waste…this disposal method eliminates overboard cuttings discharge and hence removes any environmental impact...with proper regard to the engineering of the injection well, the process is a safe, efficient, and effective disposal technique.[26]

In 1998 Statoil reported waste injection was successfully completed into the annulus of the same well that was being drilled:

A system for subsea re-injection of drilled <u>cuttings into the same well as being drilled</u> has been successfully applied in the well 6506/12-K-2H in the Smorbukk Field at Åsgard. The system consisted of a conventional SMACCC slurryfying unit, a flexible hose and a specially designed wellhead. The flexible hose and the modified wellhead have demonstrated reliable cuttings re-injection performance in practical applications. A total of 2499 m3of fluids/ slurry was injected through this system in 1997. No significant problems were observed during the re-injection period. However, minor modifications of the subsea wellhead system will be undertaken to simplify the ROV operation.[27] *[emphasis added]*

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[23] May 2009 e-mail correspondence from Phil Dreyer, Shell to Harold Curran, NSB.
[24] Brakel, J.D., Davies, J.B., Yule, G.K., Thorton, J.T.O., Shell UK E&P, "Cuttings Re-injection in Brent Reduced Drilled Cuttings Discharge to Sea," SPE Paper 37864, presented at the SPE/UKOOA European Environmental Conference, 1997.
[25] Keck, R.G., Natchiq Technical Services, "Drill Cuttings Injection: A Review of Major Operations and Technical Issues", SPE Paper 77553, prepared for presentation at the SPE Annual Technical Conference and Exhibition in San Antonio, Texas, October 2002.
[26] Minton, R.C., Secoy, B., BP Exploration Operating Co., "Annular Reinjection of Drilling Wastes," SPE Paper 25042, Journal of Petroleum Technology, November 1993.
[27] Saasen, A., Bale, A., Corneliussen, R., Kristiansen, P.B., Statoil, Oftedal, B., Procon Drilling Services, "The First Cutting Injection Operation Worldwide in a Subsea Annulus: Equipment and Operational Experience," SPE Paper 48985, presented at the 1998 SPE Annual Technical Conference and Exhibition in New Orleans, Louisiana, September 1998.

A 1993 ConocoPhillips Inc. paper references numerous publications documenting the annular injection success:

> *Although different methods of slurrying the cuttings are involved, all these publications address disposal of the cutting from one well into the same well. …A group [of] papers on cutting disposal by downhole reinjection was presented at the 1993 SPE/IADC [Society of Petroleum Engineers/International Association of Drilling Contractors] Drilling Conference. These papers addressed the disposal of limited volume of cutting from one well into that same well.[28] [See Conoco's 1993 paper for a complete bibliographic listing of case studies where annular injection from one well into the same well was achieved; nine cases were cited.]*

In 2004 TOTAL Exploration & Production Co. reported the viability of annular injection in Alwyn and Dunbar Field in the North Sea after three years of annular injection.[29]

All operations have the potential for failure, and CRI is no exception, however, many of the problems encountered early in CRI technology development have been resolved through improved technology, use of experienced professionals, and improved well construction and pre-injection fracture design.

5. **There may be sufficient geologic control to conduct CRI during exploration operations**

Shell's August 2008 report at p.13 concludes CRI is not possible during exploratory drilling because they lack geologic information to design and permit the subsurface injection operation:

> *The second reason CRI is not a feasible alternative is that Shell will not have sufficient subsurface information to determine whether a stand alone underground disposal well is possible until after exploration drilling occurs.*

It is true that a thorough understanding of subsurface geology is necessary to ensure a receptive disposal zone is available. Moreover, literature cited in this report reinforces the need for qualified, experienced engineers to design a successful wellbore casing program to allow for successful annular injection of waste behind the casing or to design a successful disposal well to allow for injection of waste through tubing in the disposal well.[30] However, many of the early technical challenges faced by subsurface waste disposal have been solved by practice, experience and technique refinements. Geologic considerations include:

> *Slurry injection relies on fracturing, and the permeability of the formation receiving the injected slurry is a key parameter in determining how readily the rock fractures, as well as the size and configuration of the fracture. When the slurry is no longer able to move through the pore spaces, and the injection pressure continues to be applied, the rocks will crack or fracture. Continuous injection typically creates a large fracture consisting of a vertical plane that moves outward and upward from the point of injection. Intermittent injection generates a series of smaller vertical planes that form a zone of fractures around the injection point.*
>
> *Most annular injection jobs inject into shale or other low-permeability formations, and most dedicated injection wells inject into high-permeability sand layers. Regardless of the type of rock selected for the injection formation, preferred sites will be overlain by formations having the opposite permeability characteristics (high vs. low). When available, locations with alternating sequences of sand and shale are good candidates to contain fracture growth. Injection occurs into one of the lower layers, and the overlying low-permeability layers serve as fracture containment barriers, while the high-permeability layers serve as zones where liquids can rapidly leak off.*[31]

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[28] Crawford, H.R., Conoco Inc., Lescarboura, J.A., Conoco Inc. Consultant, "Drill Cuttings Reinjection for Heidrun: A Study," SPE Paper 26382, prepared for presentation at the 68th Annual SPE Technical Conference and Exhibition in Houston Texas, October 1993.
[29] Onaisi, A., Po, V., Lutfalla, H., TOTAL E&P, "Learning from Three Years Annular Injection of Drill Wastes in Alwyn and Dunbar Fields in the North Sea," SPE Paper 88670, presented at the 11th Abu Dhabi International Petroleum Exhibition and Conference held in Abu Dhabi, U.A.E., October 2004.
[30] Minton, R.C., Secoy, B., BP Exploration Operating Co., "Annular Reinjection of Drilling Wastes," SPE Paper 25042, Journal of Petroleum Technology, November 1993.
[31] Fact Sheet-Slurry Injection of Drilling Wastes, http://web.ead.anl.gov/dwm/techdesc/slurry/index.cfm, September 2008.

Shell's August 2008 report concluded Shell did not have sufficient information on the fracture gradient to conduct annular disposal in **all** Beaufort and Chukchi sea exploration wells. However, the NSB challenged Shell on this point, based on the September 2008 version of this paper that concluded that Shell's Sivulliq Prospect is an example of an exploration well proposed for an area where several exploration wells have already been drilled; there should be sufficient geologic information to complete the subsurface injection operation permitting process. Upon challenge, Shell May 2009 additional information acquiesces on this point. Shell confirms it does have sufficient information in areas of previous exploration drilling to consider CRI as an option (e.g. Shell states that they identified a potential zone in the Hammerhead #2 well that should take cuttings.)[32] It is true that there may be new frontier exploration areas in the Beaufort and Chukchi Sea where there may be insufficient geologic information, or concern about increased wellbore design risk that would exclude annular injection as a preferred option. In these cases, transportation of wastes to shore and reinjection into a shore-based disposal facility may be the best option.

Alternatively, the Minerals Management Service allows waste to be temporarily stored (e.g. offshore barge near-by MODU) and then injected into the exploration well prior to abandonment.

> *In U.S. offshore areas, companies may inject E&P wastes that originate on the Outer Continental Shelf into injection wells or encapsulate them in the well bore of wells that are about to be abandoned.*[33]

This option allows operators to obtain geologic information while drilling an exploration well and then later select the best subsurface disposal interval. This is a viable option for exploration wells that are drilled merely to obtain data, and then are plugged and abandoned. Rather than disposing waste overboard, waste can be processed by an onboard CRI unit, temporarily stored in a barge and then injected into the exploration well prior to abandonment. Temporary waste storage, on the rig or at a barge along-side the rig, would eliminate concerns Shell raised about increased vessel transits. The two Barents Sea exploration well permits provided by Shell in May 2009, show that Norway also concludes that temporary storage of drilling waste and reinjection into the exploration well prior to abandonment is an environmentally acceptable option.[34] Muds are typically recycled and reused as much as possible while drilling. Mud disposal is typical done as a batch process at the end of the drilling process; therefore, mud disposal into a well prior to abandonment is an option to consider. BP reports that it's grind and inject wells in Prudhoe Bay can achieve an average injection rate of 30,000 barrels per day, even after years of disposal.[35] Injecting the waste from a single Shell exploration well, back into the same well before abandonment, should not take more than a few days. The actual injection rate will be determined by the rig pump capacity, casing size and disposal interval geologic characteristics, among other factors. This option should not have a significant impact on Shell's drilling window.

6. Does offshore CRI technology increase personnel injury risks?

Shell rejects offshore and onshore waste re-injection options, concluding that waste capture increases the risk of personnel injury and requires a large number of crane lifts. Shell envisions

[32] May 2009 e-mail correspondence from Phil Dreyer, Shell to Harold Curran, NSB.
[33] Puder, M.G., Bryson, B., Veil, J.A, Argonne National Laboratory, "Compendium of Regulatory Requirements Governing Underground Injection of Drilling Wastes," Prepared for the U.S. Department of Energy, February 2003.
[34] Norwegian Pollution Control Authority (SFT) Permits for the Barents Sea, translated by Shell into English for the Nucula Exploration Well 7125/4-2 SFT Permit and Obesum Exploration Wells 7223/5-1 S and 7223/5-1 SFT Permit.
[35] Guo, Q, Advantek International, Abou-Sayed, A.S., Advantek International, and Engel, H.R., BP Exploration (Alaska), Inc., "Feeling the Pulse of Drill Cuttings Injection Wells – A Case Study of Simulation, Monitoring and Verification in Alaska," SPE Paper 84156, presented at the SPE Annual Technical Conference in Denver, Colorado, October 5-8, 2003.

waste management that uses older technology, in which waste is stored in boxes that are lifted by crane from the offshore drill rig to a barge and then transported to shore.

Shell's August 2008 report at p.6 concludes there would be an:

> *…increase of 8100 man hours per well (9%). With a 9% increase of man hours/well there is at least a concurrent increase in the risks associated with conducting such work. The transfer of drilling wastes to a vessel capable of transporting to disposal sites would require a 100 % increase in high risk crane lifts (2000 lifts/well). Such operations represent a risk to the workforce.*

Yet, Shell's conclusions do not consider new, commonly used technology that automates the waste collection system, reducing both personnel and crane requirements. For example, M-I Swaco has developed two systems to assist offshore operators manage waste. One system handles waste in a closed-loop fully automated system right at the offshore rig location:

> *Offshore fluid operations will generate solids and liquids waste streams that in the past had to be transported to shore for treatment and disposal. Today the M-I Swaco offshore EnviroUnit can handle all these liquids waste streams on location and still be able to meet the offshore environmental discharge requirements of zero discharge of harmful chemicals….M-I Swaco has developed a new novel totally enclosed transport system, CleanCut, that can operate in the most extreme conditions.*[36]

Another M-I Swaco system reduces the cost and complexity of collecting waste for transportation to a shore-based disposal well by collecting the waste and automating delivery via piping to an offshore barge brought alongside the rig for transportation back to shore. This method eliminates crane lifts and reduces personnel requirements, which used to be needed to box up muds and cutting for transfer to shore:

> *CleanCut technology has now been proven on semi-submersible and jack-up mobile rigs, platforms, supply boats, barges and land rigs. With over 500,000m of well drilled, over 50,000 hours of running time. Total recorded availability or uptime of the CleanCut system is 99.7%...In a conventional cuttings box containment operation at least ten lifting operations per box round trip are required using conventional handling procedures. Assuming 1000 tonnes of cutting per well and 4 tonnes cutting per box this equates to 2,500 lifts per well drilled. Cuttings transportation through a closed pipeline (metal or flexible hose) <u>rules out the need for the use of lifting cranes</u> for moving cuttings collection boxes and <u>dramatically reduced the risk of personnel injury in a drilling operations</u>.*[37] *[emphasis added]*

In 2003, BP successfully tested the MI waste transfer equipment in the Gulf of Mexico (GOM); drilling waste was transferred from an offshore drill ship to a barge moored along-side.[38]The MI automated waste transfer system was used, eliminating the need to lift waste boxes by crane from the barge to the rig and back to the barge. BP's technical paper describing the GOM test, states that the test was based on technology developed by BP's North Sea Operations Group to comply with the zero-discharge North Sea regulations.

While the example of M-I Swaco's technology is cited above, M-I Swaco is only one of many vendors providing fully automated CRI units. These units are available for lease, rental or purchase from most major waste management providers. This is a service that can readily be outsourced.

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[36] Thor Eia, J., Hernandez, E., M-I Swaco, "Environmental Advances in Drilling Fluids and Waste Operations Applying Novel Technology for Fluid Recovery and Recycling," SPE Paper 102737, presented at the 2006 SPE Russian Oil and Gas Technical Conference and Exhibition in Moscow, Russia, October 2006.

[37] Thor Eia, J., Hernandez, E., M-I Swaco, "Environmental Advances in Drilling Fluids and Waste Operations Applying Novel Technology for Fluid Recovery and Recycling," SPE Paper 102737, presented at the 2006 SPE Russian Oil and Gas Technical Conference and Exhibition in Moscow, Russia, October 2006.

[38] Schonacher, D., BP, Rojas, J.C., BP, Gharst, J., Swaco, and Paiuk, B, M-I, LLC., "Meeting Zero Discharge Requirements in the Gulf of Mexico Using a Unique Cuttings Transport System," SPE Paper 80609, presented at the APE/EPA/DOE Exploration and Production Environmental Conference in San Antonio, Texas, March 10-12, 2003.

Shell argues zero discharge methods would increase personnel cost and risk, yet its own experience in automating CRI equipment aboard the Brent offshore platform contradicts this conclusion. In 1995, Shell reported:

> *…CRI was selected... the control system was automated as much as possible and included the use of variable speed pumps actuated by level sensors in the tanks to regulate the slurry retention times. In principle the system is capable of being operated by one person….*[39]

While Shell's report focuses on Shell personnel risk, it does not address the increased risk to subsistence hunters. Hunters are concerned that offshore disposal of drilling wastes will cause whales to travel further offshore (deflection), increasing the risk for whalers because they would also have to travel further offshore.

7. North Slope operators current use CRI technology offshore

Existing North Slope operators are currently using CRI as the Best Management Plan for North Slope operations both on and offshore. Waste is collected, ground into a slurry (if necessary), and injected into a subsurface disposal well either by tubular injection or annular injection. Operators have typically drilled dedicated injection wells, or have used a well annulus for waste disposal.[40] If an injection well is not available at an exploration well location, operators have collected wastes and transported them back to an injection well location. Small operators that do not have their own waste handling facilities or disposal wells typically negotiate a ballot agreement with a major North Slope operator, such as BP Exploration (Alaska) Inc. or ConocoPhillips Inc., to use its disposal facilities.

It is important to note, that offshore operators working in Alaska's Beaufort Sea may obtain a National Pollutant Discharge Elimination System (NPDES) permit to discharge water-based muds and other drilling rig wastes from the EPA, however, operators such as BP have voluntarily chosen to set a corporate zero-discharge environmental policy for its offshore operations wherever possible. For example, BP's Northstar Production Facility, located offshore in the Beaufort Sea collects muds, cuttings, industrial waste water, domestic waste water, and storm water and disposes of all non-hazardous waste by injection into a subsurface disposal well located at the Northstar Production Facility. Northstar is a zero discharge facility, which means there's no discharge of any waste into the Beaufort Sea.[41] BP holds an EPA NDPES permit to discharge Northstar waste into the Beaufort Sea, but has voluntarily elected a zero discharge approach for all wastes in cooperation with local government and tribes.[42]

Similarly, BP's Endicott Facility, located offshore in the Beaufort Sea collects muds and cuttings and transports these wastes by truck to an onshore disposal well in Prudhoe Bay. Non-hazardous industrial waste water and storm water is collected and is disposed of by injection into a subsurface disposal well located at the Endicott facility. The only offshore discharge from the Endicott facility is treated domestic waste water. Domestic waste water is treated to meet EPA NPDES permit standards prior to discharge.[43]

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[39] Van Gils, J.M.I, Thornton, J.T.O., Kece, M., Bennett, W., Yule, G.K., Shell UK E&P, "Cuttings Re-injection on Mature Platforms: a Case History," SPE Paper 29377, presented at the SPE/IADC Drilling Conference held in Amsterdam, 1995.
[40] BP Exploration (Alaska), Inc., ARCO Alaska, Inc. and ConocoPhillips, Inc. have published numerous technical papers on grind and injection technology, and the success of disposal wells as a pollution prevention measure in the SPE trade journals, and at industry conferences.
[41] Fay, C., BP Exploration (Alaska), Inc., e-mail communication with Harvey Consulting, LLC., September 11, 2008.
[42] Krieger, A.G., SPE, BP Trinidad, Kidd, G.N., SPE, BP Alaska, Cocking, D.A., SPE, BP Columbia, "Northstar Drilling-Delivering the First Arctic Offshore Development," SPE Paper 83640.
[43] Fay, C., BP Exploration (Alaska), Inc., e-mail communication with Harvey Consulting, LLC., September 11, 2008.

Finally, BP is in the process of developing its offshore Liberty project. Liberty wells will be drilled from an expansion of the existing Endicott Satellite Drilling Island. BP plans to drill a dedicated injection well to dispose of Liberty non-hazardous waste at the offshore facility through deep well injection.[44]

ConocoPhillips has also invested in waste disposal wells and CRI technology at its Kuparuk and Alpine facilities.

8. Shore-based disposal options: hauling Shell's drilling waste back to Prudhoe is not the only option

Shell's August 2008 report at p. 14 rules out transportation of offshore wastes to an onshore CRI facility as an option:

> *Developing an underground disposal well and constructing a grind and inject (G&I) facility in the Prudhoe Bay area is not possible because Shell has no onshore leases where an injection well could be drilled. Therefore, the only viable onshore disposal option would be to reach an agreement with other North Slope operators to utilize the only existing G&I Facility, located on Drill Site 4 at Prudhoe Bay. This would require the use of numerous vessels and barges to transport wastes from the Kulluk to West Dock. In addition, a fleet of large bulk material trucks will be required to transport drilling mud and cuttings to Drill Site 4 from West Dock.*

Yet, Shell could lease property from a private owner, the NSB, or the state or federal government in order to construct an environmentally sound onshore disposal facility close to its planned offshore operations to reduce the transportation distances. Alternatively, Shell could pay facility-use charges to an existing onshore disposal facility closer to its planned offshore operations. For example, for the Sivulliq exploration project, Shell could consider working with BP, utilizing existing disposal well capacity at the Badami field. Badami is equipped with a Class I injection well,[45] dock and road connecting the dock to the facility for year-round dock to facility access.[46]

DOE reports there are 58 active Class II-D (disposal) wells and six Class I wells in Alaska, with three Class I wells at Prudhoe, and one Class I well each at Northstar, Alpine and Badami fields.[47] Thus, there are several alternative onshore disposal options across the North Slope.

Environmentally conscious operators, such as ConocoPhillips and BP, have voluntarily invested in these options to provide for underground disposal of drilling waste, including water-based drilling muds. These same companies have been cooperative in reaching facility sharing agreements.

Shell's contention that the Prudhoe Bay Drill Site 4 facility is the only onshore disposal option is not accurate and overstates the distance for waste transportation to shore.

In May 2009, Shell informed the NSB that it may refurbish the Kuluk or use another ice reinforced drill ship to extending drilling operations into late fall/early winter.[48] Shell points out that extending operations into late fall/early winter, will prohibit waste barges from returning to shore to deliver

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[44] Fay, C., BP Exploration (Alaska), Inc., e-mail communication with Harvey Consulting, LLC., September 11, 2008.
[45] Puder, M.G., Bryson, B., Veil, J.A, Argonne National Laboratory, "Compendium of Regulatory Requirements Governing Underground Injection of Drilling Wastes," Prepared for the U.S. Department of Energy, February 2003.
[46] BP Exploration (Alaska) Inc., "Oil Discharge Prevention and Contingency Plan for Endicott and Badami Operations," August 2006.
[47] Puder, M.G., Bryson, B., Veil, J.A, Argonne National Laboratory, "Compendium of Regulatory Requirements Governing Underground Injection of Drilling Wastes," Prepared for the U.S. Department of Energy, February 2003.
[48] May 2009 meeting between Phil Dreyer, Shell and Harold Curran, NSB.

waste for onshore treatment and storage, because nearshore ice will set in. Shell's new plan anticipates drilling into late the fall/early winter and returning the drill fleet to the L48 or Canada to overwinter. Shell did not consider the possibility of temporary storage of waste onboard an arctic grade barge or tanker, to be shipped to its overwintering location, and offloaded at that point for onshore disposal. This option warrants further consideration.

Shell's 2007 exploration plan included a large volume of surplus storage capacity in the drilling support fleet. For example, Shell's 2007 oil spill response plan included an arctic tanker (513,000 bbl capacity) and several barges (11,000-16,000bbl capacities);[49] however, Shell's worst case-spill volume was estimated at 287,100 bbls, leaving several hundred thousand bbls of additional storage capacity available for temporary waste storage. Alternatively, additional dedicated waste management vessels could be brought in to meet the temporary waste storage needs.

9. Shore-based disposal options: Do other governments require exploration waste to be shipped to shore for disposal if offshore CRI is not possible?

Exploration wells drilled in the Kazakhstan sector of the Caspian Sea are required to dispose of exploration waste by offshore injection methods (CRI) or the waste must be collected and shipped to shore for onshore treatment and disposal.[50] A paper titled: "The Northeast Caspian Sea: Oil Developments in a Sensitive Environment" states:

> ***Legislation in Kazakhstan prohibits discharge of drilling wastes into the sea. <u>Drilling wastes are shipped onshore (Bautino) for disposal</u>****…Other wastes are classified as solid and liquid wastes. All solid wastes should be segregated and transported onshore under the regulations of Kazakhstan Domestic sewage: black water from toilets and grey water from showers, laundry, galleys, etc. is either treated or shipped to shore. Only treated water, as well as cooling and ballase water meeting SanPin (Marpole 73/78) norms can be discharged into the sea under special permit: amounts of treated water in excess of special permit limits should be transported onshore. Process (oily) water, including deck water washing, drill water, plant wash down, bilge water, and other sources is shipped onshore, where it is treated and disposed in evaporation lagoons.*

To meet the zero discharge requirements for the Caspian Sea, in 2002 BP chose to ship waste to shore for onshore treatment and disposal rather than use an offshore CRI technique. BP had engineered a sub-sea cutting re-injection (CRI) plan for it ACG Field, but found that it was more cost effective to ship the waste to shore unless eight or more wells were drilled in the area to support a dedicated CRI well offshore.[51]

Exploration wells drilled offshore of Sakhalin Island in the Russian Far East are required to collect and ship drilling waste back to shore for onshore disposal.[52] A paper titled: "Exploration Drilling in the Russian Far East: Two Years of Experience and Learning Offshore Sakhalin Island" states:

> ***<u>Environmental restrictions stipulate that all mud and cuttings from below the 30"conductor, even though the well may be drilled with a water-based mud, cannot be discharged to the environment</u>*** *and must be recovered for disposal…Discharges are especially sensitive in Sakhalin where the health of the local fisheries and*

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[49] Shell's Beaufort Sea Exploration C-Plan, MMS Completeness Submittal, Table 1-16 Storage Equipment for Recovery Operations, January 12, 2007, p. 1-63.

[50] Kaltayev, A., UMA Engineering, Sokolsky, A., CaspNIIRH. "The Northeast Caspian Sea: Oil Developments in a Sensitive Environment," SPE Paper 108913, prepared for presentation at the SPE Asia Pacific Health, Safety, Security and Environment Conference and Exhibition held in Bangkok, Thailand, 10-12 September 2007.

[51] Maggiori, D., BP Exploration, and Reith, C., JP Kenny Caledonia, "Developing Sub-Sea Cuttings Re-Injection Technology for Application in the Caspian Sea, SPE Paper 84153, presented at the SPE Annual Technical Conference in Denver Colorado, October 508, 2003.

[52] Thorogood, J.L., Hogg, T.W., Kalshikov, A.G., CJSC Elvary Neftegaz, "Exploration Drilling in the Russian Far East: Two Years of Experience and Learning Offshore Sakhalin Island," SPE Paper 103650, prepared for presentation at the 2006 SPE Russian Oil and Gas Technical Conference and Exhibition in Moscow, Russia, 3-6 October 2006.

protection of the Western Pacific Grey Whale population are paramount.. ***In a zero discharge environment, skip and ship water-based muds and cuttings is feasible, despite the volumes involved****. Operational safety at the waste pit is assured through detailed preparation and rehearsal of procedures.*

10. Will offshore CRI facilities cost $100 million capital cost to retrofit a MODU, and $100 million/year to operate?

In August 2008, Shell claimed that the cost of achieving zero-discharge at its Alaska Beaufort Sea Outer Continental Shelf (OCS) exploration wells would exceed $100 million to retrofit Shell's Kulluk drilling rig, along with an additional $100 million per year in operating cost. No data was provided to support this claim.

By comparison, Shell paid $30 million to replace and repair the Kulluk mechanical and electronic equipment, and repair the vessel hull.[53] The repairs were reported as "major." Shell's claim that a waste handling retrofit, alone, would be more than triple the amount of a major Kulluk repair was not supported. Additionally, Shell's estimated operating cost of $100 million per year was also unsupported, and likely exceeds the cost of the exploration well itself.

In 2007, ExxonMobil published a paper describing the extensive retrofit of the Concrete Island Drilling Structure (CIDS) to drill offshore of Sakhalin, Russia. ExxonMobil made numerous upgrades to CIDS including modifications to meet the Sakhalin's zero-discharge requirements and renamed the rig "Orlan". ExxonMobil states: " the Orlan was designed to operate as a zero-discharge facility…"[54]

In May 2009, Shell told the NSB that the Kulluk will not be used until it is refurbished.[55] Thus, Shell's argument about the cost of retrofitting the Kulluk may not be relevant if Shell is no longer planning to use this rig. Additional information is needed from Shell on the age, type and condition of the rig it plans to use. Shell's rig selection should take into account zero discharge design and operation as a key selection criteria to avoid retrofit costs.

The $100 million capital and $100 million operating cost estimates in Shell's August 2008 report are inconsistent with Shell's own data reported in its 1997 study entitled "Cuttings Re-injection in Brent Reduces Drilled Cuttings Discharged to Sea:"

> *During 1996, some 61,000 bbls of slurry have been injected field wide, representing 2,700 MT of cuttings, which would otherwise have been discharged to sea together with approximately 270 MT of OBM. Approximate disposal cost (field average) equates to £17 per barrel of slurry or £390 per MT of cuttings.*[56]

CRI operations at the Gyda Platform in Norway also report favorable economics at approximately $500,000 per well:

> *For a 20-well program in the Gyda/Ula Field in the North Sea, economic analysis showed that DCI [drill cuttings re-injection] would cost approximately $10 million versus $18 million for onshore processing and $39 million for using water-based mud.*[57]

[53] CBC News: "Relic of the Beaufort Oil Boom Refurbished," June 11, 2007.
[54] Higgins, A.M., Zuskov, B., Vande Zande, P., ExxonMobil Development Co., "CIDS to Orlan: Transformation and Startup of Sakhalin's Ice-Resistant Drilling Platform," SPE/IADC Paper 105649, presented at the 2007 SPE/IADC Drilling Conference in Amsterdam, The Netherlands, 20-22 February 2007.
[55] May 2009 meeting between Phil Dreyer, Shell and Harold Curran, NSB.
[56] Brakel, J.D., Davies, J.B., Yule, G.K., Thorton, J.T.O., Shell UK E&P, "Cuttings Re-injection in Brent Reduced Drilled Cuttings Discharge to Sea," SPE Paper 37864, presented at the SPE/UKOOA European Environmental Conference, 1997.
[57] Minton, R.C., Last, N.C., "Cuttings Slurrying & Re-Injection - Two Years of Experience from the Gyda Platform," presented at the 7th Annual Offshore Drilling Technology Conference, Aberdeen, Scotland, November 1993, cited in Guo, Q., SPE, Geehan, T., SPE, Ovalle, A., SPE, M-I SWACO, "Increased Assurance of Drill Cuttings Re-injection –

In a 1998 report by Argonne National Laboratory for the EPA and DOE, the Alaska Oil and Gas Conservation Commission reported one company was operating in the offshore area of the North Slope, and that operator had invested in a $5 million dollar injection facility and dedicated injection well, and was injecting all muds and cuttings, including water based muds.[58] The operating and maintenance cost was reported to be $2 million per year. This operator was BP. As explained above, BP has achieved zero discharge at its Northstar and Endicott offshore operations in the Beaufort Sea.[59] While the cost of retrofitting the 25-year-old Kulluk rig to achieve zero discharge may exceed an initial capital investment of $5 million, Shell provided no economic justification to support its $100 capital investment estimate, nor its $100 million per year estimate of operating cost.

It is recognized that retrofitting an existing mobile offshore drilling unit, such as the 1983 Kulluk drilling vessel, would entail expenses. The 25-year-old Kulluk would need to be upgraded with waste collection and disposal facilities to bring it up to 2008 technology, and Shell would need to develop a disposal well option or enter into an agreement with an existing operator for access to an existing disposal well. However, these capital costs could be amortized over the life of the drilling rig, and would be offset by existing costs of offshore disposal (e.g. permitting, monitoring, recordkeeping, studies, experts, long-term liability, project delay due to stakeholder opposition due to offshore waste discharge, litigation, etc.).

Even in cases where underground injection may not be possible offshore, a CRI unit could be installed on the offshore rig to grind wastes into a slurry that can be more easily pumped to a waste disposal barge and transported to shore. Shell did not examine the economic benefit of installing CRI units offshore to reduce handling complexity and cost. Instead Shell cites the more expensive and labor intensive method of boxing waste and moving it to a barge by crane.

11. Underground waste disposal reduces long-term corporate liability

Shell's economic assessment did not compare actual costs for zero discharge to the current waste handling costs including long-term liability, and project delay costs due to unresolved waste disposal concerns. Yet, in 2006 **Shell** and Chevron wrote a paper citing the economic virtues of CRI technology in reducing future liability and the environmental benefits of CRI technology at their Niger Delta Basin offshore operations:

> *The introduction of a new and more restrictive environmental regulation by the Department of Petroleum Resources (DPR) in Nigeria in 2002 significantly reduced the options for in-situ management of oil field waste, including drill cuttings. This created a new challenge in looking for alternative, economical management options that met the new regulatory requirements. One **technically acceptable and cost-effective option is cuttings injection**…Drill Cuttings (waste) injection involves a slurrification of wastes and injection into subsurface formation(s) with sufficient geological properties to accommodate and permanently isolate the waste at a safe depth from potable water sources and recoverable hydrocarbons. It offers the following advantage over other disposal methods: the achievement of a zero waste discharge (drilling waste was returned to its native environment); **reduction of future liability** when the injection loop is closed, and handling of wastes onsite at drilling operation. CI has also been demonstrated to be an environmentally-appropriate method for managing natural occurring radioactive materials (NORM). Cuttings injection has been successfully applied in various geographical settings worldwide."[emphasis added]*[60]

Challenges, Recent Advances and Case Studies," IADC and SPE Paper 87972, presented at the IADC/SPE, Asia Pacific Drilling Technology Conference and Exhibition held in Kuala Lumpur, Malaysia, September 2004.

[58] Argonne National Laboratory Report, "Data Summary of Offshore Drilling Waste Disposal Practices," Prepared for the U.S. Environmental Protection Agency, Engineering and Analysis Division and U.S. Department of Energy and Office of Fossil Energy, November 1998.

[59] Northstar, EPA Daily Monitoring Reports (DMR), and NSB inspection records.

[60] Okorodudu, A., Akinbodunse, A., Linden, L., Chevron Nigeria Ltd, Anwuri, L., Shell Petroleum Development Co. Nigeria Ltd., Irrechukwu, D.O., Zagi, M.M., Nigeria Department of Petroleum Resources, Guerrero, H., M-I Swaco, "Feasibility Study of Cuttings-Injection Operation: A Case Study of the Niger Delta Basin," SPE Paper 98640, presented

12. CRI technology can be cost effective for offshore operations

In its paper, "Drilling Waste Management: Case Histories Demonstrate the Effective Drilling Waste Management Can Reduce Overall Well-Construction Costs," Halliburton Fluid Systems Inc., a drilling contractor, concludes CRI technology is economic when overall well-construction costs and future liabilities are taken into account:

> *While it is true that new technology comes with a price tag, and much of the technology used in drilling waste management has been introduced in the last 10 year, many technologies now available to operators* ***are clearly cost effective when the entire well construction cost is evaluated****. The cost of making a mistake and having either an expensive remediation project or a potential liability nearly always significantly outweighs the cost of a good preventative drilling waste management program. Further, compliance with current environmental regulations does not always guarantee immunity in the future…Numerous examples exist of industries having to clean up sites that were fully compliant with all regulations at the time the waste was generated and disposed of….*
>
> *This paper demonstrates that the correct application of these technologies combined with a holistic approach to drilling waste management and drilling fluid operations results in a net reduction in well construction costs and a reduction in the potential for environmental liability… environmental compliance (whether internally or externally driven) is not the only reason to utilize these types of technologies and services [emphasis added].*[61]

One economic advantage often overlooked is the overall reduction in well construction costs by reusing the optimal mud system for the exploration well. Extended reach, deepwater, multi-lateral and high performance wells often require mud formulations that do not meet EPA's NPDES discharge limitations.[62] When possible, operators have moved away from oil-based muds and synthetic muds to avoid waste management costs, and have reduced or eliminated mud additives to meet offshore NPDES permit toxicity limitations often at the cost of less-efficient drilling operations. Where zero discharge waste practices are employed, operators can use the most efficient, technically appropriate mud formulation for their exploration well, reducing overall well construction costs by reducing drilling time and ensuring a successful well is drilled.

International operators report favorable economics for eliminating exploration and production waste by deep well injection. For example, a 2001 Advantek International Corp. report concludes:

> *Downhole disposal of muds and cuttings waste through hydraulic fracturing provides a zero discharge solution and eliminates future cleanup liabilities…This downhole disposal technology has shown success in both onshore and offshore drilling operations and is becoming a routine disposal option…It also offers favorable economics.*[63] *[emphasis added]*

Similarly, in 2004, Petronas Carigali Bahrain Ltd. (PCBL) used down hole waste re-injection while drilling two exploration wells in the environmentally sensitive offshore environment of Bahrain, concluding:[64]

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at the SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production in Abu Dhabi, U.A.E., April 2006.

[61] Browing, K., Seaton, S., Halliburton Fluid Systems, "Drilling Waste Management: Case Histories Demonstrate that Effective Drilling Waste Management Can Reduce Overall Well-Construction Costs," SPE Paper 96775, presented at the 2005 SPE Annual Technical Conference and Exhibition in Dallas Texas, October 2005.

[62] Crawford, H.R., Conoco Inc., Lescarboura, J.A., Conoco Inc. Consultant, "Drill Cuttings Reinjection for Heidrun: A Study," SPE Paper 26382, prepared for presentation at the 68th Annual SPE Technical Conference and Exhibition in Houston Texas, October 1993.

[63] Abou-Sayed, A., SPE, Advantek International, Guo, Q., SPE, Advantek International, "Design Considerations in Drill Cuttings Re-Injection Through Downhole Fracturing," IADC/SPE Paper 72308, Presented at the IADC/SPE Middle East Drilling Technology Meeting in Bahrain, October 2001.

[64] Lee, T.W., Yusof, M.R, Boni, R., Rahman, S.A, Petronas Carigali, "Protecting Shallow Water Environment Through Re-injecting Drilling Wastes Down Hole: A Proactive Management Decision," SPE Paper Number 86727, presented at

In view of the sensitive environments, PCBL made a proactive decision to slurrify and re-inject drilling wastes down-hole in order to reduce the volume of plume producing solid and liquid effluent discharged into the marine environment. The environmental benefit realized from the decision has far exceeded the cost installation and operation of the cuttings reinjection unit.

It cost the company close to USD half a million to mobilize/demobilize, install and operate the Cuttings Re-injection (CRI) unit onboard the drilling rig for the drilling of the two wells…However, without the CRI unit, the company would need to spend about USD half a million to conduct post monitoring and assessment and depending on the levels and nature of impact, the cost of reinstating the shallow water environment in Bahrain could be astronomical and may not be fully effective. There were tremendous benefits from the management decision of re-injecting down hole the drilling wastes from the exploration wells in Block IV & Block VI, Bahrain. First, it minimized the impact of drilling waste discharges into the shallow water environment. The action also reduced future environmental liability and most of all; it projected a proactive environmental management approach to all stakeholders. [emphasis added]

Shell argues that it would not be economic to upgrade a mature asset like its Kulluk drilling unit, yet in 1995 Shell demonstrated that mature assets can be economically upgraded when it successfully installed and operated CRI equipment on one of its North Sea platforms. Shell was willing to invest in CRI technology to allow continued use of oil-based drilling muds. Shell's study concluded that the cost of oil-based muds and CRI technology was economic and provided the added benefit of collecting and properly disposing all wastes in an environmentally sound manner:

CRI was selected and has since proven to be an economic and technically viable alternative to the use of water-based or pseudo-oil-based drilling fluids in Brent. CRI can provide the 'total containment' of the oily cuttings as well as other drilling chemicals and liquid platform waste.[65]

In 1991, Arco reported CRI technology was the best demonstrated method for disposal of oil cuttings and muds generated by offshore drilling and resulted in economic savings of $75,000 to $225,000 per well.[66]

ExxonMobil reported that significant cost savings were achieved for offshore waste disposal by suspending the first platform well as a temporary annular injection well in 1999. At the "Jotun B" platform in the Norwegian North Sea, ExxonMobil drilled the upper portion of a well, temporarily suspended the well at the 13-3/8 casing, and then cased the upper section of the well for temporary annular waste injection. Wastes from eight subsequent wells were injected into the temporary injection well. The temporary injection well was later converted into an oil production well. ExxonMobil reported:

In order to avoid sending any cutting or well-related waste to shore, it was decided to suspend the first well on the platform, B-17, at the 13-3/8" casing and complete it with tubing for annulus injection…The cost of all the basic CRI equipment, plus hardfacing of (11) 9-5/8" casing hangers, control retrofits, and piping manifolds and wellhead/tree connections was about $1.4 million. The cost of temporarily completing the B-17 well for injection with tubing and a special injection tree was $762,000 USD [United States Dollars]. Pulling the tubing packer in preparation for drilling the B-17 to the reservoir will add $372,000 USD, for a total cost of $1.13 MUSD [million United States Dollars]. …This is partly offset by a $633,000 USD savings from not having to send waste to shore while drilling the first annulus injector….This well will be deepened late in the program as a production well [after its temporary service as an injector is completed].[67]

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the SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production in Calgary Alberta, Canada, March 2004.

[65] Van Gils, J.M.I, Thornton, J.T.O., Kece, M., Bennett, W., Yule, G.K., Shell UK E&P, "Cuttings Re-injection on Mature Platforms: A Case History," SPE Paper 29377, presented at the SPE/IADC Drilling Conference held in Amsterdam, 1995.

[66] Malachosky, E., SPE, Shannon, B.E., SPE, Jackson, J.E. and Aubert, W.G., SPE, Arco Oil and Gas Co., "Offshore Disposal of Oil-Based Drilling-Fluid Waste: An Environmentally Acceptable Solution," SPE Paper 23373, Drilling & Completion, December 1993.

[67] Kunze, K.R., Skorve, H., ExxonMobil, "Merits of Suspending the First Platform Well as a Cuttings Injector," SPE Paper 63124, prepared for presentation at the 2000 SPE Annual Technical Conference and Exhibition held in Dallas, Texas, October 2000.

ExxonMobil's "Jotun B" platform case history demonstrates that an offshore platform can be retrofitted for several million dollars, not hundreds of millions of dollars. It also shows that a temporary injection well can be drilled for annular waste injection and this well can later be drilled to a deeper depth and converted into an oil producer.

13. Best environmental solution for water-based muds and cutting

Shell's August 2008 report concludes that offshore dumping of drilling waste is environmentally sound. Yet, BP, Statoil Horsk Hydro and several other companies have, voluntarily, and at significant cost, taken proactive steps to eliminate offshore dumping of drilling muds and cuttings, citing environmental protection as a key reason and justification.

The U.S. Department of Energy (DOE) also advocates CRI technology:

> *Because wastes are injected deep into the earth below drinking water zones, proper slurry injection operations should pose lower environmental and health risks than more conventional surface disposal methods.*[68]

BP's corporate environmental policy of "no damage to the environment" drives the company toward innovative disposal practices to achieve zero discharge. A published report by BP in 2002 states:

> *Although some local regulations may permit the discharge of produced water and cuttings to the marine environment, such discharges are not a long-term disposal options. Tightening environmental legislation and BP's environmental policy of 'no damage to the environment' are reducing opportunities for discharge to the sea.*[69]

One has to question: "If water-based muds did not pose environmental harm, why would international companies, such as BP, Statoil and others elect to invest in use CRI technology for underground disposal of water-based muds, citing environmental improvement?"

Shell's own, 2002 report "Assessment of Environmental Impacts from Drilling Muds and Disposal, Offshore Brunei" confirms that Shell's own research has shown environmental impact from water-based muds:

> *Effects on the sea bed from both WBM [Water-based Synthetic Muds] and ESBM [Ester-based Synthetic Muds] and their associated cuttings result primarily from smothering of benthic organisms due to sedimentation and anoxic conditions due to bacterial decomposition within the cutting piles…**zero discharge of WBM and ESBM is considered the best option for the marine environment**…*[70]*[emphasis added]*

Shell's August 2008 report acknowledges a zone of impact from the drilling wastes, yet is inconsistent in reporting the size of the impact zone. Shell cites several different impact radii (e.g. 600', 700' and 1.2 miles), and reports an impacted area of 2.5 acres.

Shell's August 2008 report contains math errors. An impact radii of 600' equates to 26 acres, not 2.5 acres. An impact radii of 1.2 miles, equates to an impact zone of 2,895 acres. Multiple wells will compound the cumulative area affected. Cumulative effects are not discussed in Shell's report. Nor is the environmental impact or length of time need to recover from these larger zones of

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[68] Argonne National Laboratory, "An Introduction to Slurry Injection Technology for Disposal of Drilling Wastes," Publication prepared for the U.S. Department of Energy, September 2003.

[69] Hagan, J.T., SPE, Murray, L.R., Meling, T. BP, et.al., "Engineering and Operational Issues Associated with Commingled Drill Cuttings and Produced Water Re-injection Schemes," SPE Paper 73918, prepared for presentation at the SPE Conference on Health, Safety and Environment in Oil and Gas Exploration and Production in Kuala Lumpur, Malaysia, March 2002.

[70] Sayle, S., Whitford, A.J., Seymour, M., Brunei Shell Petroleum, "Assessment of Environmental Impacts from Drilling Muds and Disposal, Offshore Brunei," SPE Paper 73930, presented at the SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production held in Kuala Lumpur, Malaysia, March 2002.

deposit in an arctic ecosystem. Arctic ecosystems can take decades to recover from environment disturbances.

Subsequent analysis completed by NSB's expert Dr. Raven shows that Shell's NDPES Permit allowing 10,000-15,000 bbls of muds and cuttings to be discharged into the Beaufort Sea will impact an area of approximately 31 acres.[71]

In 1990, the United States passed the Pollution Prevention Act, establishing a national policy that places priority on pollution prevention and specifies that disposal into the environment should only be allowed as a **last resort**:

> *The Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and* ***disposal or other release into the environment should be employed only as a last resort*** *and should be conducted in an environmentally safe manner."*[72] *[emphasis added]*

Under United States policy, Shell's proposal to dispose of exploration waste in the Beaufort Sea should be considered only as a "last resort" not a primary option.

Companies operating in the Norwegian sector of the North Sea all worked toward a goal of zero discharges by 2005. The report "Results and Commitment from the Zero Discharges Work on Produced Water Discharges on The Norwegian Continental Shelf" states:

> *Within the drilling activities, main focus is the substitution of chemicals, and minimisation of drilling waste streams by reusing drilling fluids and injecting cutting and excessive mud in the ground.*[73]

In 2007, MI-Swaco Drilling Engineers reported:

> *The development of new oilfield technologies to explore such remote areas as deep waters and environmentally sensitive locations brings with it increased emphasis on protecting the natural resources of the drilling area. Accordingly,* ***many regulatory agencies demanding zero discharge policies require all generated wastes to be disposed in an environmentally sound manner****. Such process requires the adequate management of wastes generated during drilling operations including cuttings, excess drilling fluid, contaminated rainwater, produced water, scale, produced sand, and even production and cleanup waste…* ***Cutting Re-Injection (CRI) nowadays is considered top-of-the-line technology for the final disposal of drilling wastes*** *through sub-surface injection into an engineered-designated formation where wastes are permanently contained."*[74] *[emphasis added]*

In 2005 Sakhalin Energy, Shell's partner in Sakhalin, Russian exploration and development reported:

> *Subsurface re-injection of drill cuttings and used mud often is the most cost effective,* ***environmentally acceptable method*** *to dispose of these wastes products. This is particularly true for drilling operations in remote and environmentally sensitive areas such as offshore Sakhalin Island where drilling waste treatment and management facilities are usually limited in these isolated areas.*[75] *[emphasis added]*

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[71] Dr, Ravens, "Responses to the North Slope Borough's questions regarding whale deflection and cumulative zone of impact associated with Shell's proposed Beaufort Sea exploratory drilling discharges,"April 2009.

[72] Pollution Prevention Act of 1990, U.S. Code, Title 42, Public Health and Welfare, Chapter 133, Pollution Prevention.

[73] Utvik, T.I.R, Norsk Hydro, Garpestad, E., ConocoPhillips, Tangvald, M., The Norwegian Oil Industry Association, Frost, T.K., Statoil, "Results and Commitment from the Zero Discharges Work on Produced Water Discharges on The Norwegian Continental Shelf," SPE Paper 86801, March 2004.

[74] Alba, A., Fragachan, F., Ovalle, A., Shokanov, T., M-I Swaco, "Environmentally Safe Waste Disposal: The Integration of Cutting Collection, Transport, and Reinjection," SPE Paper 108912, presented at the International Oil Conference and Exhibition in Veracruz Mexico June 2007.

[75] Guo, Q., SPE, Geehan, T., SPE, M-I Swaco, Pincock, M., Sakhalin Energy Investment, Co., " Managing Risks and Uncertainties in Drill Cuttings Re-Injection in Challenging Environments- Field Experience from Sakhalin Island," SPE Paper 93781, presented at the 2005 SPE/EPA/DOE Exploration and Production Environmental Conference, Galveston, Texas, March 2005.

As scientific investigation techniques become more sophisticated over time, wastes once allowed for disposal may, in the future, be banned. Even industry authors criticize the limited testing required by the United States to assure the public that water-based muds are environmentally acceptable for offshore disposal. A publication by Marathon Oil Company, and Baker Hughes Inc., states:

> *The US uses one species to evaluate drilling fluid chemicals for offshore operations... Other scientists question the use of universal species and would prefer using organisms that live in the area to be exploited…in the North Sea, Regional Seas program and Russia a variety of species are used belonging to several trophic levels in the environment… This aspect is desirable since organisms from different trophic levels may be impacted differently and a single species test may not adequately evaluate chemicals or drilling muds…[In the North Sea]…These tests usually evaluate both acute and chronic impacts to better understand the effect of the discharged chemicals.*[76]

Shell's paper at p.7 acknowledges its plan to discharge arsenic, cadmium, lead, and mercury into the Beaufort Sea, but discounts the impacts, concluding these pollutants are not bio-available under normal marine conditions. However, no studies or data are cited that support this conclusion.

Shell's paper at p.10 concludes its discharges are:

> *…too small to contribute substantially to the diet of fish, birds, or marine mammals harvested by subsistence users, the scientific evidence strongly indicated that the metal constituents of concern present in WBM and cuttings are not generally bioavailable following discharge and do not readily bioconcentrate or biomagnify within the food web.*

Again, no studies or data are cited that support this conclusion.

Yet, Statoil's paper titled "Environmental Risk Management of Discharges from E&P activities in the North Sea describes potential impacts to marine life from drill waste:[77]

> *Discharges from exploration drilling, result in discharge of small-sized particles that may stay in suspension in the water column due to their low sinking velocity…Suspended particulate matter may have adverse effects on pelagic species primarily in terms of clogging gills and corresponding inhibition of oxygen transfer. Recent literature indicates that barite in the water column may have some influence on filtrating organism.*[78]*…The main environmental impact from the discharge of drilling solids may [be] attributed to the substrate modification, disturbance and burial ("smothering effect") of benthic fauna by the settlement of drill cuttings and muds.*

The North Slope Borough has hired experts to examine the toxicity, human health and biological impacts of water-based drilling muds and other OCS exploration waste. Therefore, these concerns are not addressed in detail in this document. Additional papers on these topics are forthcoming.

14. Subsistence Impacts

Shell's paper at p. 5 concludes shore-based zero discharge options will increase vessel tonnage and transit in the "theater of operation:"

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[76] Jones, F.V., Marathon Oil Company, Hood, C., Baker Hughes INTEQ, et.al., "International Methods of Evaluating the Discharge of Drilling Fluids in Marine Environments," SPE Paper 46826, presented at the 1998 SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production held in Caracas, Venezuela, June 1998.

[77] Frost, T.K., Johnsen, S., Hjelsvold, M., F&T Statoil, "Environmental Risk Management of Discharges from E&P Activities in the North Sea," SPE Paper 73854, prepared for presentation at the SPE International Conference on Health, Safety, and Environment in Oil and Gas Exploration and Production held in Juala Lumpur, Malaysia, 20-22 March 2002.

[78] Cranford et. al., 1999: "Chronic toxicity and physical disturbance effects of water- and oil-based drilling fluids and some major constituents on adult sea scallops (Placopecten magellanicus)". Marine Environmental Research 48 (1999), pp 225-256.

…Multiple additional vessels would be required to implement a zero discharge operation. The presence of additional vessels in the theater represents a known and quantifiable increase in potential for environmental incidents and conflicts with subsistence harvest activities. The anticipated increase in vessel traffic associated with a zero discharge operation is 16% above the proposed base case.

Yet, there should be no conflict with subsistence activities, if Shell honors the Conflict Avoidance Agreement Principals of the Alaska Eskimo Whaling Commission (AEWC) that restricts industrial vessel operation to periods of time prior to and after the subsistence hunt. As proposed above, Shell could temporarily store wastes in an offshore barge alongside the drilling rig, and later pump the waste into the exploration well prior to plugging and abandoning the well.

Shell's report does not address the increased risk to subsistence hunters. Hunters are concerned that offshore disposal of drilling wastes will cause whales to travel further offshore (deflection), increasing the risk for whalers because they would also have to travel further offshore.

15. Onshore CRI technology is Environmentally Sound

Shell's paper at p.14 argues that onshore disposal of offshore drilling waste is not environmentally sound. Shell writes:

Effects of Onshore Disposal: As described above, reinjection of drilling wastes during exploration is not possible; therefore, the only potential alternative to ocean discharge of WBM and cuttings is onshore disposal. Considering that the ocean discharge of water-based muds and cuttings is widely accepted, the potential for effects of on-shore disposal must be considered in the process of documenting the best overall waste management solution. These effects include:

- *Increased air emissions,*
- *Increased noise generation in the marine environment,*
- *Increased waste generation,*
- *Increased water use,*
- *Increased energy consumption,*
- *Increased wildlife and habitat disturbances due to greater vessel traffic,*
- *Increased risk of unintentional waste releases and/or fuel spills,*
- *Increased transportation and handling risks, and*
- *Increased occupational hazards and worker safety risks.*

Increased operational costs are also an effect of onshore disposal, but this effect is excluded from consideration. All the environmental, human health and safety, and operational effects are part of a comparative framework in which the relative effects of ocean discharge and onshore disposal are evaluated.

Shell's environmental argument does not hold for a number of reasons.

Foremost, NSB residents are concerned about vessel noise during subsistence hunting periods. In cooperation with NSB subsistence hunters, other offshore operators have restricted offshore drilling activities, vessel traffic and noise. If Shell operates at this high standard, the noise argument is moot.

Shell has not explained how onshore reinjection options increase "waste generation", "water use" or "occupational hazards and worker safety risks."

Shell argues that onshore waste disposal methods cause increases in air pollution. Shell's August 2008 report at p.15 estimates oxides of nitrogen pollution (NO_x) will increase by 20 tons per well; no basis for this calculation is provided. Yet, Shell's December 29, 2006 air permit application for the Kulluk drilling rig shows a resupply vessel like the Jim Kilabuk only emits 1.2 tons of NO_x per well, and the entire drilling rig with many engine, compressors, cranes, boilers and incinerators, is estimated at 36 tons of NO_x per well.[79] Additional information from Shell will be required to justify, what appears to be a very high estimated amount of air pollution attributed to a waste transportation vessel, or relatively by comparison calls into question the validity of the rig emission estimates.

If Shell is concerned about minimizing air pollution, there are a number of air pollution reduction technologies that could be used to reduce the total amount of pollution from Shell's overall offshore exploration operations. Reductions could easily offset any small amount of air pollution added from a waste disposal vessel.

Shell warns that transportation of waste to shore may pose an increased "risk of unintentional waste releases." However, without shore-based disposal all Shell proposes to dump **all** its waste offshore. How does the risk of offshore waste disposal increase over that?

Shell's arguments that proper waste handling may increase the potential for fuel spills, or increased energy consumption are disputable, because those same reasons are ones used to oppose offshore drilling in total. The lowest environmental impact, lowest risk would be achieved by no offshore drilling at all.

Summary

International oil and gas exploration operators have been steadily moving toward zero-discharge waste management practices in response to community concerns and more stringent international practices for several decades. While Shell argues that offshore disposal of water-based muds and other drilling wastes is environmentally sound and is allowed by US regulators, this approach is not consistent with the voluntary efforts of other multinational oil companies such as BP, who has lead the effort to develop oil and gas operations in the Beaufort Sea. Hauling waste to a shore-based CRI facility or investment in an offshore CRI facility is a standard of excellence, against which other operators are measured. The community expects this standard of environmental responsibility be maintained.

Voluntary movement towards a zero or near-zero discharge approach will yield numerous benefits to Shell. By working cooperatively with subsistence users, and addressing the concerns of local residents, Shell may avoid further project delays, resulting in a substantial cost savings to Shell. Long-term liability would also be minimized by taking a cooperative approach to project design and through adopting long-term waste management solutions.

To summarize, Shell's proposed Outer Continental Shell (OCS) exploration operations in Alaska could be achieved using one of several viable options for waste handling: (1) annular injection of waste streams into the same well while drilling, (2) temporary storage of waste and disposal into the exploration well prior to abandonment, (3) transportation of waste to the nearest onshore treatment facility or (4) a combination of these four alternatives.

This paper cites technical papers demonstrating that annular injection has been achieved during offshore exploration drilling operations on a MODU through a subsea wellhead. While the technology has been developed, Shell still may find some site-specific reasons for rejecting this technology at some of their exploration projects. In those cases, transportation of waste to an

[79] Shell Kulluk 40 CFR Part 55 Preconstruction Permit Application for the 2007-2009 Beaufort Sea OCS Exploration Drilling Program, submitted by Susan Childs, Shell Offshore Inc., to Daniel Meyer, Environmental Protection Agency, December 29, 2006.

onshore treatment facility is a viable option, and subsistence impacts can be avoided all together by avoiding exploratory operations during subsistence hunting periods.

While Shell does not currently own offshore or onshore-based waste disposal facilities on the North Slope, its intent for long-term operation in Alaska makes this an investment opportunity. The cost of investing in a Shell-owned waste management facility on the North Slope can be amortized over a number of projects, making its economic attractiveness increase over time. Alternatively, existing operators have established fee-based agreements for use of existing facilities, and this can be a temporary option for Shell, until it invests in its own facility.

Please contact me at (907) 694-7994 if you have any questions on this analysis.

Sincerely,

Susan L. Harvey

Susan L. Harvey

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Analysis of the Pros and Cons of Zero Discharge of Muds and Cuttings During Exploration Drilling In the Alaskan Beaufort Sea Outer Continental Shelf

Report Prepared by

Shell Exploration and Production Company

For

The Honorable Mayor Edmond Itta
North Slope Burrough

Contents

Introduction

The following document presents information relevant to understanding the relative pros and cons of the release of muds and cuttings from exploratory drilling operations proposed by Shell in the Alaskan Beaufort Sea to the water column and the seafloor. This analysis is prepared and presented for the purpose of supporting decision-making processes and for informing participants in this process of relevant information.

For the purposes of this document pros are defined as considerations and concerns that support “zero discharge” drill muds and cuttings to the environment. Cons are those considerations that support this release the proposed Shell exploratory drilling program, which does include release of muds and cuttings. While it is recognized that zero discharge would seem, on the surface, to represent the most environmentally protective approach to drilling, it is important to understand the <u>increment of protection</u> gained through the adoption of a zero discharge scenario. In an effort to understand this increment of protection, this document examines multiple potential environmental impacts that have been perceived as possible effects. In many cases, these potential impacts have been assessed in previous studies or evaluation of risk. This body of science is presented as a means to delineate the increment of protection. In many cases, perceived risks may already be mitigated through operational measures that have been built into Shell’s drilling program.

It is also important to understand the costs related to such an approach, in terms of monetary costs , time costs, and total footprint. While these costs are difficult to accurately forecast without detailed operational plans and bids, the estimates contained herein provide an ability to compare the increment of protection to the increment of cost.

Finally, zero discharge imposes multiple operational adjustments that have their own associated environmental impacts and risks. Increased vessel traffic is one example of these associated impacts. It is important to compare the increment of associated impacts with the increment of protection derived from zero discharge to be sure that they produce a net environmental benefit.

Description of Exploratory Drilling Discharges

The current plan for exploratory drilling in the Beaufort outer continental shelf (OCS) includes the discharge of drilling debris (cuttings) removed from the excavated hole and drilling fluids (muds) to the marine environment, This discharge has been evaluated in detail by the Environmental Protection Agency and other relevant state and federal regulatory agencies. Offshore discharge of drilling wastes (muds and cuttings) are currently authorized by an approved NPDES permit and have been found to be the most practical means of achieving the lowest total environmental impact. The resulting environmental impacts are short term and localized (radius<600 ft). Recovery typically occurs within a couple years. The current disposal plan is to separate drill cuttings from the drilling fluid, dispose of cuttings below the sea surface, recycle fluid. At the end of the season, the rig fluid surface volume will be managed to a minimum, then discharged below the sea surface.

The cuttings referred to in the above are comprised of naturally occurring sedimentary deposits from the seafloor of the Beaufort OCS. The sediments in the Beaufort Sea through which the wells will be drilled are the products of the weathering of formations in the Brooks Range, the transportation of the resulting products to their present sites, and subsequent compaction. They are similar in content and source to the surface sediments on the North Slope and, as such, to current discharges from the rivers flowing from the Brooks Range, across the North Slope plain and into the Beaufort Sea. The sediments the wells will penetrate are made up of a clastic sequence of alternating lithologies including shales, claystones, siltstones, and sandstones. In the shallower intervals, thin coal seams may be encountered. A carbonate cement may be present in some of the sediments. The aforementioned minerals are neither toxic nor carcinogenic in a marine environment

Drilling fluid, or mud, is comprised primarily of seawater with a restricted group of largely inert additives that are pumped down the drillstring, through the drill bit and back up the drillstring/hole annulus to the rig. It functions in the rotary drilling process as follows: it cools and lubricates the bit and drillstring, transports drill cuttings (fragments of rock generated by the drilling process), to the surface, provides hydrostatic pressure in the borehole to prevent influx of formation fluids, and stabilizes reactive shales if encountered in the borehole. At the surface, the cuttings are mechanically separated from the drilling fluid and discarded. The drilling fluid is conditioned, if required, and recycled. The drilling fluid (mud) system that Shell plans to use in the upcoming Beaufort Sea Drilling Campaign is a 10 Percent Salt/PHPA water-based mud (WBM). The additives were selected to be acceptable to the EPA Regions 10 (Alaska) and 9 (California, which has the strictest environmental guidelines in the U.S.). The additives are either on the Norwegian PLONOR (Pose Limited Or No Risk to the environment) list or are deemed acceptable (green/yellow listed) for discharge by the SFT (Norwegian Pollution Control Authority). The following components make up the mud system.

1. Water (73%) the main ingredient; seawater will be used as the base liquid
2. Barite (Barium Sulfate), up to (14%) barium or barium sulfate is a naturally occurring, chemically inert mineral used to control the density of the drilling fluid.

3. Salt (10.5%) sodium chloride, approximately 2.5 percent results from the use of seawater as base fluid, the remainder is granulated salt.
4. Bentonite (clay), (1.5%) primarily montmorillonite clay, a naturally occurring mineral often formed by the alteration of volcanic ash in water, used to increase the viscosity of the drilling fluid.
5. Other Chemicals (1% combined)
    a. Partially Hydrolyzed PolyAcrylamide (PHPA), a long chain polymer. It stabilizes the shale formations in the well bore.
    b. Xantham Gum (poly-saccharide biopolymer), a long chain organic polymer manufactured from corn. Used to thicken the liquid phase of the drilling fluid.
    c. Caustic Soda (Sodium Hydroxide), Sodium Bi-Carbonate, Citric Acid These additives are used to adjust the pH of the drilling fluid for corrosion protection and efficient polymer utilization.
    d. Soda Ash (Bi-Sodium Carbonate) is used in drilling fluids to control amount of calcium or magnesium ions in the seawater component.
    e. Carboxy-Methylated Cellulose/Poly-Anionic Cellulose (CMC/PAC), is a water soluble polymer used to control fluid loss of the drilling fluid to the drilled formations.
    f. Chrome-Free Lignosulfonate is used as a thinner or dispersant to adjust the thickness of the drilling fluid's liquid phase.

Drilling mud and cuttings discharges generally disperse in the water column into an upper plume and a lower plume. The behavior of these two plumes is dependent on the physical (e.g., particle size) and chemical characteristics of the effluent, the prevailing currents and oceanographic conditions, and the depth of the seafloor. The upper plume contains very fine particles and soluble material and is considered most important to possible water quality impacts. The smaller and lighter particles, including a portion of the fine grained barite and bentonite particles, remain in the water column long enough to be influenced by variations in ambient current velocities and release depth. The lower plume contains the majority of discharged material (cuttings, barite, and bentonite) and is considered most important to possible impacts on the seafloor. Drill cuttings are rapidly deposited in the immediate vicinity of the drill rig – typically settling within 300 to 700 feet of the discharge point in accumulations that vary from 1/10 at distance to 1/2 foot thick very near the point of discharge (depending on the total depth of the exploratory well) but decreasing in thickness with distance from the discharge point. The settling behavior is dependent on the particle size, sorption capacity of the crushed rock, and on a number of technological factors (type and formulation of drilling fluids, physiochemical parameters in the drilling zone, conditions of the mud and cuttings, contact with formation hydrocarbons, and methods of cuttings separation, recycling, or treatment). The finer mud-type materials, such as barite, are typically deposited further out from the discharge point up to 0.6 or 1.2 miles from the discharge point depending on current velocity.

Overview of Zero Discharge of Drilling Muds and Cuttings

As described in the introduction, the main purpose of this document is to provide an overview of the relevant pros and cons of zero discharge of drilling muds and cuttings in the Alaskan Beaufort OCS. Table 1 provides a listing of these pros and cons. Each will be discussed in greater detail in ensuing segments of this report.

Generally, the pros associated with zero discharge are the elimination of potential environmental and subsistence food and health impacts that could result from discharge of drilling wastes. Whether such impacts are noteworthy or *de minimus*, the preclusion of discharge would remove potential for these impacts to occur.

Zero discharge during exploratory drilling, however, necessitates the implementation of alternative disposal measures that may carry their own environmental impacts. To the extent that these impacts can be anticipated and qualitatively or quantitatively enumerated, they are included as cons to the zero discharge scenario.

Evaluation of the Ecological Effects of Drill Muds and Cuttings Discharge

In order to accurately evaluate the incremental environmental benefit derived from a zero discharge approach to exploratory drilling it is necessary to evaluate the relative risks associated with discharge of muds and cuttings. It must be recognized that significant environmental impacts have been associated with past and, in some cases, current drilling practices within the oil and gas industry. It is important, however, to differentiate between some of these practices and the practices that have been proposed by Shell for use in the Alaskan OCS and approved by the EPA and other regulatory agencies. This section provides a listing of many perceived potential effects related to drilling waste discharge and evaluates the relative risk associated with each on the basis of current knowledge related to the characteristics of mud and cutting composition, the behavior of these releases in marine systems, and the ecological interactions between biological resources and components of released materials. These evaluations are based upon decades of monitoring and evaluation both specific to the Alaskan Arctic environment and the global marine environment.

Members of the general public are typically concerned about trace metals present in drilling fluids. Most of the trace metal constituents found in seafloor accumulations of WBM and cuttings originate from the weighting agent barite, which can be highly persistent in marine sediments. Metals in the environment have been of concern due to the potential for toxicity to marine organisms of

Table 1: Summary of pros/cons related to zero discharge of drilling wastes.

Pro/Con	Description	Qualitative Assessment
Pro	Minimization of seafloor deposition and habitat alteration	Approximate footprint of depostion is 2.5 acres / exploration well. Although these deposition zones are generally colonized and ecologically within 1-4 years, changes in sediment grain size and type may produce biological community differences that persist for decades.
Pro	Limit or prevent the release of potentially toxic substances to the water column and seafloor	Cuttings derived from seafloor deposits are compositionally similar to current erosional discharges from the mainland. The water based drilling fluids to be used during exploration drilling have been selected specifically for compatibility with marine discharge. The constituents of muds are characteristically extremely low in toxicity to non-toxic.
Pro	Limit the release of suspended solids to the water column	Due to the subsurface release of muds and cuttings, suspended solids would result in a limited surface expression of a plume. This plume, however, would be detectable within the water column for a distance of 1-2 miles from the discharge. While constituents within this plume may be detectable and avoided by subsistence resources, e.g. bowhead whales, such avoidance has not been identified or quantified
Con	Increase of vessel tonnage and transit in the theater of operation	Multiple additional vessels would be required to implement a zero discharge operation. The presence of additional vessels in theater represents a known and quantifiable increase in potential for environmental incidents and conflicts with subsistence harvest activities. The anticipated increase in vessel traffice associated with a zero discharge operation is 16% above the proposed base case.

Pro/Con	Description	Qualitative Assessment
Con	Increase in fuel consumption	Fuel consumption of a zero discharge operation is anticipated to be 6 % above the proposed base case. Inherent in fuel consumption is the potential for release during fuel transfer operations
Con	Increased release of air pollutants including greenhouse gases.	Anticipated increase in CO_2 releases is 3 tons/day (6 %) and 20 tons/well for NO_x (4 %)
Con	Increased numbers of high risk operations, e.g. crane lifts.	The transfer of drilling wastes to a vessel capable of transporting to disposal sights would recquire a 100 % increase in high risk crane lifts (2000 lifts/well). Such operations represent a risk to the workforce.
Con	Increase number of man hours/well	Increase of 8100 man hours/well (9%).
Con	Increased safety risks	With a 9 % increase of man hours/well there is at least a concurrent increase in the risks associated with conducting such work.
Con	Increase of cost in retro-fitting of available drilling rigs to accommodate zero discharge	Existing rigs are not currently configured to support zero discharge. These rigs would require extensive retro-fitting to facillitate the additional handling and transfer of drilling wastes. These measures would impose direct cost increases in excess of $100 million.
Con	Increase of > $100 million per year operational costs.	The transport and disposal of drilling wastes would require the deployment of additional vessel, personnel, and logistics resources into the drilling area. Direct costs associated with these deployments exceed $100 million / year

some (but not all) valence forms of some metals. Most of the trace metals found in drilling fluids and cuttings, however, are not of the most toxic valence form, are not bioavailable, or are not biologically active, and, under normal marine conditions, occur as insoluble forms. Concentrations of barium (as barite), chromium (as ferrochrome lignosulfonate), lead, and zinc have been the metals of primary ecotoxicological concern, but drilling fluids may contain trace concentrations of arsenic, cadmium, lead, mercury, and other substances that are found as contaminants of barite depending on its source. Also of concern are specialty drilling fluid additives such as corrosion inhibitors, lost circulation materials, lubricants, and surfactants, but these additives are selected for their lack of toxicity and only used in small amounts to alter drilling fluid properties in response to or to prevent specific drilling problems.

Predicting the ecological effects of WBM and cuttings constituents requires an understanding of the physical and biological processes of environmental fate. After discharge, the following physical processes drive the environmental fate of WBM and cuttings constituents in the water column and within seafloor accumulations: solubility in seawater, natural levels of sedimentation, and the availability of oxygen within the sediment environment. The environmental fate of WBM and cuttings constituents is also dependent on the following interrelated biological processes: bioaccumulation in tissues, biomagnification within trophic structures, bioelimination in fecal pellets after ingestion, and bioturbation in which constituents are moved within sediment layers as a result of the burrowing and feeding behavior of benthic organisms. These complex physical and biological processes may have the capacity to remove or relocate soluble constituents from the water column or make sediment-entrained constituents more mobile.

Drilling fluids typically contain high concentrations of fine-grained particles such as barite, bentonite, and other drilling additives. Although these materials may be chemically inert, adverse physical effects such as smothering and fouling have been documented for marine biological resources provided that mud and cuttings residues are sufficiently high in concentration, that marine organisms are unable to avoid burial or susceptible fouling effects, and exposed for a sufficiently long time. The lethal, sublethal, and community-based effects associated with discharges of WBM and cuttings in the Arctic marine environment were reviewed. Based on this information, potential project-specific discharge-related impacts to the mid-shelf marine environment (20-m to 40-m water depths) are reviewed.

Most short-term (acute) toxicity tests and bioassays do not differentiate between physical and chemical toxicity of WBM, but investigators generally attribute the acute lethal responses of test organisms to their intolerance of high-suspended particulate concentrations. The most common short-term lethal effects of WBM and cuttings discharges are due to the covering or smothering of bottom-dwelling organisms that are unable to move away from the discharge point. These smothering effects occur in the immediate vicinity of the discharge and are the most likely effects of ocean discharge of WBM and cuttings. WBM and cuttings discharges are also capable of causing sublethal effects to marine organisms as a result of fine-grained particulates and other solids suspended in the water column – commonly referred to as total suspended solids (TSS). Sublethal responses observed following drilling mud exposure have included alteration of respiration and filtration rates and altered behavior. These responses are most commonly a result of particle coagulations that clog feeding or respiratory structures or cause abrasions.

Discharged material also has the potential to cause longer-term (chronic) effects on those bottom-dwelling organisms that are susceptible to low levels of organic or inorganic chemical toxicity. Of specific potential concern are the sublethal impacts arising from trace metals in drilling muds deposited on the seafloor. Metal-induced physiological effects include modification of enzyme activity, alteration of the oxygen-carrying capacity of the blood, reduction in reproductive success, increase in egg mortality, decrease in disease resistance, and reduction in growth rates. Under normal marine conditions, however, metals are, for the most part, unavailable for uptake into living organisms. Although there were strong correlations in the past between drilling mud discharges and long-term marine ecosystem impacts in the North Sea, the effects are now believed to have been caused by the toxicity of aromatic hydrocarbons present in the oil-based muds historically used.

In addition to individual organism-level effects, WBM and cuttings discharges are capable of impacting the marine environment immediately surrounding the drilling unit by changing the benthic community structure, including changes in abundance, species richness (number of species), and diversity. Significant effects are not typically seen beyond 700 feet from the drilling unit. These effects are primarily due to changes in sediment composition or grain size within the area impacted by the deposition of discharged material. The altered area becomes attractive to a different community of naturally occurring benthic organisms that are better suited to the finer-grained material that occurs in WBM and cuttings accumulations.

A determination of potential project-specific discharge-related effects on the marine environment and key biological resources is presented. Potential effects were determined by evaluating the general scientific knowledge of environmental fate and ecotoxicological effects and assessing the potential for various ecological receptors to be sufficiently exposed to WBM and cuttings constituents in the water column or in seafloor accumulations.

A bell-shaped accumulation of WBM and cuttings is predicted to form after discharge, with the greatest thickness immediately around the discharge point and thickness decreasing exponentially with distance. For the typical Beaufort Sea drilling location, predicted seafloor accumulation of WBM and cuttings in excess of ½ inch in depth was limited to an area less than 2.5 acres based on a total discharge of 7,083 bbl of cuttings and WBM (including a bulk discharge of used WBMs at the end of drilling). Although some suspended solids and associated trace metals will be added to the water by discharging drilling mud and cuttings, marine water quality criteria for the protection of aquatic life is expected to be met. The mid-shelf of the Beaufort Sea is considered a high sedimentation environment, with low rates of benthic bioturbation and low oxygen penetration despite areas of significant ice gouging. These conditions indicate a low potential for significant degradation of water and sediment quality by WBM and cuttings constituents.

In the Arctic, WBM and cuttings discharges may temporarily block sunlight and reduce photosynthesis of phytoplankton in the water column during dispersion, but the impact would be limited to the immediate vicinity of the drill site. Plankton and their consumers (including fish, birds, and marine mammals such as bowhead whales that feed on pelagic zooplankton) are not expected to be significantly impacted by WBM and cuttings because: (1) the impacted water column area is small (300 feet radius), (2) the exposure to WBM and cuttings constituents will be extremely short in duration (hours), (3) the generational periods for plankton species is naturally short, and (4) the abundance of plankton is normally high. The benthic community in the immediate vicinity of the drilling discharge most likely to be impacted due to the physical smothering that occurs with seafloor accumulations of WBM and cuttings. Smothering of individual organisms present within the nearfield accumulation area (300 to 700 feet of the discharge point) may occur. It is expected that benthic organisms would begin to recolonize the nearfield and farfield impacted areas during the following year. Benthic invertebrates in the mid-shelf marine environment and their consumers (including fish, bottom-feeding sea ducks, bowhead whales, and other marine mammals) are also not expected to be significantly impacted by WBM and cuttings because: (1) the areas of short-term adverse impact are small compared to the undisturbed area available, (2) the exposure to soluble components of WBM and cuttings constituents will be short in duration (up to 1 or 2 years), (3) the natural recolonization rates are high, and (4) the abundance of key species is normally high.

Drilling discharges could displace fish a short distance from a drilling location, but the effects would be localized and temporary. Effects on fish and fish larvae present within a few meters of the discharge point would be expected to occur, primarily due to the physical effects of suspended solids. No specific demersal (near bottom) fish spawning locations have been identified in any of the areas Shell has identified as potential oil and gas prospects. The most abundant marine fish, Arctic cod, spawns with planktonic eggs and larvae, but this occurs under the sea ice during winter.

Because bottom-feeding sea ducks occur in dispersed flocks, relatively few individuals are anticipated to rely specifically on prey potentially affected or buried at a particular drill site. Most bottom feeding by sea ducks occurs in water depths of less than 33 feet and shoreward of Shell's Beaufort Sea leases.

Marine mammals are not expected within 300 feet of exploratory rigs during drilling operations. Although highly unlikely, it is possible that a bowhead whale or other marine mammal could attempt to feed along the surface or in the water column within 300 feet of a floating drill rig either during or immediately after a discharge event. Bowhead whales are regularly exposed to high concentrations of suspended particulate matter (or TSS) in naturally turbid nearshore Arctic waters or as a result of seafloor disturbances that whales cause themselves during bottom-feeding or during water column-feeding in shallow waters. It is believed that a very long exposure to suspended solids would be required to induce adverse physiological responses from suspended particulate matter. It is equally unlikely that a marine mammal would remain within 300 feet of an active discharge long enough to be significantly exposed to toxic levels of chemical compounds or to bioaccumulate organic or inorganic compounds at sufficient levels to cause toxicity. Polar bears, walrus, seals, and whales are not expected to be adversely affected by WBM and cuttings discharges either directly, by exposure to WBM and cuttings constituents, or indirectly, by disruption or degradation of their habitat and food supply.

There is essentially no potential for discrete WBM and cuttings discharges to sufficiently alter the amount of or degrade the quality of prey species, including zooplankton, benthic invertebrates, fish, or marine mammals, to cause a disruption of the Arctic marine food web, especially when compared to the total area in the Beaufort Sea containing undisturbed habitat and prey items. Therefore, no significant effects are expected on the most important Arctic marine trophic pathway in which energy is transferred from phytoplankton, to zooplankton (euphausiids and copepods), to Arctic cod, to marine mammals (including the bowhead whale), and ultimately, to humans. Due to the limited nature and extent of expected WBM and cuttings constituents, the likelihood that significant constituent loading or health effects would occur to humans from consuming marine species such as shellfish, fish, birds, or marine mammals, is considered extremely small. Not only are the areas potentially affected by discharges too small to contribute substantially to the diet of fish, birds, or marine mammals harvested by subsistence users, the scientific evidence strongly indicates that the metal constituents of concern present in WBM and cuttings are not generally bioavailable following discharge and do not readily bioconcentrate or biomagnify within the food web.

Environmental Management of Ocean Discharges

There are many checks and balances provided by Shell and Federal regulators to ensure that environmental effects of ocean discharge are minimized and that changes can be made to operations if adverse impacts are found.

First, an exploratory drilling project undergoes an extensive approval review process. As part of the regulatory process, an environmental assessment (EA) was done using site-specific information on the background conditions in the area. The EA predicted impacts of operations utilizing dispersion modeling and previous studies of impacts from similar operations to predict the potential for the surrounding environment to be impacted by ocean discharges. Through this process, significant concerns can be addressed before the project is approved. Recently, a more holistic approach has been utilized, in which assessments are made of the full cycle of environmental effects that could be realized by not only proposed operations but also alternatives (e.g., onshore disposal).

Second, all chemicals used for offshore discharge must be approved for use. Ocean discharges of WBM and cuttings have been regularly evaluated and permitted by the EPA in the U.S. Beaufort and Chukchi Seas. The Arctic Oil & Gas Final General Permit, issued by EPA Region 10 and effective through 2011, authorizes certain discharges from oil and gas exploratory facilities located in or adjacent to the Beaufort Sea (and other locations offshore of Alaska) in accordance with effluent limitations, monitoring requirements and other conditions set forth within the General Permit. Permissible discharges in the General Permit that are related to exploratory drilling and logistics include drilling muds and cuttings.

On July 19, 2007, the EPA issued authorizations for Shell to conduct permissible discharges from the Kulluk as described above. Shell is currently preparing the required plans to manage these authorized waste discharges, including a Quality Assurance Plan and Best Management Practices/Pollution Prevention Plan, which are part of Shell's comprehensive environmental compliance program. These plans provide schedules of activities, prohibitions of practices, maintenance procedures, operating procedures, practices to control spillage or leaks, and other management practices to prevent or reduce the pollution of waste discharges.

Third, compliance of operations to regulatory and design standards are monitored and reported through an environmental management framework. Within this environmental management framework, the primary tools used by regulators and operators in evaluating the environmental behavior of drilling fluid discharges and their potential impact on the marine environment are laboratory testing to determine the quantities and concentrations of specific constituents and their compliance with regulated levels, computer modeling of settling and dispersion patterns, and environmental effects monitoring (EEM) field studies. The objectives of an EEM program are to confirm our understanding of predicted environmental effects, provide early warning of potential adverse impacts, provide information for modifications to operational practices and procedures, and provide the basis for technical improvements.

Another check on the environmental soundness of operations is the Health Safety and Environment - Management System (HSE-MS) under which Shell operates. The HSE-MS is a set of guiding principles that govern all operations of a facility and is part of an overall management system for planning, developing, implementing, achieving, reviewing and maintaining Shell's commitment to Goal Zero – no significant environmental incidents.

Alternatives Analysis

Drilling waste management alternatives can be roughly grouped into three categories: **cuttings reinjection on-site, ocean discharge**, and **onshore disposal**. All three groups of waste management options come with their own set of advantages and disadvantages. A deeper understanding of the specifics of each technology is required in order to make the best waste management decisions.

<u>Cuttings Reinjection</u>

Background: An alternative for drilling waste disposal is on-site cuttings reinjection (CRI). This process involves pumping fluids and seawater-diluted cuttings that have been ground into small particle sizes into an underground formation. Before injection is possible, most formations must be fractured with hydraulic pressure, creating small cracks that allow fluids and solids to be pushed away from the well bore in into the subsurface formations (strata). Injected fluids are confined in the receiving formations mechanically (by cemented casing) and geologically (by caprock). Cuttings may be injected via the annulus of a well being drilled or into a dedicated or dual use (one that will later be completed for production) disposal well. Injection is a complicated process, requiring intricate design, specialized equipment, careful monitoring and detailed contingency plans. The most significant limitations for CRI are the requirement for accessible surface wellhead equipment and the presence of a suitable injection formation. For example, the formation must have natural sealing structures that prevent broaching into other formations or to the surface.

Case against Cuttings reinjection: It is not technologically possible to reinject used drilling mud and cuttings underground during exploratory drilling from a floating vessel such as the Kulluk.

CRI technology has been applied primarily from bottom-founded installations, and there has only been one experimental effort at injecting from a floating vessel. The water depth capability of bottom-founded drilling units is limited to 25 to 80 feet and therefore this type of unit cannot be used at the Sivulliq location due to the depth of water.

The main challenge is that the wellheads and associated Blowout Preventers (BOPs) used with floating vessels such as the Kulluk are located on the seafloor and are not capable of accepting ground-up mud and cuttings while drilling an exploratory well. The subsea BOP equipment is designed to reliably seal off the well and the marine riser has the ability to be rapidly disconnected to permit the drilling unit to quickly move off the well site in case of ice encroachment or an extreme weather event. The subsea wellhead and BOP system can be left in the mud-line cellar (excavated below the seafloor to protect wellhead equipment from ice keels) and can be reconnected to the drilling unit when conditions improve. In bottom-founded mobile exploratory drilling units, the wellhead and BOP equipment are installed at the surface – directly beneath the floor of the rig derrick and protected within the base of the structure – so no subsea BOP equipment is required. Surface wellhead equipment contains a system of valves and sealing elements that allow access to the casing annuli in the well, thus permitting injection of drilling mud and cuttings as a disposal option in some instances.

The second reason CRI is not a feasible alternative is that Shell will not have sufficient subsurface information to determine whether a stand alone underground disposal well is possible until after exploration drilling occurs.

Onshore Disposal

Background: If drilling wastes are not handled onsite either via ocean discharge or CRI, they will need to be transported to shore for disposal. Consideration of any onshore disposal option must also include consideration of the offshore operations and transport associated with getting the drilling waste to shore. There are a number of environmental, operational, and economic disadvantages to the selection of onshore disposal. These operations require extensive use of support vessels to take the cuttings to a shore location. Fuel is expended by the work boats during the offshore loading and transport process, resulting in air emissions. There may be significant costs associated with transporting cuttings to a shore base; these costs may be prohibitive for remote applications. Safety and environmental risks associated with handling and transporting cuttings to shore are increased over those of other options, particularly in areas prone to inclement weather. Finally, there may be operational issues with handling large volumes of cuttings either generated from high rates of drilling or from shutdown of offloading and transport operations due to inclement weather.

Onshore, there are a number of options for treatment, recycling, and disposal of drilling wastes. These options include landfill disposal, biodegradation techniques (land treatment or composting), stabilization/solidification, and thermal treatment technologies (thermal desorption and incineration). The viability of each of these options will depend upon assessment of environmental (e.g., potential for leaching of constituents into ground or surface water, emissions from equipment and transport to site, resultant end product, compliance with regulations), operational (e.g., presence or proximity of infrastructure or facility, climatic limitations, personnel requirements and health and safety), and economic (e.g., cost of processing, onshore transport, future liability). In Alaska, onshore disposal alternatives, such as permanent landfills (reserve pits), landfarming, or solidification techniques are not suitable and no longer practiced on the North

Slope due to the sensitivity of the tundra or lack of infrastructure. Transporting the wastes south and off of the North Slope for disposal elsewhere is impracticable due to the distances and cost involved. Developing an underground disposal well and constructing a grind and inject (G&I) facility in the Prudhoe Bay area is not possible because Shell has no onshore leases where an injection well could be drilled. Therefore, the only viable onshore disposal option would be to reach an agreement with other North Slope operators to utilize the only existing G&I Facility, located on Drill Site 4 at Prudhoe Bay. This would require the use of numerous vessels and barges to transport wastes from the Kulluk to West Dock. In addition, a fleet of large bulk material trucks will be required to transport drilling mud and cuttings to Drill Site 4 from West Dock.

Effects of Onshore Disposal: As described above, reinjection of drilling wastes during exploration is not possible; therefore, the only potential alternative to ocean discharge of WBM and cuttings is onshore disposal. Considering that the ocean discharge of water-based muds and cuttings is widely accepted, the potential for effects of on-shore disposal must be considered in the process of documenting the best overall waste management solution. These effects include:

- Increased air emissions,
- Increased noise generation in the marine environment,
- Increased waste generation,
- Increased water use,
- Increased energy consumption,
- Increased wildlife and habitat disturbances due to greater vessel traffic,
- Increased risk of unintentional waste releases and/or fuel spills,
- Increased transportation and handling risks, and
- Increased occupational hazards and worker safety risks.

Increased operational costs are also an effect of onshore disposal, but this effect is excluded from consideration. All the environmental, human health and safety, and operational effects are part of a comparative framework in which the relative effects of ocean discharge and onshore disposal are evaluated.

Anticipated Impacts Associated with Zero Discharge Operations

Impacts associated with zero discharge operations generally fall into three categories, 1) increased costs of capital investments and operating costs, 2) increased environmental implications associated with operations, including air releases, vessel traffic, and potential for accidental releases, and 3) increased safety exposure to a larger workforce.

Costs associated with the percautionary adoption of zero discharge operations in the Alaskan Beaufort OCS would exceed $100 million for capital outlay to retro-fit existing rigs to accommodate handling and transfer of drilling wastes. These modifications would likely require re-location of the rigs to a remote ship-yard and loss of operational opportunity of at least one year (costs not included in this estimate). These represent best-estimate approximations of the associated costs and presume that such modifications are possible to both the Kulluk and Discoverer.

Per well operational cost increases are in excess of $100 million. These costs are associated primarily with the mobilization and utilization of additional vessel and personnel resources as well as handling and disposal operational costs.

While it may seem counterintuitive that precautionary measures implemented to reduce potential perceived environmental risks may actually increase environmental impacts, the reality is that operational requirements associated with zero discharge operations produce quantifiable impacts as well as increased risks of high consequence incidents. The increased operations on drilling rigs and support vessels would increase air emissions by 3 tons/per day (6%) for CO_2 and 20 tons/well for No_x. Although there is no existing correlation between exploration drilling and human health conditions in local populations, incidence of such pulmonary ailments as asthma are correlated with decreased air quality.

Vessel traffic has been demonstrated to present a risk to marine mammal populations through collision, deflection, and interference with subsistence harvest activities. A 16 % increase in vessel tonnage required to implement zero discharge would have an, at least, concommitant increase in the potential for transit related marine mammal and other biological resource interactions.

Vessel traffic is also one of the most significant risk factors in the incidence of high consequence environmental accidents. Vessel collisions, interactions with ice, and re-fueling accidents are leading causes of spills and other releases in the seas and arctic. Increasing vessel traffic therefore increases the likelihood for such releases.

Despite extensive safety programs, such as the Goal Zero initiative, increased operations and use of manpower carry a concommitant increased exposure to safety incidentsIt is anticipated that a zero discharge operation would increase the number of man hours per well by approximately 8100 hours per well (2-3 wells per year). Many of these increased man hours would also be involved in relatively high risk activities that the industry typically makes every effort to minimize such as crane lifts. Such lifts are one of the highest risk activities that occur and require a high degree of professionalism and monitoring to be conducted safely.

Summary and Conclusion

Based on the information summarized in this letter, it is our conclusion that drilling mud and cuttings discharges associated with short-term exploration operations will not have a significant effect on the environment due to the water column release or seafloor deposition. Periodic, minor increases in the turbidity and suspended particulate matter concentration in the water column are likely, but this is not expected to have an environmentally significant effect on the zooplankton food supplies of bowhead whales in the vicinity of exploratory drilling rigs. The most likely environmental effect is expected to be a small, short-term, reversible disruption to the animals that live in and on the bottom of the ocean in the immediate vicinity of the discharge point. Based on the weight of evidence from laboratory and field studies around the world and in the Arctic, it is also our conclusion that exploratory drilling activities will not result in environmentally significant levels of trace metal contamination, and benthic recolonization will begin soon after discharges cease.

As summarized in this reported, Shell has evaluated drilling waste disposal alternatives and selected ocean discharge to the Beaufort Sea as the preferred method. This selection was based on the favorable effects of ocean discharge when compared to onshore disposal. Discharge to the Beaufort Sea, as authorized under the current NPDES General Permit, results in minimal adverse environmental impacts, and is technically feasible, with limited potential cost-, schedule-, and safety-related effects. All planned exploration drilling waste discharges to the marine environment will be authorized under the EPA's NPDES General Permit AKG280000 for the Beaufort Sea, Alaska, that sets limits on discharge type, volumes, rates, and imposes monitoring requirements. Discharges will be subject to waste minimization and monitoring through Shell's Environmental Compliance Program including a NDPES Quality Assurance Plan and Best Management Practices Plan.

The potential fate and effect of WBMs and cuttings discharges to the sea has been researched in laboratory and field studies in the Arctic and around the world by academic investigators, regulatory agencies, and the oil and gas industry. The general consensus among these researchers is that trace contaminants present within WBMs and cuttings are relatively inert and do not accumulate in the tissues of marine organisms or transfer within the food web. Based on these studies, it is Shell's understanding that there are no long-term effects on the marine environment due to the water column release or seafloor deposition of WBMs and cuttings. The most likely environmental effect is expected to be a small, short-term and reversible disturbance to seafloor organisms in the immediate vicinity (less than 700 feet) of the discharge point and periodic, minor increases in turbidity during discharges.

Cuttings reinjection has little history of use from floating drilling units has not been done successfully to date and presents additional technical challenges; any failures in the injection process pose serious threats to the drilling operation. Disposing drilling wastes onshore also presents increased environmental and safety risks associated with transporting and handling large amounts of waste. In addition, drilling operations would need to be curtailed if onshore disposal was impacted by weather or ice conditions. Most importantly, curtailing drilling operations increases the likelihood of hazardous incidents to our workers.

Given the limitation of impacts associated with discharge of drilling wastes, the adoption of a zero discharge approach represents a primarily precautionary approach to environmental management which is neither consistent with national policy, nor, with best practices. The increment of environmental protection gained through zero discharge does not generally warrant the several hundreds of millions of dollars that would be required to implement such a program.

Finally, zero discharge is a misnomer for such operational procedures. While it is possible to approach zero discharge of muds and cuttings, such operations result directly in increased environmental releases, primarily in the form of air emissions. There is also an associated increase in the risk of accidental releases from increased vessel presence, waste handling, and traffic.

CHEMICAL ASSESSMENT IN CAMDEN BAY (SIVULLIQ PROSPECT AND HAMMERHEAD DRILL SITE), BEAUFORT SEA, ALASKA

Final Report Submitted to
Shell Exploration & Production Co., Anchorage, Alaska
July 2009

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES

Page

Section 3

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

Page

LIST OF FIGURES

EXECUTIVE SUMMARY

Sediment and water were collected in Camden Bay (Alaskan Beaufort Sea) during August 2008 to help establish a baseline data set in advance of proposed offshore oil and gas exploration and production. Surface sediments were collected at 46 locations, short sediment cores (8-10 cm long) were collected at 12 locations and hydrographic profiles and water samples were collected at 8 locations. The sampling stations were configured as follows: 6 locations within 250 m (L250 stations) and 6 locations between 250 and 500 m (L500 stations) of a possible future Sivulliq drill site, 10 locations near a 1985 Hammerhead drill site (HH stations), 19 random stations from a hexagonal grid across the study area (HEX stations) and 5 stations nearer to shore along a possible future pipeline corridor (P stations). The samples were used for chemical and biological studies. This report presents results from the chemical studies that include the following: (1) sediment total concentrations of aluminum (Al), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), manganese (Mn), lead (Pb), selenium (Se), silver (Ag), vanadium (V), zinc (Zn), total organic carbon (TOC), calcium carbonate ($CaCO_3$), grain size, petroleum hydrocarbons (PH), polycyclic aromatic hydrocarbons (PAH) and radionclides (^{210}Pb, ^{137}Cs and ^{226}Ra used to determined sedimentation rates) and (2) water column concentrations of salinity, temperature, turbidity, pH, dissolved oxygen, total suspended solids (TSS) and particulate organic carbon (POC).

Concentrations of total Al, Fe, Cd, Hg, V and Zn were at background values at all 46 stations, including those from the 1985 HH drill site (e.g., Figure ES1). When concentrations of total Fe, Cd, Hg, V and Zn were plotted versus Al, all data points plotted within the same 99% prediction intervals that had been used previously to define background values for each metal in sediments from the coastal Beaufort Sea (e.g., Cd in Figure ES2). Thus, concentrations of total Fe, Cd, Hg, V and Zn in Camden Bay sediments were at background values that were geochemically consistent with other areas in the coastal Beaufort Sea.

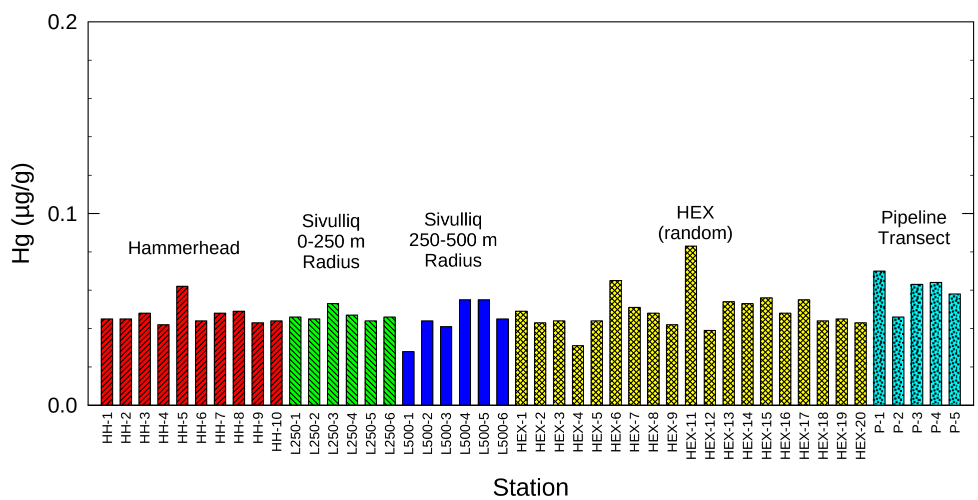


Figure ES1. Values for total Hg in surface sediments from the 2008 study area in Camden Bay.

Because all data points for these five metals plotted below the upper prediction intervals on the metal versus Al plots (e.g., Cd in Figure ES2), no anthropogenic inputs of these metals to Camden Bay has occurred. The conceptual framework for this conclusion is described in detail in the report.

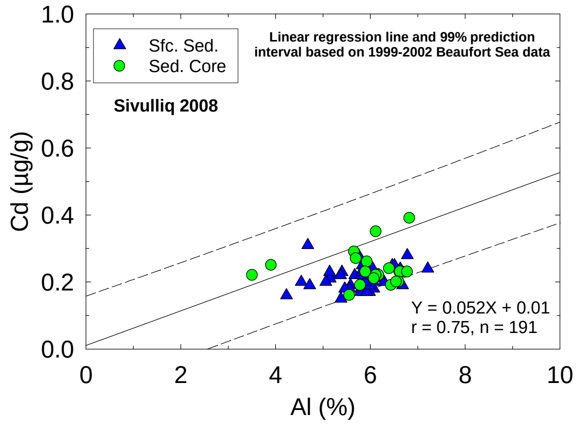


Figure ES2. Concentrations of Cd versus Al for all sediments from this 2008 study of Camden Bay. Solid line, equation and dashed lines (99% prediction interval) are from a linear regression for data from a separate study of the coastal Beaufort Sea by Trefry et al. (2003) as described in detail in this report.

Concentrations of Ba were at background values for 42 of 46 stations in Camden Bay (Figure ES3). Four surface samples collected within ~100 m of the 1985 HH drill site, plus samples from sediment cores at two of the four HH stations, contained Ba at 1.4 to 200 times (average 39 times) above background values of ~600 µg/g. This Ba enrichment was most likely due to the presence of barite ($BaSO_4$) from residual drilling mud and cuttings. The highest sediment Ba value was 124,000 µg/g (12.4%) at the bottom of the core (7.5-8 cm) collected at station HH-5. Industrial barite contains an average of ~53% Ba and thus the sample from the bottom of the core at station HH-5 contained about 23% barite.

Total concentrations of the other six metals studied (Ag, As, Cr, Cu, Pb and Se) were at background values at 45 of 46 locations in Camden Bay, with one exception, drill site HH-5.

Age-dating of a sediment core from one station near the proposed Sivulliq drill site (station L250-2) yielded an average sedimentation rate of 0.12 cm/yr based on data for ^{137}Cs (Figure ES4) and excess ^{210}Pb. At this rate, ~2.5 cm of new sediment would have been deposited at this site in Camden Bay since the HH site was occupied in 1985. Age-dating of a core from station HH-5, coupled with data for concentrations of Ba, suggest that minor amounts of drilling mud and cuttings have been mixed over time with a thin layer of recent sediment. As mentioned, several metals were present at above background values at station HH-5. No metal values in sediment cores from stations L250-2 and L500-2 (the Sivulliq area) or from

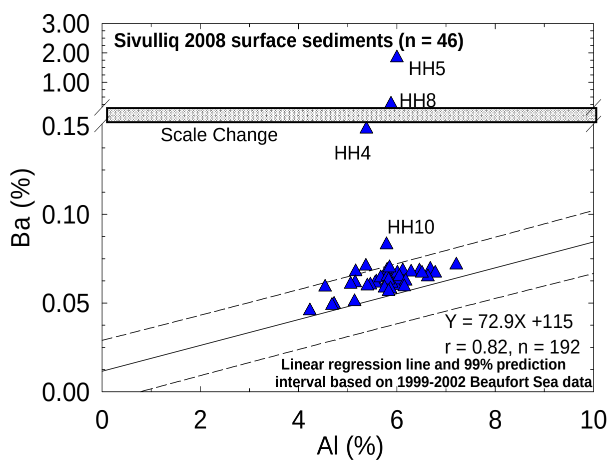


Figure ES3. Concentrations of Ba versus Al for surface sediments from the 2008 study of Camden Bay. Solid line, equation and dashed lines (99% prediction interval) are from a linear regression for data from a separate study of the coastal Beaufort Sea by Trefry et al. (2003) as described in detail in the report. A background sediment Ba value of 600 µg/g is equal to 0.06% Ba on the graph.

station HH-8 exceeded background values except for Ba in the top two layers of the core from station HH-8.

Concentrations of total petroleum hydrocarbons (TPH) and total polycyclic aromatic hydrocarbons (TPAH) in surface sediments were at background values for Camden Bay at 45 of 46 locations (TPAH in Figure ES-5). Elevated TPH and TPAH were found in surface sediments at station HH-5 where values were ~6 and ~4 times greater, respectively, than found at other stations (Figure ES5). Sediment from station HH-5 had a distinct unresolved complex mixture (UCM) or "hump" in the n-C10 to n-C30 range and the UCM for the HH-5 sample was 160 µg/g relative to 18 µg/g at station HH-1. This TPH anomaly in the surface sediments was believed to have been introduced from a trace amount of petroleum input at some time during the past 20 years and it is equivalent to <1% of the background levels of naturally occurring organic matter.

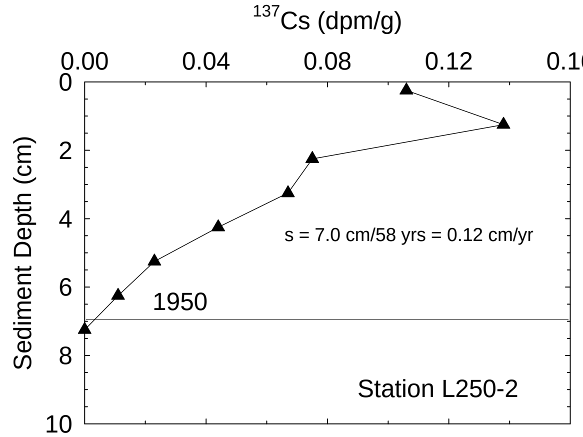


Figure ES4. Vertical profile for ^{137}Cs in sediment core from station L250-2 (Sivulliq area). ^{137}Cs was first introduced to Earth during bomb testing in the early 1950s and that date was used to help set the chronology for the sediment core.

Data for individual PAH in the 2008 data set for Camden Bay, excluding station HH-5, were similar to the ranges reported in a 2005 data set for Camden Bay. Good correlations among different individual PAH, along with the carbon preference index for aliphatic hydrocarbons that was >2, suggest that sediments, excluding the sample from HH-5, have common natural sources of PAH and PH with variations in concentrations that are partly controlled by sediment grain size and possible differences in diagenesis among sites.

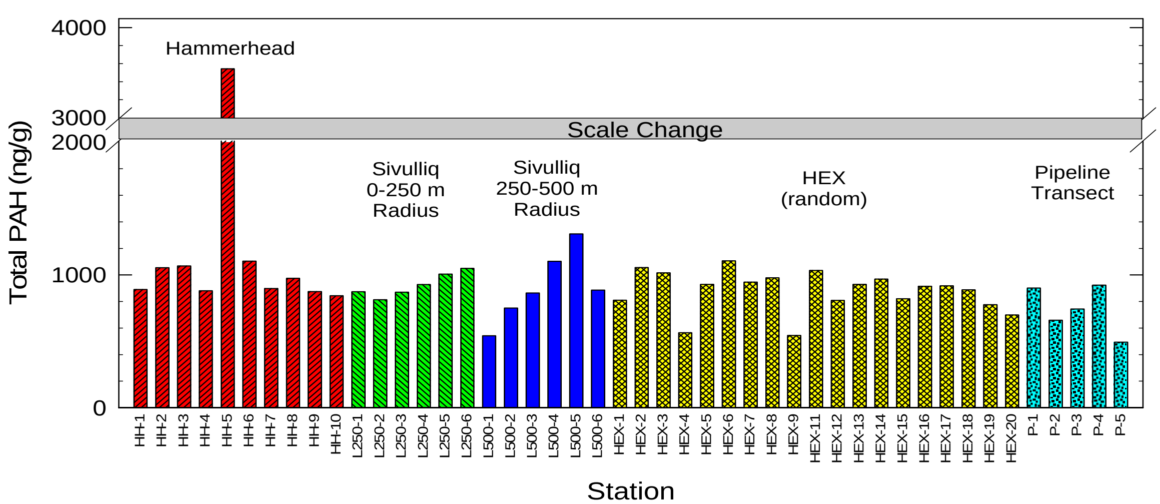


Figure ES5. Concentrations of total polycyclic aromatic hydrocarbons (TPAH) in surface sediments from the 2008 study area in Camden Bay.

The ecological implications of the chemical data from the 2008 survey of Camden Bay were evaluated using sediment quality guidelines and results from the companion study of sediment biology by Dunton et al. (2009). All concentrations of Ag, Cd, Hg and Zn were below the Effects Range Low (ERL) established by Long et al. (1995). One value of 49 µg/g for Pb from station HH-5 was above the ERL of 47 µg/g. Use of sediment quality guidelines comes with a variety of limitations as discussed in the report. Well tested and validated sediment quality criteria were not available for the other metals studied (As, Ba, Cr, Cu, Mn, Se, V). In the case of Ba, toxicity tests are limited; however, Starczak et al. (1992) found no significant differences in growth rates for a polychaete worm in sediments containing 10% barite (Ba~50,000 µg/g). Only the sample from station HH-5, at a sediment depth of ~8 cm, contained Ba at >10%, the highest value tested in a study where no effects were observed. All 46 samples from the 2008 survey of Camden Bay contained concentrations of TPAH that were below the ERL. Field work for the companion study of sediment biology by Dunton et al. (2009) found no measurable differences in benthic community abundance or structure at the 10 HH stations, including HH-5, relative to the other stations in the area.

Data from the eight water column stations show stratification at all sites, except one site closest to shore, with overall surface salinity values of 25 to 29 and near-bottom (25 m) salinity values of 31 to 31.7 (e.g., Figure ES6). Temperature profiles show similar stratification with surface water values of 4 to 6°C relative to ~0.3° C at 25 m (e.g., Figure ES6). Concentrations of dissolved oxygen were at 89 to 104% saturated and pH values ranged from 7.8 to 8.4. *In situ* turbidity values were low, relatively uniform at 1.8 to 3 NTU, and close to the 1 NTU detection limit of the sensor (e.g., Figure ES 7). Concentrations of total suspended solids (TSS) determined for discrete water samples averaged 0.26 ± 0.13 mg/L at 2 to 3m and 0.73 ± 0.31 mg/L at 10 to 25 m (e.g., Figure ES7). These TSS values are consistent with values for clear offshore water in the coastal Beaufort Sea. Concentrations of particulate organic carbon (POC) averaged 26% and 11% of the TSS values in the 2 to 3 m and 10 to 25 m layers of the water column, respectively, (e.g., Figure ES7).

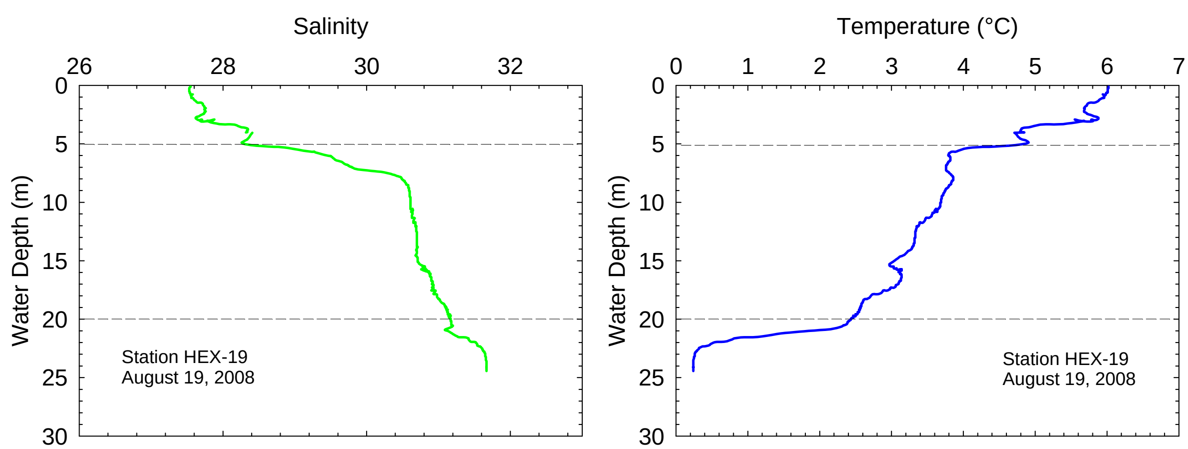


Figure ES6. Vertical profiles for salinity and temperature at station HEX-19.

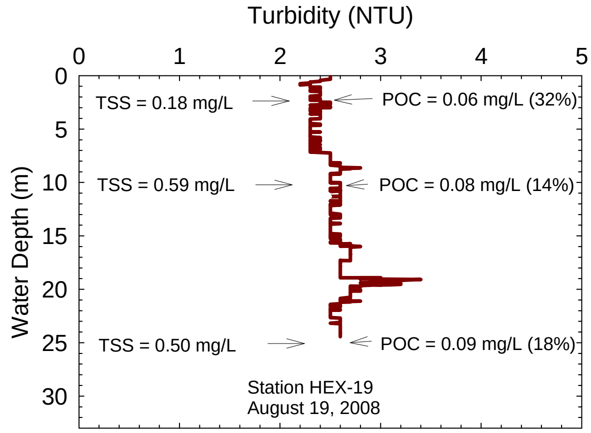


Figure ES7. Vertical profile for turbidity at station HEX-19. Numbers on graph show values for total suspended solids (TSS) and particulate organic carbon (POC) for discrete water samples. Numbers in parentheses show % of TSS that was POC.

Overall, based on the chemical results, sediments in Camden Bay have background values for trace metals, aliphatic hydrocarbons and polycyclic aromatic hydrocarbons, except within <100 m of a 1985 drilling site. From another perspective, based on one example drill site, movement of drilling mud and cuttings in Camden Bay, at a water depth of ~32 m, was restricted for 20 years to within ~100 m of a discharge site. Furthermore, baseline data and supporting interpretative techniques are now in place to facilitate identification of anomalous concentrations of potential contaminants in sediments from Camden Bay well before they reach values that could have adverse environmental effects.

1.0 INTRODUCTION

1.1 Overview and Goals

This 2008 study of Camden Bay in the coastal Beaufort Sea was designed to obtain the following: (1) baseline environmental data in advance of proposed offshore oil and gas exploration and production in the bay and (2) environmental data for a site where exploratory drilling took place in 1985 to assess the long-term fate of drilling discharges. The study had a chemical and biological component. This report considers the chemical results. The biological results are presented in a companion report by Dunton et al. (2009). Chemical data from the 2008 sampling expedition include the following:

1. Concentrations of total trace metals (Ag, Al, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Pb, Se, V, Zn) grain size, total organic carbon (TOC), carbonate, aliphatic petroleum hydrocarbons (PH), and polycyclic aromatic hydrocarbons (PAH) for 46 surface sediment samples from 46 locations in Camden Bay.
2. Concentrations of total trace metals in 19 samples from 4 sediment cores.
3. Age dating of 2 sediment cores.
4. Continuous, vertical profiles for temperature, salinity, turbidity, pH and dissolved oxygen at 8 locations.
5. Discrete water samples from 3 depths at the 8 locations where vertical hydrographic profiles were obtained. Samples were analyzed for total suspended solids (TSS) and particulate organic carbon (POC).

1.2 Study Area

A total of 46 stations were occupied in Camden Bay during August 2008 (Figures 1.1 and 1.2). Camden Bay is located in the Alaskan Beaufort Sea between Kaktovik (Barter Island) and Prudhoe Bay (Figure 1.3). Most of the stations were located in the general area of a proposed Sivulliq drill site, about 25 km north of Flaxman Island (Figure 1.3). Two exploratory wells were drilled in the Sivulliq area, formerly called Hammerhead (HH), during 1985 and 1986. During the 2008 Camden Bay study, 10 stations around the 1985 HH drill site were sampled (Figure 1.2a). The distribution of samples in four different groupings is outlined below with detailed information and station locations for all sample stations in Tables 1.1 to 1.4.

1. HH 1985 exploratory drill site where 10 stations, identified as HH-1 to HH-10 were occupied (Figure 1.2a).
2. Random stations to the north and south of the HH area referred to as HEX-1 to HEX-20 (excluding HEX-10, Figure 1.1).
3. Stations within 250 and between 250 and 500 m of possible future, Sivulliq drill site identified as L250-1 to L250-6 and L500-1 to L500-6 (Figure 1.2b).
4. Stations along a possible pipeline corridor identified as P-1 to P-5 (Figure 1.1).

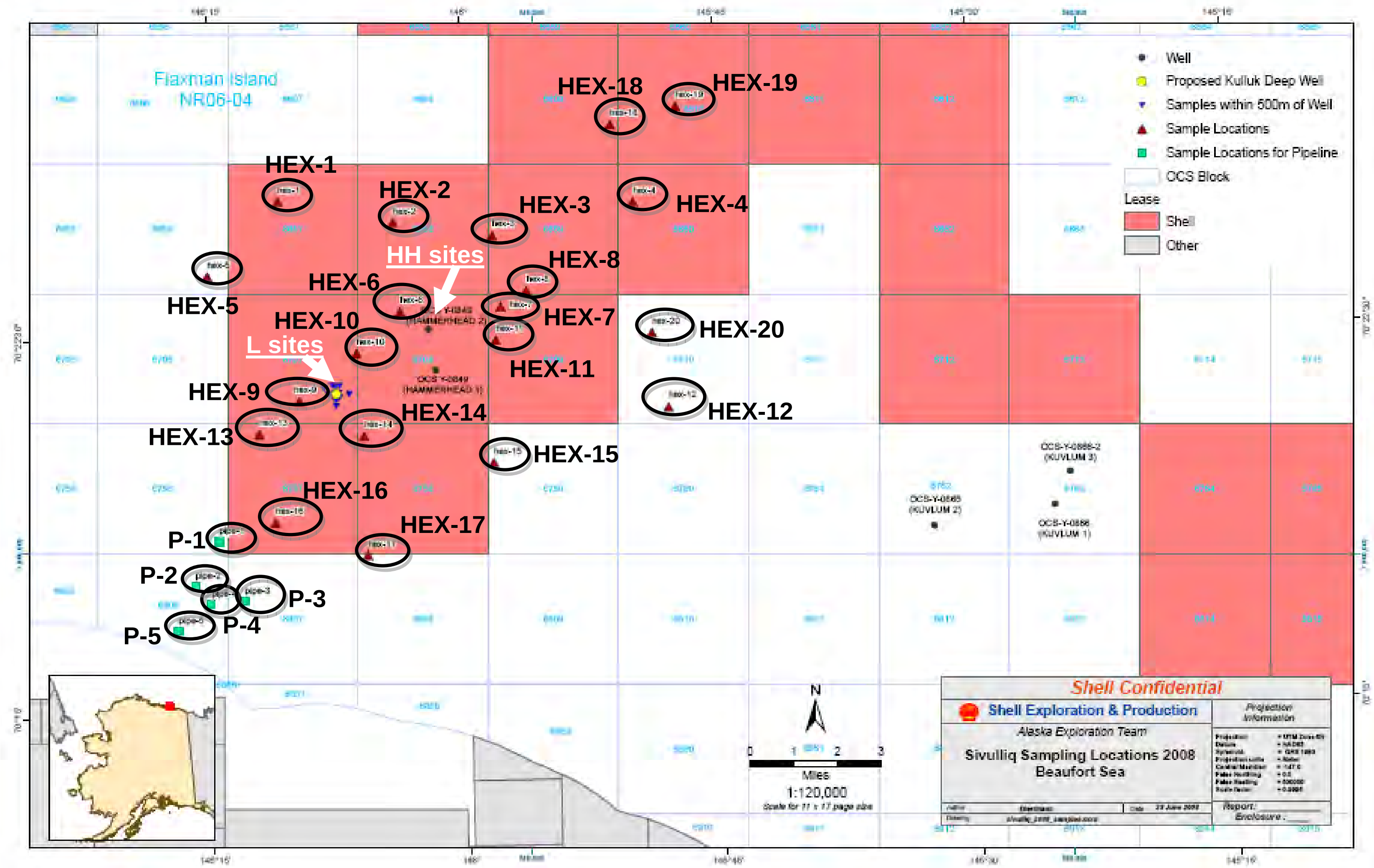
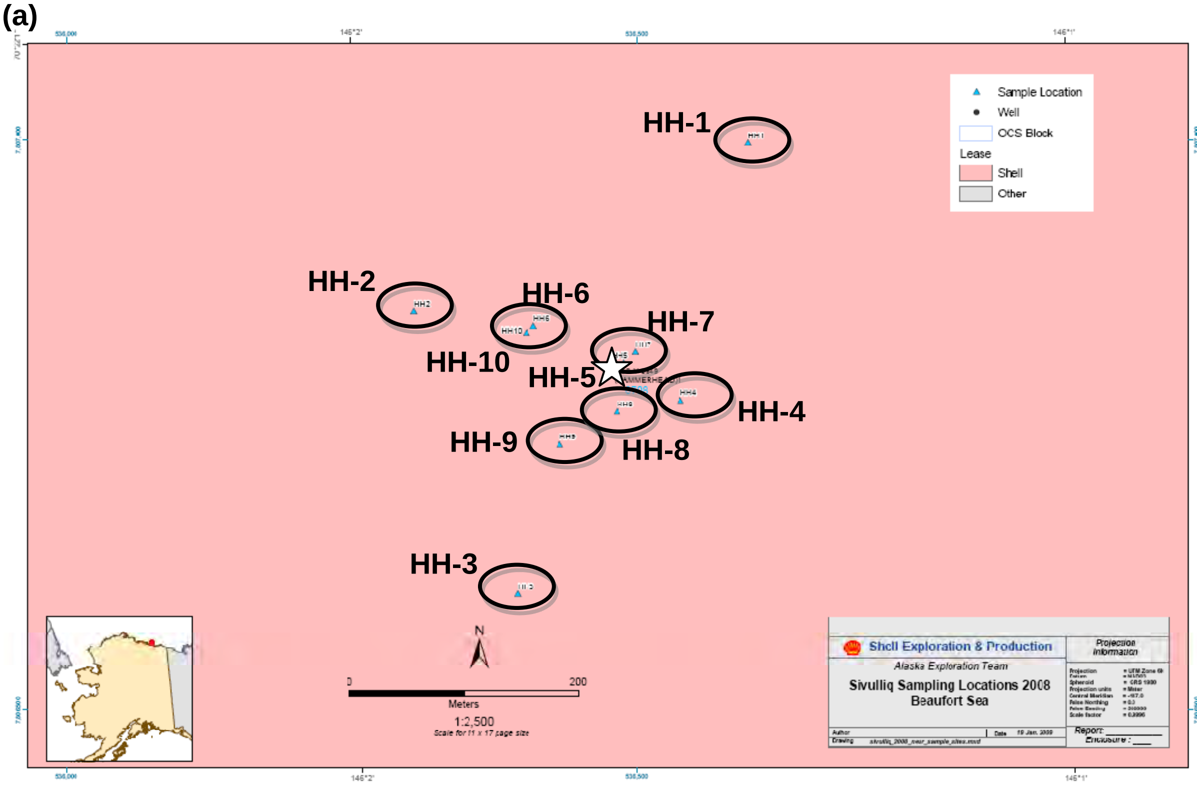


Figure 1.1. Map showing sampling locations during 2008 study of Camden Bay in the coastal Beaufort Sea. Maps showing the HH and L sites are presented in Figure 1.2.

(a)



(b)

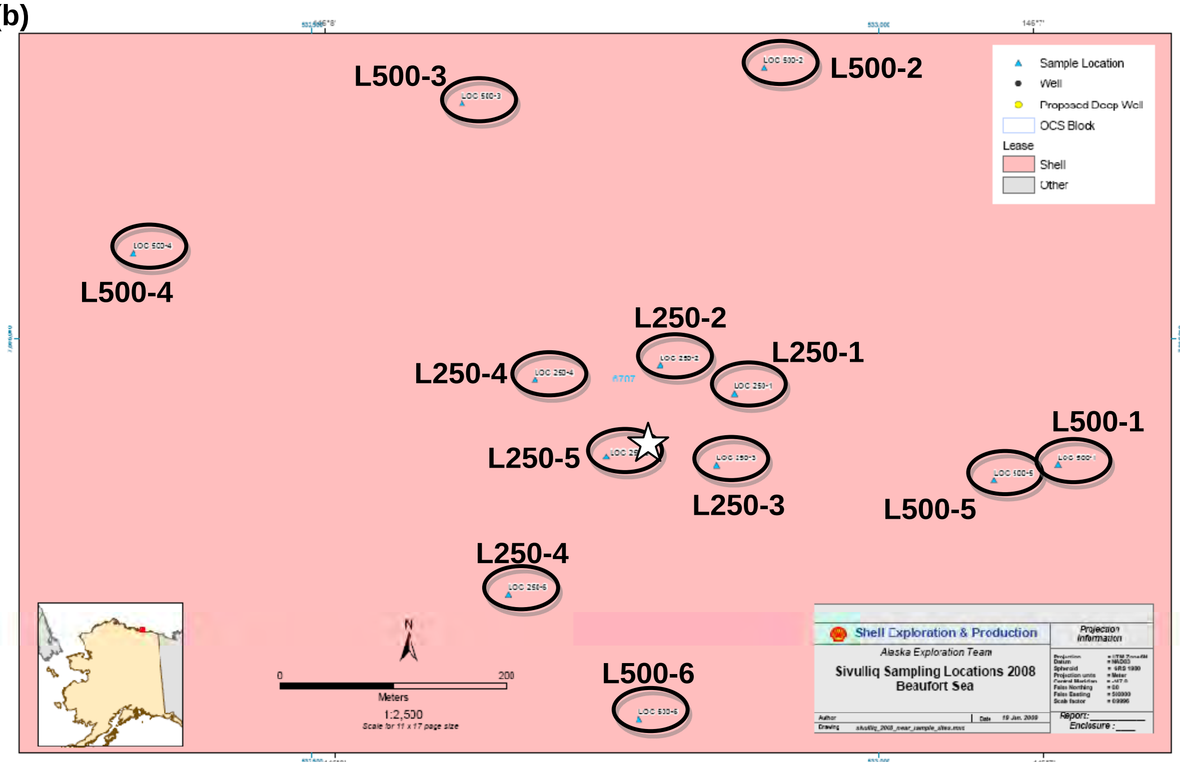


Figure 1.2. Maps showing (a) Hammerhead (HH) stations and (b) Sivulliq stations (L250 and (L500) in Camden Bay. Stars show (a) 1985 HH and (b) possible Sivulliq drill sites.

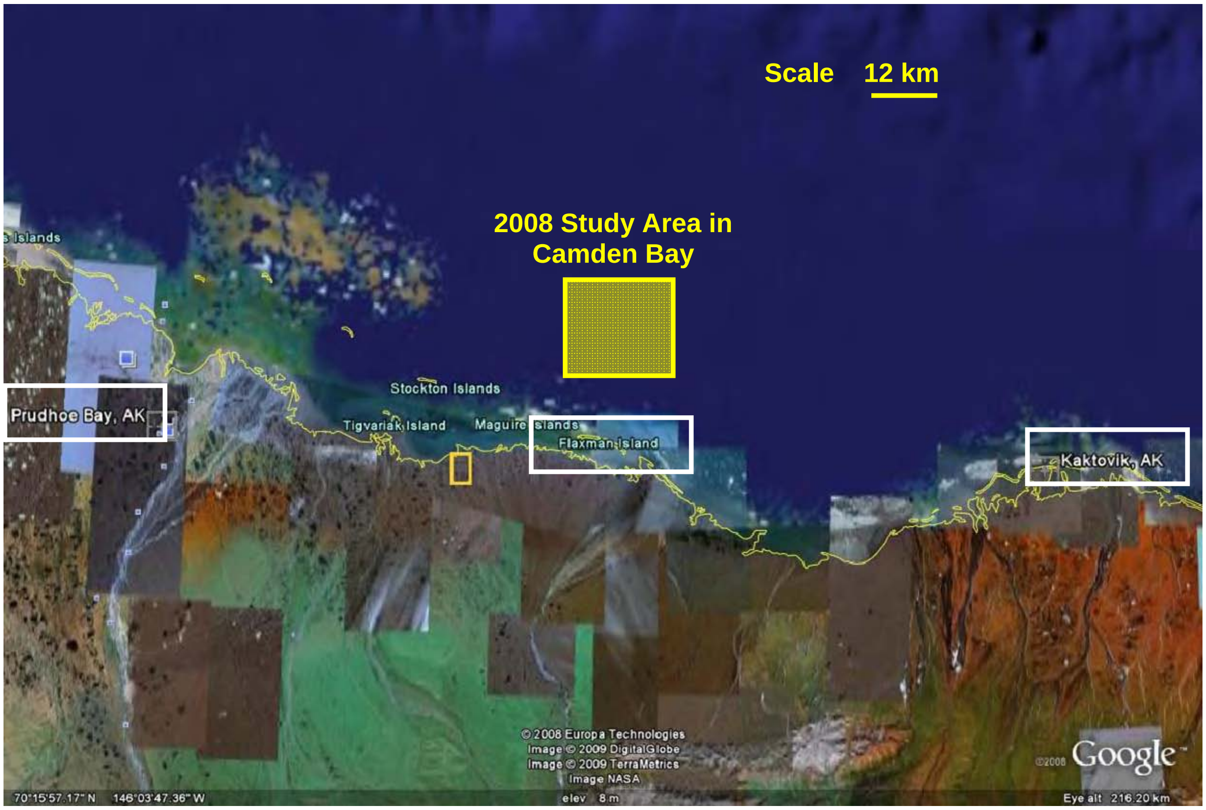


Figure 1.3. Overview of 2008 study area in Camden Bay with Prudhoe Bay to the west, Flaxman Island to the south and Kaktovik to the east.

Table 1.1. Sample locations and supporting information for the Hammerhead (HH) area where exploratory drilling took place in 1985. Distances between grabs were calculated using coordinates for the chemistry and biology sites and equations from Byers (1997).

Station	Grab Type	Date	Time	Lat (N)	Long (W)	Distance between grabs (m)	Water Depth (m)
HH-1	Chem	17-Aug-08	1001	70° 21.968′	146° 01.443′	-	31.7
	Biol	17-Aug-08	1019	70° 21.958′	146° 01.458′	21	32.3
HH-2	Chem	17-Aug-08	1416	70° 21.891′	146° 01.915′	-	32.9
	Biol	17-Aug-08	1434	70° 21.890′	146° 01.871′	27	32.3
HH-3	Chem	17-Aug-08	1116	70° 21.757′	146° 01.776′	-	31.7
	Biol	17-Aug-08	1144	70° 21.786′	146° 01.765′	54	32.6
HH-4	Chem	17-Aug-08	1610	70° 21.847′	146° 01.544′	-	32.9
	Biol	17-Aug-08	1635	70° 21.850′	146° 01.528	11	31.7
HH-5	Chem	17-Aug-08	1035	70° 21.865′	146° 01.622′	-	32.0
	Biol	17-Aug-08	1051	70° 21.870′	146° 01.652′	21	31.7
HH-6	Chem	17-Aug-08	1736	70° 21.883′	146° 01.748′	-	32.0
HH-7	Biol	17-Aug-08	1309	70° 21.870′	146° 01.606	-	32.6
	Chem	17-Aug-08	1355	70° 21.875′	146° 01.606′	9	31.7
HH-8	Biol	17-Aug-08	838	70° 21.842′	146° 01.633′	-	32.9
	Chem	17-Aug-08	928	70° 21.850′	146° 01.578′	37	31.4
HH-9	Chem	17-Aug-08	1205	70° 21.827′	146° 01.714′	-	31.1
	Biol	17-Aug-08	1236	70° 21.841′	146° 01.737′	30	32.6
HH-10	Biol	17-Aug-08	726	70° 21.880′	146° 01.758′	-	31.7
	Chem	17-Aug-08	748	70° 21.891′	146° 01.714′	34	31.7

Table 1.2. Sample locations and supporting information for the Sivulliq area within 250 m (L250) and between 250 and 500 m (L500) of the proposed drill site. Distances between grabs were calculated using coordinates for the chemistry and biology sites and equations from Byers (1997).

Station	Grab Type	Date	Time	Lat (N)	Long (W)	Distance between grabs (m)	Water Depth (m)
L250-1	Chem	18-Aug-08	1317	70° 21.436′	146° 07.427′	-	31.7
	Biol	18-Aug-08	1335	70° 21.436′	146° 07.397′	19	31.7
L250-2	Chem	18-Aug-08	846	70° 21.450′	146° 07.531′	-	32.0
	Biol	18-Aug-08	906	70° 21.454′	146° 07.490′	27	31.7
L250-3	Chem	18-Aug-08	923	70° 21.402′	146° 07.453′	-	32.0
	Biol	18-Aug-08	938	70° 21.400′	146° 07.375′	49	31.4
L250-4	Biol	18-Aug-08	950	70° 21.444′	146° 07.708′	-	32.0
	Chem	18-Aug-08	1006	70° 21.452′	146° 07.697′	16	30.8
L250-5	Chem	18-Aug-08	1028	70° 21.407′	146° 07.609′	-	31.4
	Biol	18-Aug-08	1048	70° 21.410′	146° 07.576′	12	31.1
L250-6	Chem	18-Aug-08	1203	70° 21.342′	146° 07.750′	-	31.7
	Biol	18-Aug-08	1305	70° 21.342′	146° 07.764′	9	31.4
L500-1	Biol	18-Aug-08	1352	70° 21.400′	146° 06.972′	-	30.8
	Chem	18-Aug-08	1412	70° 21.397	146° 06.993′	14	31.4
L500-2	Chem	18-Aug-08	752	70° 21.591′	146° 07.378′	-	31.4
	Biol	18-Aug-08	822	70° 21.575′	146° 07.334′	40	31.7
L500-3	Chem	18-Aug-08	721	70° 21.576′	146° 07.805′	-	31.4
	Biol	18-Aug-08	739	70° 21.580′	146° 07.831′	18	31.4
L500-4	Chem	18-Aug-08	646	70° 21.507′	146° 08.272′	-	32.6
	Biol	18-Aug-08	705	70° 21.528′	146° 08.221′	50	31.7
L500-5	Chem	18-Aug-08	1115	70° 21.393′	146° 07.062′	-	32.3
	Biol	18-Aug-08	1142	70° 21.412′	146° 07.039′	38	31.7
L500-6	Chem	18-Aug-08	1441	70° 21.282′	146° 07.568′	-	31.7
	Biol	18-Aug-08	1503	70° 21.284′	146° 07.545′	15	31.4

Table 1.3. Sample locations and supporting information for random sites in Camden Bay from a hexagonal (HEX) grid pattern. Distances between grabs were calculated using coordinates for the chemistry and biology sites and equations from Byers (1997).

Station	Grab Type	Date	Time	Lat (N)	Long (W)	Distance Between Grabs (m)	Water Depth (m)
HEX-1	Chem	20-Aug-08	713	70° 25.245	146° 10.830′	-	34.7
	Biol	20-Aug-08	744	70° 25.260′	146° 10.832′	28	34.7
HEX-2	Chem	21-Aug-08	629	70° 24.794′	146° 04.054′	-	35.1
	Biol	21-Aug-08	652	70° 24.806′	146° 04.037	25	35.4
HEX-3	Chem	19-Aug-08	1046	70° 24.512′	145° 58.249	-	34.7
	Biol	19-Aug-08	1106	70° 24.518′	145° 58.253′	11	34.4
HEX-4	Chem	19-Aug-08	1234	70° 25.131′	145° 49.908′	-	37.2
	Biol	19-Aug-08	1256	70° 25.151′	145° 49.870′	44	37.2
HEX-5	Chem	20-Aug-08	815	70° 23.801′	146° 11.118	-	33.2
	Biol	20-Aug-08	831	70° 23.797′	146° 11.131′	11	32.9
HEX-6	Chem	18-Aug-08	1652	70° 23.020′	146° 03.693′	-	33.5
	Biol	18-Aug-08	1721	70° 23.023′	146° 03.710	12	33.2
HEX-7	Chem	19-Aug-08	1004	70° 23.076′	145° 57.799′	-	32.9
	Biol	19-Aug-08	1021	70° 23.108′	145° 57.812′	60	32.9
HEX-8	Chem	19-Aug-08	921	70° 23.409′	145° 56.283′	-	35.1
	Biol	19-Aug-08	938	70° 23.401′	145° 56.278′	15	32.9
HEX-9	Chem	20-Aug-08	930	70° 21.269′	146° 09.680′	-	30.5
	Biol	20-Aug-08	957	70° 21.272′	146° 09.696′	11	30.8
HEX-10	Chem	18-Aug-08	1559	70° 22.203′	146° 06.291	-	31.1
	Biol	18-Aug-08	1627	70° 22.212′	146° 06.292′	17	32.6
HEX-12	Chem	19-Aug-08	805	70° 21.167′	145° 53.543′	-	32.0
	Biol	19-Aug-08	827	70° 21.165′	145° 53.587′	28	31.1
HEX-13	Biol	20-Aug-08	904	70° 20.635′	146° 12.150	-	29.9
	Chem	20-Aug-08	910	70° 20.603′	146° 12.084′	72	30.1
HEX-14	Chem	21-Aug-08	733	70° 20.548′	146° 05.912′	-	30.8
	Biol	21-Aug-08	753	70° 20.562′	146° 05.914′	26	31.4
HEX-15	Chem	21-Aug-08	900	70° 20.045′	146° 00.439′	-	30.5
	Biol	21-Aug-08	918	70° 20.049′	146° 00.480′	27	32.0
HEX-16	Chem	20-Aug-08	1046	70° 19.620′	146° 09.361	-	29.0
	Biol	20-Aug-08	1058	70° 19.616′	146° 09.321	26	29.4
HEX-17	Chem	21-Aug-08	824	70° 18.947′	146° 04.507′	-	29.1
	Biol	21-Aug-08	838	70° 18.944′	146° 04.418′	56	29.7
HEX-18	Chem	19-Aug-08	1321	70° 26.689′	145° 51.200′	-	37.8
	Biol	19-Aug-08	1335	70° 26.683′	145° 51.149′	34	38.1
HEX-19	Chem	19-Aug-08	1426	70° 27.089′	145° 47.383′	-	38.1
	Biol	19-Aug-08	1442	70° 27.088′	145° 47.388′	4	38.1
HEX-20	Biol	19-Aug-08	644	70° 22.547′	145° 52.792′	-	32.3
	Chem	19-Aug-08	657	70° 22.558′	145° 52.779′	22	32.6

Table 1.4. Sample locations and supporting information for sites along a possible pipeline route from the Sivulliq drill site in Camden Bay. Distances between grabs were calculated using coordinates for the chemistry and biology sites and equations from Byers (1997).

Station	Grab Type	Date	Time	Lat (N)	Long (W)	Distance Between Grabs (m)	Water Depth (m)
P-1	Chem	22-Aug-08	631	70° 18.480′	146° 13.381′	-	26.3
	Biol	22-Aug-08	651	70° 18.482′	146° 13.371′	7	26.0
P-2	Chem	22-Aug-08	834	70° 17.644′	146° 15.910′	-	23.3
	Biol	22-Aug-08	913	70° 17.640′	146° 15.973′	40	23.5
P-3	Chem	22-Aug-08	708	70° 17.311′	146° 13.099′	-	23.5
	Biol	22-Aug-08	722	70° 17.333′	146° 13.102	41	23.7
P-4	Chem	22-Aug-08	753	70° 17.260′	146° 15.007	-	23.5
	Biol	22-Aug-08	818	70° 17.259′	146° 15.076′	43	23.5
P-5	Biol	22-Aug-08	937	70° 16.737′	146° 16.952′	-	22.0
	Chem	22-Aug-08	946	70° 16.745′	146° 16.966′	40	21.8

Table 1.5. Locations and supporting information for 2008 water column stations in Camden Bay.

Station	Water	Date	Time	Lat (N)	Long (W)	Water Depth (m)
L250-1	Profile: Salinity Temp. pH, O_2 Turbidity Samples: TSS POC	20-Aug-08	1545	70° 21.399′	146° 07.249′	31.4
HEX-3		21-Aug-08	1600	70° 24.542′	145° 58.149	36.0
HEX-6		21-Aug-08	1330	70° 23′	146° 03′	32.9
HEX-16		20-Aug-08	1345	70° 19.563′	146° 09.294′	29.1
HEX-18		18-Aug-08	2000	70° 26.671′	145° 51.209′	38.4
HEX-19		18-Aug-08	1800	70° 27.049′	145° 47.433′	38.1
P-1		22-Aug-08	1700	70° 18.432′	146° 13.358′	25.6
P-5		22-Aug-08	1400	70° 16.733′	146° 16.924′	22.2

2.0. METHODS

2.1. Field Sampling and Initial Processing

Sampling in Camden Bay was carried out during August 17-22, 2008, from the MV *Arctic Seal*. Scientists John Trefry and Robert Trocine from Florida Institute of Technology (FIT) and Ken Dunton, Susan Schonberg and Nathan McTigue from the University of Texas (UT) participated in the survey.

Sediment samples were collected using a Van-Veen grab sampler. During the collection and handling of sediment samples from the grab sampler, extreme care was taken to avoid contact with metal and hydrocarbon sources. The sampler was cleaned daily using Alconox and followed by water and acetone rinses. Samples were taken away from the sides of the grab and metal spatulas were not used for the collection of trace metal samples. The grab sampler was protected from stack smoke, grease drips from winches and wire, and other potential airborne contamination during sampling. Surface sediment samples were collected from the top 1 cm of the grab to represent recent accumulation. The top 1 cm was collected by several scoops of the grab that were placed directly in the appropriate sample containers.

In-situ profiles of seawater temperature, depth, salinity, turbidity, pH and dissolved oxygen were obtained using a YSI Sonde 6600 instrument. Data from the Sonde were uploaded onto a portable field computer after each profile was obtained. The Sonde was factory calibrated prior to the field season and re-checked in the field each day.

Water samples were obtained using a peristaltic pumping system (Masterflex model 75-45-30 pump with high-capacity pump head) equipped with acid washed Tygon tubing attached to a Teflon weight. Approximately 10 L of water were discarded before the sample was pumped directly into an acid-washed 5-L plastic container. Water filtration was carried out aboard ship in a mobile chemistry lab. Water samples were vacuum filtered through polycarbonate filters (Poretics, 47-mm diameter, 0.4-µm pore size). Prior to the field effort, the filters were acid washed in 5N HNO_3, rinsed three times with distilled-deionized water (DDW), dried and then weighed to the nearest µg using a Sartorius Model M3P electronic balance under cleanroom conditions. Vacuum filtration on site was carried out using acid-washed glassware. The particle-bearing filters were sealed in acid-washed petri dishes, labeled and then double-bagged in plastic and stored until dried and re-weighed at FIT using the Sartorius Model M3P balance.

2.2. Laboratory Analysis

2.2.1. Sediment Metal Analysis

Sediment metal analyses were carried out at FIT. Sediment samples were initially brought to room temperature; then, each wet sediment sample was homogenized in the original 75-mL plastic vial using a Teflon mixing rod. Approximately 20 g of sediment were transferred into pre-weighed plastic vials to determine water content (water content data are in Appendices on CD). Once transferred, the wet sediment and the vial were re-weighed. In addition, 2 to 4 g of homogenized sample were transferred into glass centrifuge tubes to determine the total Hg content of the sediments. The portion used for determining water content was frozen, freeze-dried, and re-weighed. The dried sediment samples were again homogenized using a Teflon mixing rod.

About 0.4 gram of each freeze-dried, homogenized sediment sample and Standard Reference Material (SRM) #2709 (San Joaquin soil with certified Ba value) provided by the National Institute of Standards and Technology (NIST) were totally digested in Teflon beakers using concentrated, high-purity hydrofluoric acid (HF), nitric acid (HNO_3) and perchloric acid ($HClO_4$). Complete digestion of the sediment (EPA Method 3052) was chosen because it accounts for the entire amount of metal in the sample and better facilitates identification of anthropogenic metal inputs, as described in the results and discussion. If metal contamination is identified, then additional chemical analyses that seek to determine concentrations of bioavailable metals are recommended. In the digestion process, 1 mL $HClO_4$, 3 mL HNO_3, and 3 mL HF were added to the sediment in the Teflon beaker, covered with a Teflon watch cover, and heated at 50°C until a moist paste formed. The mixture was heated for another 3 hours at 80°C with an additional 3 mL HNO_3 and 3 mL HF before bringing the sample to dryness. Finally, 1 mL HNO_3 and ~30 mL of distilled-deionized water (DDW) were added to the sample and heated strongly to dissolve perchlorate salts and reduce the volume. The completely dissolved and clear samples were diluted to 20 mL with DDW and stored in 30-mL, low-density, polyethylene screw-cap bottles.

Sediment total Hg analyses were carried out using wet samples to prevent the loss of Hg during drying. The total Hg results presented in the data tables have been converted to dry weight values based on the percent water loss calculated from the freeze-dried sub-samples used in the digestions for the remaining metals. Sediments to be analyzed for Hg were digested by heating 2 to 4 grams of wet sediment in acid-washed, 50-mL glass centrifuge tubes with 4 mL, concentrated, high-purity, HNO_3 and 2 mL, concentrated high purity, sulfuric acid (H_2SO_4). Two samples of the Certified Reference Material (CRM) sediment MESS-3, provided by the National Research Council of Canada (NRC), were prepared with each batch of samples digested. Sample tubes were heated for 1 hour in a 90°C water bath and allowed to cool. Each tube was centrifuged at 2,000 rpm and the supernatant decanted into a 25-mL graduated cylinder. The sediment pellet was rinsed twice by resuspension in 5 mL DDW, centrifuged, and the rinses decanted into the graduated cylinder before diluting to a final volume of 20 mL with DDW. The sediment solutions were stored in 20-mL, high-density, polyethylene screw-cap bottles.

Labware used in the digestion process was acid-washed with hot 8 N HNO_3 and rinsed three times with DDW. Two procedural blanks, two duplicate samples, and two portions of the SRM or CRM were prepared with each batch of samples digested.

Sediment samples, reference materials, and procedural blanks were analyzed by flame atomic absorption spectrometry (FAAS), cold vapor atomic absorption spectrometry (CVAAS), or inductively coupled plasma-mass spectrometry (ICP-MS). Concentrations of Al, Cr, Cu, Fe, Mn and Zn were determined by FAAS using a Perkin-Elmer Model 4000 atomic absorption spectrometer following U.S. EPA Methods 7020, 7190, 7210, 7380, 7460, 7910 and 7950, respectively. The concentrations of Ag, As, Ba, Cd, Pb and Se were quantified by ICP-MS based on EPA Method 6020 using a Varian Model 820-MS instrument with Collision Reaction Interface (CRI) and SPS3 sample preparation system. Sediment total Hg concentrations were determined by CVAAS (EPA Method 7471A) using a Laboratory Data Control Model 1235 Mercury Monitor. In all cases, the manufacturers' specifications were followed and adherence to QA/QC requirements was maintained. The method used for each element and the corresponding method detection limits (MDLs) are given in Table 2-1. All analytical techniques followed manufacturers' specifications and SOPs on file at FIT.

2.2.2. Grain Size

Grain size analyses were carried out using the classic method of Folk (1974) that includes a combination of wet sieving and pipette techniques. Initially, 10 to 30 g of wet sediment were

Table 2.1. List of instrumental methods and method detection limits (MDL) for metals and total organic carbon (TOC) in sediments for this study.

Sediment		
Metal	**Method**	**MDL (µg/g)**
Ag – silver	ICP-MS	0.007
Al – aluminum	FAAS	10
As – arsenic	ICP-MS	0.02
Ba – barium	ICP-MS	0.01
Cd – cadmium	ICP-MS	0.001
Cr – chromium	FAAS	1
Cu – copper	FAAS	0.8
Fe – iron	FAAS	10
Hg – mercury	CVAAS	0.001
Mn – manganese	FAAS	2
Pb – lead	ICP-MS	0.002
Se – selenium	ICP-MS	0.02
V – vanadium	FAAS	8
Zn – zinc	FAAS	2
TOC	Shimadzu Carbon System	0.03%

Notes: CVAAS = Cold Vapor Atomic Absorption Spectrometry
FAAS = Flame Atomic Absorption Spectrometry
ICP-MS = Inductively Coupled Plasma/Mass Spectrometry

placed in a wide-mouth dish using a larger mass for sandy samples and a smaller mass for muddy samples. The sample was first poured through 2 mm (gravel) and 63 µm (sand) sieves and rinsed until the water was clear. The sediment on each sieve was washed into separate beakers, allowed to settle and the overlying, clear water was decanted. The weighed beakers were dried at ~105°C and re-weighed. A glass bottle containing the sieved, muddy water (<63 µm) was shaken for about 15 minutes and gently poured into a 1-L cylinder. The cylinder was stirred vigorously with a stirring rod and a timer was started as soon as the rod was removed. After 20 seconds, 20 mL of sample were withdrawn from a depth of 20 cm using a Class A pipette. The pipette sample was drained into a weighed beaker, dried at ~105°C for 24 hours, and weighed for total silt + clay. After 2 hours and 3 minutes, 20 mL of sample was withdrawn from a depth of 10 cm using a Class A pipette. This pipette sample was drained into a weighed beaker, dried at 105°C for 24 hours, and weighed for total clay. All masses were determined to the nearest 0.0001 g.

2.2.3. Total Organic Carbon

A 0.5 to 1 gram portion of the freeze-dried sediment was placed in a 10-mL Pyrex beaker. Then, 1 mL of DDW and 2 mL of concentrated hydrochloric acid (HCl) were added to remove any inorganic carbon present. The sediment was dried at 60°C and re-weighed to determine the increase in weight due to the formation of hydrated calcium chloride ($CaCl_2 \cdot 2H_2O$) from the addition of HCl. Then, approximately 200 to 400 mg of pre-treated sediment were weighed into ceramic boats and combusted at 900°C in a Shimadzu TOC-5050A carbon system with SSM-5000A solid sampling module at FIT following the manufacturer's instructions. The total organic carbon (TOC) content of the sediment samples was determined using a four-point calibration curve with pure sucrose as the standard. The TOC concentrations were corrected to account for the increase in sediment mass following the addition of HCl. The calibration curve was checked every 10 samples by analyzing the CRM MESS-3, a marine sediment.

2.2.4. Particulate Organic Carbon

Samples for particulate organic carbon (POC) were prepared by filtration of seawater in the field through pre-combusted Gelman Type A/E glass fiber filters mounted on acid-washed filtration glassware. The POC filters were sealed in acid-washed petri dishes, labeled, double bagged in plastic and then stored frozen until dried at FIT.

At FIT, the POC filters were treated with H_3PO_4 to remove inorganic carbon phases, rinsed with DDW, dried and their particulate mass determined. The filters were then placed in ceramic boats and combusted at 900° C in a Shimadzu TOC-5050A carbon system with SSM-5000A solid sampling module following the manufacturer's instructions. The POC content of the samples was determined using a four-point calibration curve with pure sucrose as the standard. The calibration curve was checked every 10 samples by analyzing the CRM MESS-3.

2.2.5. Excess ^{210}Pb and total ^{137}Cs in Sediments

Samples from sediment cores were analyzed for excess ^{210}Pb and total ^{137}Cs at FIT to determine sedimentation rates. Age dating using ^{137}Cs (half-life = 30.1 yrs) is based on the fact that this isotope was first introduced to Earth during atmospheric bomb testing in the early 1950s. The ^{137}Cs reached the Earth as fallout and accumulated in marine sediments. The depth just below where ^{137}Cs is detected in a sediment core is assumed to date to ~1950. In contrast, ^{210}Pb (half-life 22.3 yrs) is a naturally occurring isotope that forms from the decay of ^{226}Ra via ^{222}Rn. Some ^{210}Pb is introduced to the atmosphere through its parent radionuclide ^{222}Rn. This ^{210}Pb reaches Earth as fallout and, like ^{137}Cs, is deposited in sediments and is referred to as unsupported or excess ^{210}Pb. This excess ^{210}Pb decays away over about 4 to 5 half-lives (~80 to 100 years) with increasing depth in the sediment column. The decrease in amount of excess ^{210}Pb in the sediment column can be directly converted to a sediment age.

Approximately 8 to 10 grams of freeze dried sediment were ground to a fine powder using a Spex 8000 mixer mill. The samples were then tightly packed into a 2 cm diameter, 5 cm long polycarbonate vial to a depth of 3 cm. A rubber stopper was used to seal the vial and was cemented into place with two-part epoxy to prevent leakage of ^{222}Rn and disruption of secular equilibrium between ^{226}Ra and ^{210}Pb. The samples were then set aside for at least 20 days to establish secular equilibrium and the activities of the various radionuclides were then determined by counting.

For counting, the sealed vial was placed in a well-type intrinsic germanium detector (WiGe, Princeton Gamma Tech Model IGW11023). Each sample was counted for 2 to 3 days or until there were >1000 net counts for ^{210}Pb. The peaks monitored for the purposes of this study were as follows: ^{210}Pb at 46.5 KeV, ^{214}Pb at 295.2 KeV and 351.9 KeV, ^{214}Bi at 609.3 KeV, and ^{137}Cs at 661.6 KeV. The ^{226}Ra daughter isotopes ^{214}Pb (2 peaks) and ^{214}Bi were used to determine the activity of ^{226}Ra. The activity of excess ^{210}Pb was calculated by subtracting the A(^{214}Pb, ^{214}Bi) from the A(^{210}Pb). Detector efficiency and counting accuracy were standardized using standard reference river sediment 4350B (^{137}Cs) from the NIST and RGU-1 (^{210}Pb) from the International Atomic Energy Agency. The specific activity [decompositions per minute per gram (dpm/g)] of each sediment sample was calculated from the detector efficiency, gamma intensity, geometry factor and sample weight (Kang et al., 2000). All values are reported as the activity on the date of sampling. Errors were based on 1-sigma counting statistics.

For cores with reliable data, as described in the results, sedimentation rates (S) in cm/yr were calculated using the following equations:

^{137}Cs:

$$S = \frac{\text{Depth in cm at which Activity } ^{137}\text{Cs} = \text{zero}}{[\text{Year} - (1950)] \text{ in years}}$$

^{210}Pb:

$$S = \frac{(-)\text{ decay constant for } ^{210}\text{Pb-210 } (0.0311\text{ yr}^{-1})}{\text{Slope for plot of natural logarithm (ln) excess } ^{210}\text{Pb vs. sediment depth}}$$

2.2.6. Extraction of Sediments for Aliphatic, Aromatic and Total Petroleum Hydrocarbons

Sediment analyses for organic substances were carried out by B&B Laboratories in College Station, Texas. Standard operating procedure 1003 (B&B Laboratories method follows EPA Method 8270C) was used for extraction, isolation, and concentration of selected organic compounds from sediment samples. Final extracts were used in the quantitative determination of PAHs, aliphatic hydrocarbons, and TPH by chromatographic procedures. This procedure also was used to extract sediment samples for gravimetric determination of extractable organic material (EOM).

An automated extraction apparatus (Dionex ASE200 Accelerated Solvent Extractor) was used to extract various organics from 1 to 15 g of pre-dried sample. The extractions were performed using 100% dichloromethane inside stainless-steel extraction cells held at elevated temperature and solvent pressure. The extracted compounds dissolved in the hot solvent were collected in 60-mL glass vials. Extracts were concentrated to 1 to 3 mL, using a water bath, and if necessary, processed through a clean-up column in order to minimize matrix interference. Extracts were then concentrated to a final volume of 1 mL and submitted for determination of TPH, aliphatic and aromatic hydrocarbon analytes using B&B SOPs 1013, 1016, 1006, 1042, and 1007, respectively. These methods follow U.S. EPA Methods 8270C.

2.2.7. Aliphatic Hydrocarbon Determination by Gas Chromatography/Flame Ionization Detection

Concentrations of the aliphatic hydrocarbons listed in Table 2.2 were determined for sediment extracts by high resolution, capillary gas chromatography with flame ionization detection (GC/FID). The list (Table 2.2) includes normal alkanes with 8 to 40 carbons (C_8 to C_{40}), selected isoprenoids, Total Petroleum Hydrocarbons (TPH), the Total Resolvable Hydrocarbons (TRH) and the Unresolved Complex Mixture (UCM). The gas chromatograph was temperature-programmed and operated in split mode. The capillary column was a Restek Scientific RTX-1 (30 m long by 0.25 mm ID and 0.25 μm film thickness). Carrier flow was regulated by electronic pressure control. The auto-sampler was capable of making 1 to 5 μL injections. Dual columns and FIDs were used. The data acquisition system was by HP Chemstation software, capable of acquiring and processing GC data.

A calibration curve was established by analyzing each of 5 calibration standards (1.25, 10, 25, 40 and 50 μg/mL), and fitting the data to a straight line using the least square technique. For each analyte of interest, a response factor (RF) was determined for each calibration level. All 5 response factors were averaged to produce a mean relative response factor for each analyte. If an individual aliphatic hydrocarbon was not in the calibration solutions, an RF was estimated from the average RF of the hydrocarbon eluting immediately before the compound. The RF for TPH, TRH, and UCM were determined by averaging the response factor from each of the five calibration standards for five n-alkanes ranging from n-C11 to n-C34.

Table 2.2. List of target compounds for aliphatic and aromatic hydrocarbons.

Aliphatic Hydrocarbons
$n-C_{10}$
$n-C_{11}$
$n-C_{12}$
$n-C_{13}$
$n-C_{14}$
$n-C_{15}$
$n-C_{16}$
$n-C_{17}$
Pristane (Pr)
$n-C_{18}$
Phytane (Ph)
$n-C_{19}$
$n-C_{20}$
$n-C_{21}$
$n-C_{22}$
$n-C_{23}$
$n-C_{24}$
$n-C_{25}$
$n-C_{26}$
$n-C_{27}$
$n-C_{28}$
$n-C_{29}$
$n-C_{30}$
$n-C_{31}$
$n-C_{32}$
$n-C_{33}$
$n-C_{34}$
CPI*
Total Petroleum Hydrocarbons
Total Resolved Hydrocarbons
Unresolved complex mixture

Polycyclic Aromatic Hydrocarbons
Naphthalene*
C1-C4 Naphthalenes*
Benzothiophene
C1-C3 Benzothiophenes
Biphenyl
Acenaphthylene*
Acenaphthene*
Dibenzofuran
Fluorene*
C1-C3 Fluorenes*
Carbazole
Anthracene
Phenanthrene*
C1-C4 Phenanthrene/Anthracenes*
Dibenzothiophene*
C1-C3 Dibenzothiophene*
Fluoranthene†
Pyrene†
C1-C3 Fluoranthenes/Pyrenes*
Naphthobenzothiophene
C1-C3 Naphthobenzothiophenes
Benz(a)anthracene†
Chrysene†
C1-C4 Chrysenes*
Benzo(b)fluoranthene†
Benzo(k)fluoranthene†
Benzo(e)pyrene
Benzo(a)pyrene†
Perylene
Indeno(1,2,3-c,d)pyrene†
Dibenzo(a,h)anthracene†
Benzo(g,h,i)perylene†
Total Polycyclic Aromatic Hydrocarbons
Individual Alkyl Isomers and Hopanes
2-Methylnaphthalene
1-Methylnaphthalene
2,6-Dimethylnaphthalene
1,6,7-Trimethylnaphthalene
1-Methylphenanthrene
C29-Hopane
18a-Oleanane
C30-Hopane

*included in sum for petrogenic PAH.
†included in sum for pyrogenic PAH.

*Carbon Preference Index (CPI) = $[C_{21,23,25,27,29,31}/C_{22,24,26,28,30,32}]$

An analytical set consisted of standards, samples, and quality control samples. Each extraction batch was analyzed as an analytical set including samples and some or all of the following quality control samples: method blank, duplicate, matrix spike, matrix spike duplicate and standard reference material.

2.2.8. Aromatic Hydrocarbon Determination by Selected Ion Monitoring – Gas Chromatography/Mass Spectrometry

The quantitative method for determining concentrations of the polycyclic aromatic hydrocarbons (PAHs) and their alkylated homologues listed in Table 2.2 is outlined below and follows U.S. EPA method 8270C. Quantitation was performed by capillary gas chromatography/mass spectrometry (GC/MS) in selected ion monitoring mode (SIM). The gas chromatograph was temperature-programmed and operated in splitless mode. The capillary column was an Agilent Technologies HP-5MS (60 m long by 0.25 mm ID and 0.25 μm film thickness). Carrier flow was by electronic pressure control. The autosampler was capable of making 1 to 5 μL injections. The mass spectrometer was capable of scanning from 35 to 500 AMU every second or less in the electron impact ionization mode. The data acquisition system allowed continuous acquisition and storage of all data during analysis and was capable of displaying ion abundance versus time or scan number.

Calibration solutions were prepared at five concentrations ranging from 0.02 to 1 μg/mL by diluting a commercially available solution containing the analytes of interest (NIST SRM 2260). For each analyte of interest, a relative response factor (RRF) was determined for each calibration level. The 5 response factors were then averaged to produce a mean relative response factor for each analyte.

An analytical set consisted of standards, samples, and quality control samples. Each extraction batch was analyzed as an analytical set including samples and some or all of the following quality control samples: method-blank, duplicate, matrix-spike, matrix-spike duplicate, and/or blank spike, blank spike duplicate and SRM.

2.3 Quality Assurance and Quality Control

A quality assurance (QA) plan, which included quality control (QC) measures, was employed for the program. This section presents some key elements of the plan.

For this project, QC measures included balance calibration, instrument calibration (FAAS, CVAAS, ICP/MS, GC/MS, GC/FID, TOC analyzer, turbidimeters, and *in-situ* instrument sensors), matrix spike analysis for each analyte, duplicate sample analysis, SRM analysis, procedural blank analysis and standard checks. With each batch of up to 40 samples, 2 procedural blanks, 2 SRMs, 2 duplicate samples and 2 matrix-spiked samples were analyzed.

Electronic balances used for weighing samples and reagents were calibrated prior to each use with certified (NIST-traceable) standard weights. All pipets (electronic or manual) were calibrated prior to use. Each of the spectrometers used for metals analysis was initially standardized with a three- to five-point calibration with a linear correlation coefficient of r^2 0.999 required before experimental samples could be analyzed. Analysis of complete three- to five-point calibrations and/or single standard checks alternated every 5 to 10 samples until all of the analyses were complete. The RSD between complete calibration and standard check was required to be <15 percent or recalibration and reanalysis of the affected samples was performed.

Matrix spikes were prepared for a minimum of 5% of the total number of samples analyzed and included each analyte. Results from matrix spike analysis using the method of standard additions provide information on the extent of any signal suppression or enhancement due to the sample matrix. If necessary (i.e., spike results outside 80 to 120% limit), spiking frequency was increased to 20% and a correction applied to the metal concentrations of the experimental samples.

Duplicate samples from homogenized field samples (as distinct from field replicates) were prepared in the laboratory for a minimum of 5% of the total samples. These laboratory duplicates were included as part of each set of sample digestions and analyses and provided a measure of analytical precision.

Two procedural blanks were prepared with each set of 40 samples to monitor potential contamination resulting from laboratory reagents, glassware, and processing procedures. These blanks were processed using the same analytical scheme, reagents, and handling techniques as used for the experimental samples.

A common method used to evaluate the accuracy of environmental data is to analyze SRMs, samples for which consensus or "accepted" analyte concentrations exist. The SRM and CRM used were previous identified. Metal concentrations obtained for the SRMs were required to be within $\pm$20% of accepted values for >85% of other certified analyses. When no certified values existed, matrix spikes were used to evaluate analytical accuracy.

Throughout the field surveys, field notes were maintained by the scientists in log books and on station logs. Exceptions to procedures specified in the sampling and analysis plans, if any, were recorded on the forms. Data quality objectives and criteria and results for QA/QC measurements for each data set are given along with the complete data set in the Appendices.

3.0. RESULTS AND DISCUSSION

3.1. Overview

The following presentation and discussion of chemical data for sediments from the 2008 survey of the Chukchi Sea is structured to achieve the objectives listed below:

(1) Develop a baseline data set for selected metals and organic substances in sediments from Camden Bay.

(2) Determine whether established techniques for identifying contaminated sediments in the coastal Beaufort Sea (e.g., Trefry et al., 2003) can be applied in Camden Bay and whether these techniques can be used to identify any contamination in sediments from the 1985 Hammerhead Drill Site or be applied at future development sites in Camden Bay or the coastal Beaufort Sea.

(3) In combination with the biological portion of this study (Dunton et al., 2009) and within the limitations of available sediment quality criteria, assess the ecological implications for any sediment contamination identified in Camden Bay.

The complete data set is available in Appendices that are stored on CD and available through Shell Exploration & Production Co., Anchorage, or the authors.

3.2. Metals in Sediments

Average concentrations of metals in sediments from baseline stations in the HEX, L250, L500 and P area of the 2008 study of Camden Bay were relatively uniform (Table 3.1) and well within the range of concentrations previously reported for the coastal Alaskan Beaufort Sea (Table 3.2). For example, concentrations of Al in sediments from this 2008 study of Camden Bay (Figure 3.1) had a relative standard deviation (RSD = [standard deviation/mean] x 100%) of 11% (Table 3.1). For the HEX, L250, L500 and P stations, the RSD values for Ag, Al, Ba, Cd, Cr, Cu, Fe, Pb, V and Zn also were low with a range of 11 to 14% (Table 3.1). The relative uniformity in metal concentrations is due to the generally consistent texture (grain size) of the sediments within the limited geographic setting for the 2008 study of Camden Bay (Figure 1.3). Furthermore, average concentrations of metals for sediments from HEX, L250, L500 and P stations in Camden Bay were at concentrations that were equivalent to or lower than typical values for average marine sediments or continental crust, with the exceptions of Ag and As (Table 3.2). Trefry et al. (2003) showed that the somewhat higher values for Ag and As are background levels for the coastal Beaufort Sea (Table 3.2).

Based on previous studies, metal concentrations for a much broader 300 km stretch of the coastal Beaufort Sea from Camden Bay to Harrison Bay showed greater variability than observed in the present study with RSDs from 35 to 50% (Table 3.2) and ranges in concentrations that sometimes varied by more than a factor of 10 (Table 3.2). Variability in

Table 3.1. Summary data for metals in surface sediments from the HEX, L250, L500 and P areas and for the cumulative data set for these four areas. SD = standard deviation and RSD = relative standard deviation. TOC = Total Organic Carbon.

Area	Statistic	Ag (µg/g)	Al (%)	As (µg/g)	Ba (µg/g)	Cd (µg/g)	Cr (µg/g)	Cu (µg/g)	Fe (%)	Hg (µg/g)	Mn (µg/g)	Pb (µg/g)	Se (µg/g)	V (µg/g)	Zn (µg/g)	TOC (%)
HEX Random Stations (n = 19)	Mean	0.14	5.76	16.3	635	0.23	77.3	21.0	2.99	0.049	336	15.2	0.35	123	87.2	0.77
	SD	0.02	0.58	3.0	54	0.02	7.6	2.9	0.27	0.011	52	1.6	0.05	15	9.1	0.19
	Max	0.18	6.78	20.8	708	0.28	90.4	27.4	3.49	0.083	473	18.4	0.46	152	105	1.31
	Min	0.12	4.54	9.6	493	0.19	60.0	15.3	2.49	0.031	289	11.8	0.27	94	70.3	0.55
L250 (n = 6)	Mean	0.12	5.90	16.4	635	0.19	81.7	22.0	2.96	0.047	336	14.9	0.30	128	92.4	0.72
	SD	0.02	0.18	3.8	18	0.01	4.6	1.1	0.08	0.003	29	0.7	0.03	3	1.7	0.08
	Max	0.15	6.06	21.1	661	0.21	89.6	24.1	3.12	0.053	373	15.9	0.34	131	95.5	0.85
	Mean	0.10	5.58	11.2	613	0.17	77.1	21.1	2.90	0.044	288	14.3	0.25	124	90.5	0.62
L500 (n = 6)	Mean	0.11	5.84	15.3	614	0.19	78.3	21.5	2.96	0.045	428	14.1	0.29	124	88.5	0.71
	SD	0.01	1.04	4.4	90	0.03	12.5	4.2	0.45	0.010	129	2.7	0.03	24	15.3	0.14
	Max	0.13	7.21	21.8	714	0.24	95.8	26.7	3.56	0.055	584	17.6	0.35	156	108	0.95
	Min	0.10	4.23	11.7	456	0.16	59.3	15.1	2.27	0.028	287	9.9	0.26	87	64.5	0.53
P (n = 5)	Mean	0.13	5.76	13.3	574	0.26	82.8	24.4	3.01	0.060	464	14.6	0.40	122	91.4	0.95
	SD	0.02	0.85	2.8	81	0.03	9.8	3.2	0.43	0.009	149	2.7	0.19	20	10.3	0.22
	Max	0.16	6.63	17.0	668	0.31	92.4	27.4	3.49	0.070	17.4	17.4	0.62	143	103	1.16
	Min	0.12	4.68	9.5	486	0.23	71.9	20.7	2.48	0.046	11.2	11.2	0.25	96	80.1	0.68
HEX, L250, L500, P (n = 36)	Mean	0.13	5.78	15.6	623	0.22	78.7	21.6	2.97	0.05	368	14.8	0.35	123	88.4	0.77
	SD	0.02	0.64	3.5	61	0.03	8.3	3.1	0.30	0.01	93	1.8	0.09	16	9.7	0.17
	RSD (%)	14	11	22	10	14	11	14	10	21	25	12	27	13	11	31

Table 3.2. Summary data for metals in surface sediments from the cumulative data for (1) the HEX, L250, L500 and P areas (excluding HH stations) in this study, (2) the coastal Alaskan Beaufort Sea, (3) average marine sediments and (4) average continental crust. SD = standard deviation and RSD = relative standard deviation.

Area	Statistic	Ag (µg/g)	Al (%)	As (µg/g)	Ba (µg/g)	Cd (µg/g)	Cr (µg/g)	Cu (µg/g)	Fe (%)	Hg (µg/g)	Mn (µg/g)	Pb (µg/g)	Se (µg/g)	V (µg/g)	Zn (µg/g)
HEX, L250, L500, P (n = 36)	Mean	0.13	5.78	15.6	623	0.22	78.7	21.6	2.97	0.05	368	14.8	0.35	123	88.4
	SD	0.02	0.64	3.5	61	0.03	8.3	3.1	0.30	0.01	93	1.8	0.09	16	9.7
	RSD (%)	14	11	22	10	14	11	14	10	21	25	12	27	13	11
	Max	0.18	7.21	21.8	714	0.31	95.8	27.4	3.56	0.083	622	18.4	0.62	156	108
	Min	0.10	4.23	9.5	456	0.16	59.3	15.1	2.27	0.028	287	9.9	0.25	87	64.5
Coastal Alaskan Beaufort Sea[1] (n = 241)	Mean	0.10	3.81	10.3	414	0.19	58.8	17.7	2.21	0.039	325	9.7	-		69.9
	SD	0.05	1.44	3.6	146	0.09	21.3	8.8	0.77	0.021	131	4.0	-		27.3
	RSD (%)	50	38	35	35	47	36	50	35	54	40	41	-		39
	Max	0.42	7.26	23.2	863	0.75	104	45.8	3.91	0.113	789	21.5	-		136
	Min	0.01	1.06	1.0	142	0.03	12.7	3.6	0.72	0.003	62	2.8	-		15
Average Marine Sediments[2]		0.06	7.2	7.7	460	0.17	72	33	4.1	0.19	770	19	0.42		95
Average Continental Crust[3]		0.07	8.0	1.7	584	0.1	126	25	4.3	0.04	716	15	0.12		65

[1]Trefry et al. (2003) and Brown et al. (2004, 2009)
[2]Salomons and Förstner (1985)
[3]Wedepohl (1995)

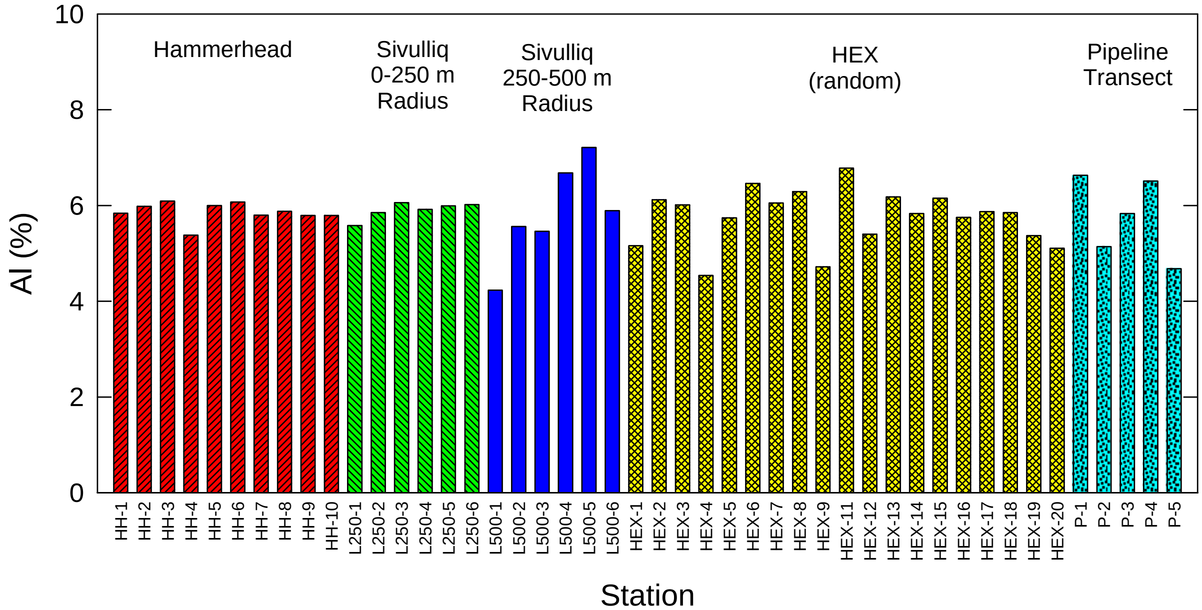
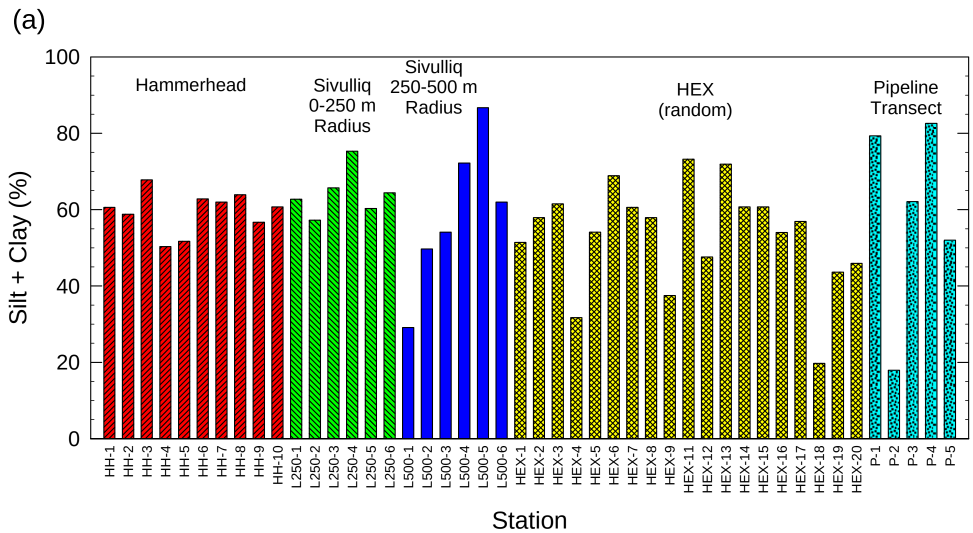


Figure 3.1. Concentrations of total Al for surface sediments in Camden Bay.

metal concentrations can result from natural differences in grain size, mineralogy, organic matter content, natural diagenetic reactions and anthropogenic inputs. Therefore, these factors must be considered collectively in any attempt to explain metal distribution or to identify the presence of anthropogenic metals in sediments.

Crecelius et al. (1991) showed that sediment grain size was a primary variable controlling metal concentrations in surface sediment from the coastal Beaufort Sea where levels of silt plus clay averaged 42 ± 25% and ranged from 5 to 86%. Concentrations of silt + clay in surface sediments from the 2008 study of Camden Bay averaged 59 ± 12% and ranged from 18% at station P-2 to 87% at station L500-5 (Figure 3.2a). The higher average fraction of silt + clay in Camden Bay during this study than in previously studied areas of the coastal Beaufort Sea is most likely due to the greater distance from shore (~15 to 25 km for the 2008 Camden Bay study area versus <1 to perhaps 15 km in previous studies). Transport of fine-grained sediments and less sand to offshore areas, relative to nearshore areas, often leads to the trends described above.

Observed variations in concentrations of metals were directly related to variations in sediment grain size as shown for Al in surface sediments in Figure 3.2b. The finer-grained material with a higher % silt + clay was richer in Al-bearing clay minerals whereas the coarser grained sediment contained Al-poor quartz sands and carbonate shell fragments. Concentrations of carbonate (mostly from shells) also influence metal values as carbonate typically has very low metal concentrations. In this study, concentrations of carbonate averaged 7.0 ± 2.4% and ranged from 4% at station HH-5 to 17% at station P-5 (Figure 3.3a).



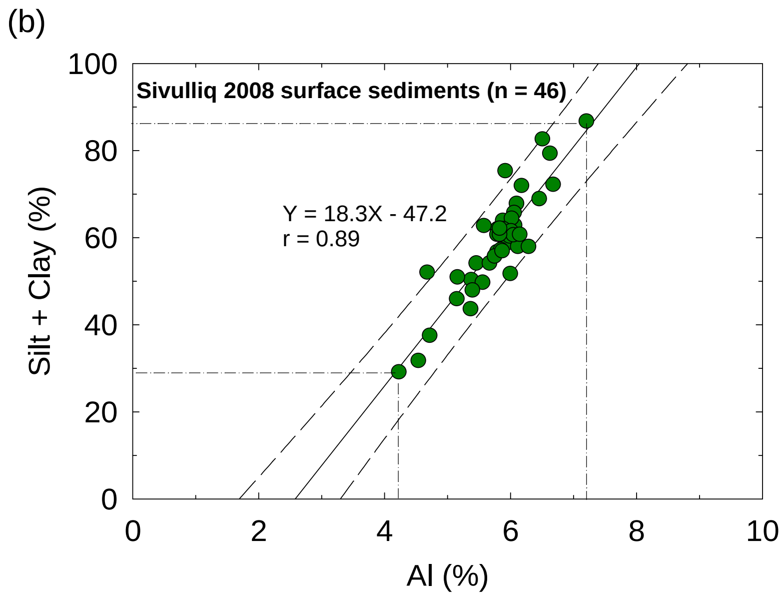


Figure 3.2. Values for (a) silt + clay and (b) silt + clay versus Al for surface sediments from the 2008 study area. Solid line in (b) is from a linear regression, dashed lines show 95% prediction interval, r is the correlation coefficient. Dash-dot lines highlight increased Al values with corresponding increases in silt + clay content.

The total organic carbon (TOC) content of the surface sediments averaged 0.77 ± 0.17% and ranged from 0.53% at station L500-1 to 1.3% at station HEX-7 (Figure 3.3b). With low values and a small range in concentrations, the influence of carbonate and organic matter on metal concentrations in this study was probably minor. Concentrations of metals that are enriched in plankton and other organic matter relative to sediments, including Ag, As, Cd, Hg and Se, can be higher when sediments are more organic rich. Loss on ignition (LOI) at

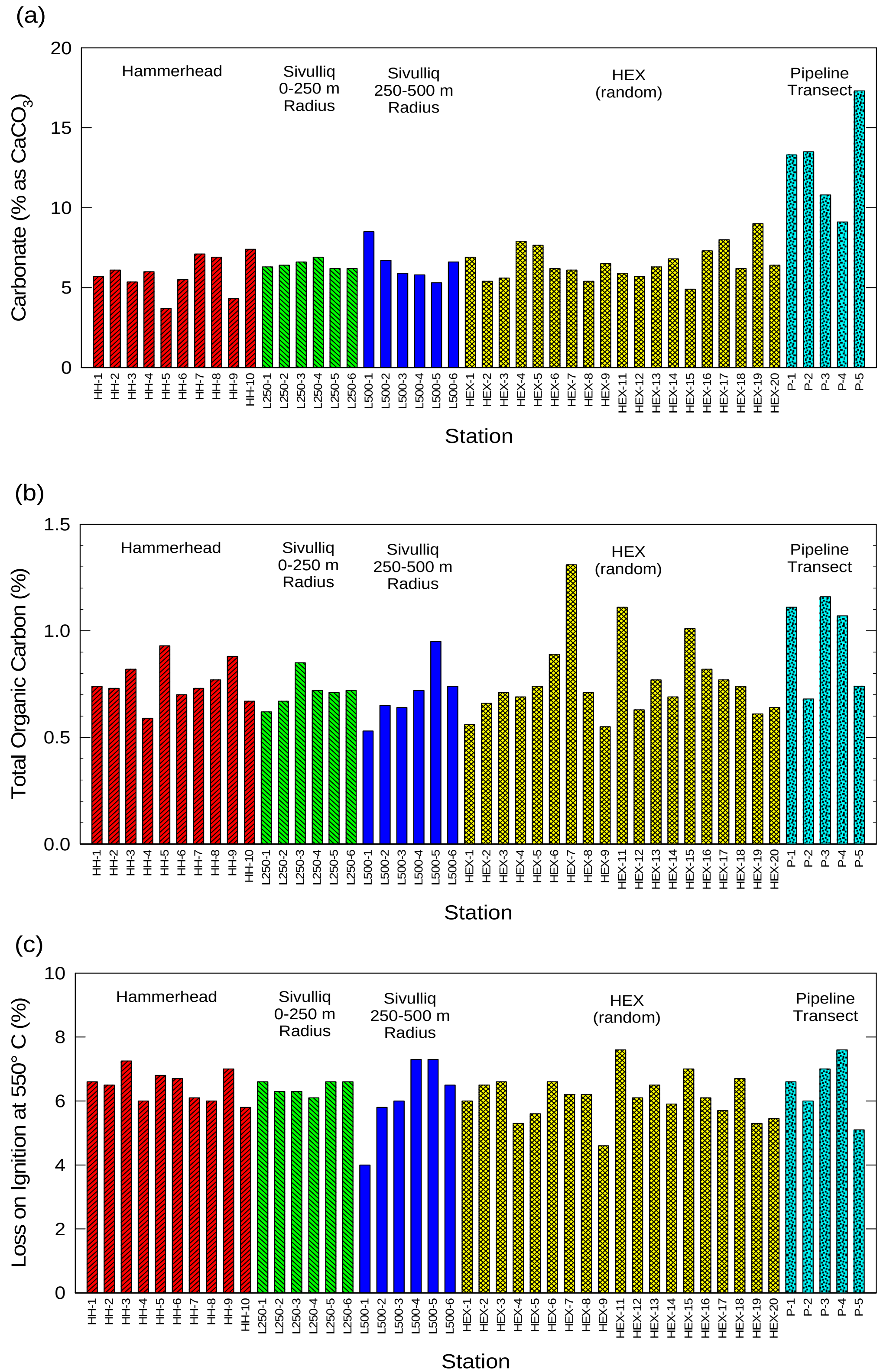


Figure 3.3. Values for (a) carbonate, (b) total organic carbon and (c) loss on ignition at 550° C for surface sediments from the 2008 study area in Camden Bay.

550° C has sometimes been used as a proxy for TOC in sediments, thus both measurements were made in this study. Values for LOI in surface sediments were relatively uniform at 6.3 ± 0.7%, about 8 times higher than values for TOC because the LOI values includes O, H and other elemental components of organic matter (not included in the TOC value) as well as water that is not released from clays until temperatures are >200 or 300°C. Burone et al. (2003) made measurements of both LOI and TOC for sediments from a bay in southeastern Brazil and found the following relationship:

$$\text{TOC (\%)} = (-0.256) + (0.151)(\text{LOI in \%})$$

Using an average of 6.3% LOI for data from the 2008 study of Camden Bay, the equation from Burone et al. (2003) yields a TOC value of 0.70, relatively close to our average TOC value of 0.77%.

Similar to the observation for Al, concentrations of Fe in surface sediments from Camden Bay were relatively uniform at 3.0 ± 0.3 % (Figure 3.4a). Despite relatively narrow ranges in concentrations of Al and Fe, a linear plot for the two metals yielded a correlation coefficient (r) of 0.94 (Figure 3.4b). The corresponding linear regression line is not shown on Figure 3.4b. Instead, the linear regression line and 99% prediction interval shown on Figure 3.4b are from 1999-2002 data for the coastal Beaufort Sea (Trefry et al., 2003). The linear regression line and prediction interval from 196 samples in the coastal Beaufort Sea on Figure 3.4b have been used to effectively delineate background concentrations of both Fe and Al in the coastal Beaufort Sea (Trefry et al., 2003). All data points for Fe and Al in surface and subsurface sediments from the 2008 Camden Bay study plotted within the 99% prediction interval developed for these two metals using 1999 to 2002 data from coastal Beaufort Sea (Figure 3.4b). Thus, based on Al and Fe, the sediments in Camden Bay were geochemically consistent with other areas along the coastal Beaufort Sea from Camden Bay to Harrison Bay.

Under natural conditions, concentrations of other trace metals in sediments commonly follow a strong, positive linear trend versus Al in a given depositional environment. For example, concentrations of Zn in surface and subsurface sediments from Camden Bay plotted within or near the lower limit of the 99% prediction interval that was independently developed using data for 195 sediment samples collected from the coastal Beaufort Sea during 1999-2002 (Figure 3.5b). The two-fold range in Zn concentrations, yet good linear fit for Zn versus Al, is consistent with mixing of relatively uniform composition, metal-rich aluminosilicate phases with metal-poor quartz sand and carbonate shell. Zinc concentrations in natural sediments from the Beaufort Sea are predicted to plot within the prediction interval in Figure 3.5b. If a data point was to plot above the upper prediction interval on Figure 3.5b, the corresponding sample would most likely contain an anthropogenic Zn component or contain some much less common Zn-bearing mineral. Based on the 2008 data for surface and subsurface sediments from Camden Bay, no anthropogenic Zn is present in surface sediments from any location, including the 1985 Hammerhead Drill Site. Furthermore, a baseline for Zn concentrations in Camden Bay has been established for Camden Bay whereby any future contaminant inputs can be identified by data points that plot above the upper prediction interval on a graph such as shown in Figure 3.5b.

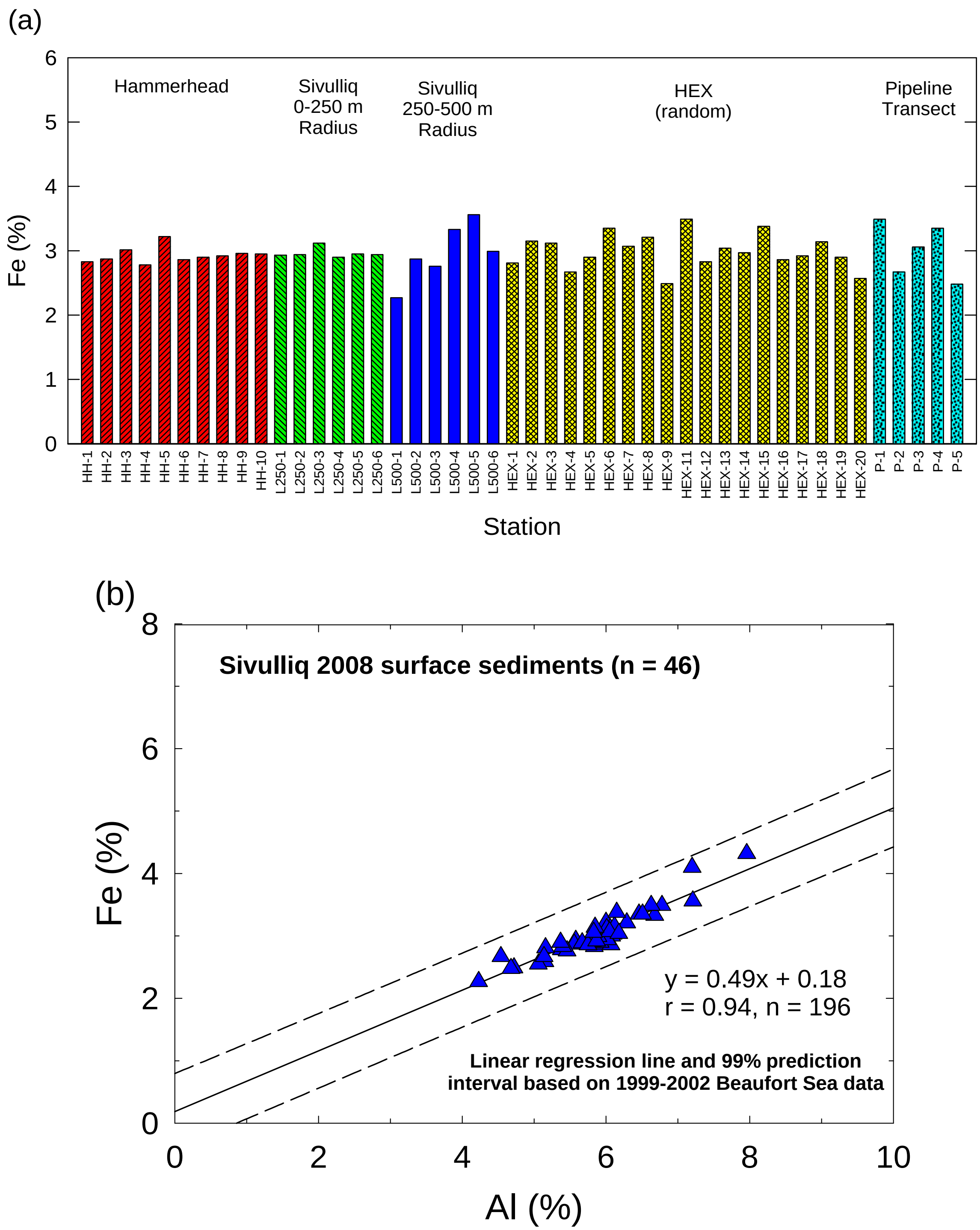


Figure 3.4. (a) Values for total Fe and (b) concentrations of total Fe versus Al for all surface sediments from the 2008 study of Camden Bay. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

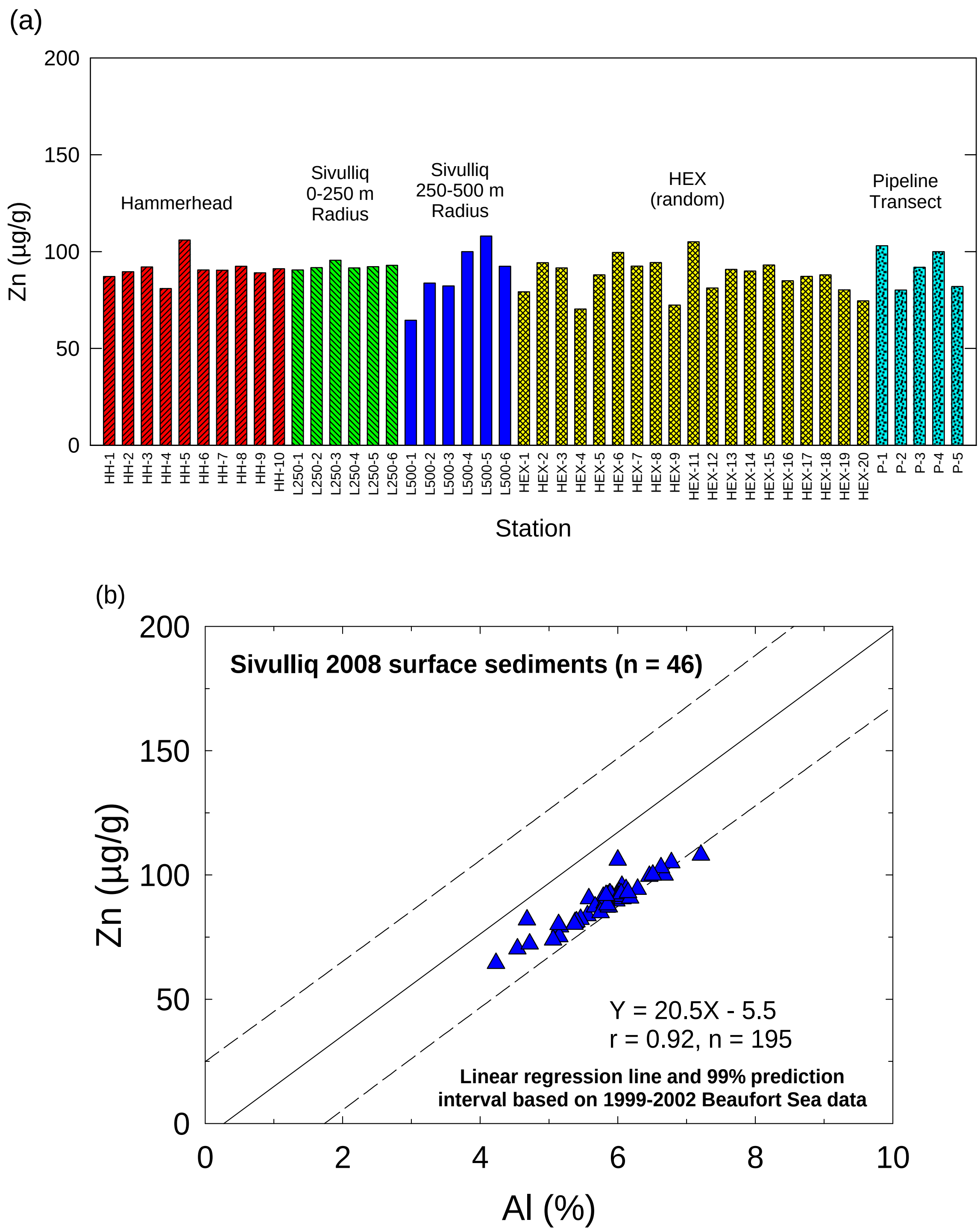


Figure 3.5. (a) Values for total Zn and (b) concentrations of total Zn versus Al for surface sediments from the 2008 study of Camden Bay. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

Results for V and Cd were very similar to those observed for Zn in that none of the 2008 data points from Camden Bay plotted above the upper prediction interval on the metal versus Al plots that define background (or baseline) concentrations for Camden Bay and the coastal Beaufort Sea (Figures 3.6 and 3.7). Thus, these metal versus Al plots can be used to help identify anomalous concentrations of potential contaminants in sediments from Camden Bay well before they reach values that could have adverse environmental effects.

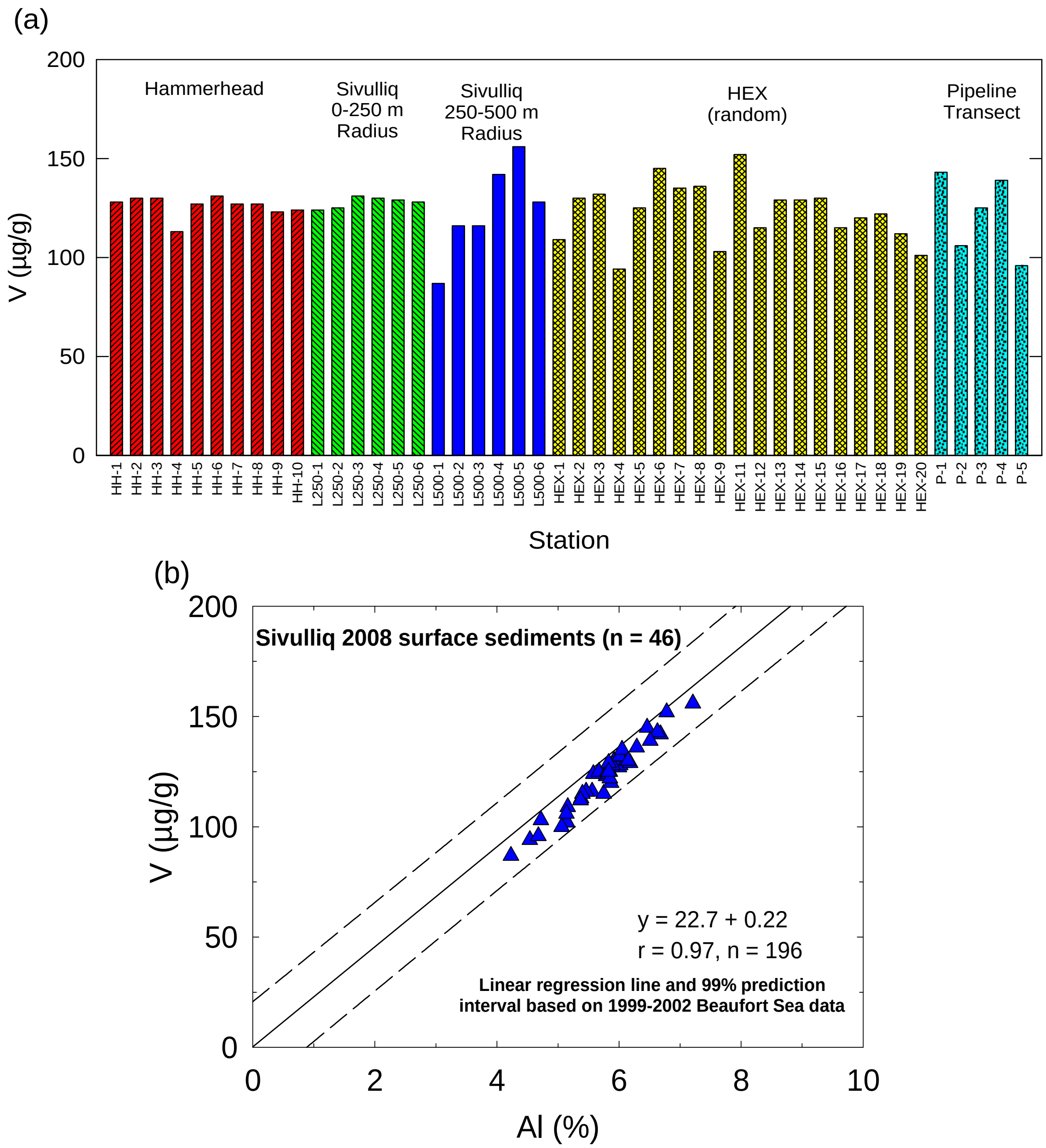


Figure 3.6. (a) Values for total V and (b) concentrations of total V versus Al for surface sediments from the 2008 study of Camden Bay. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

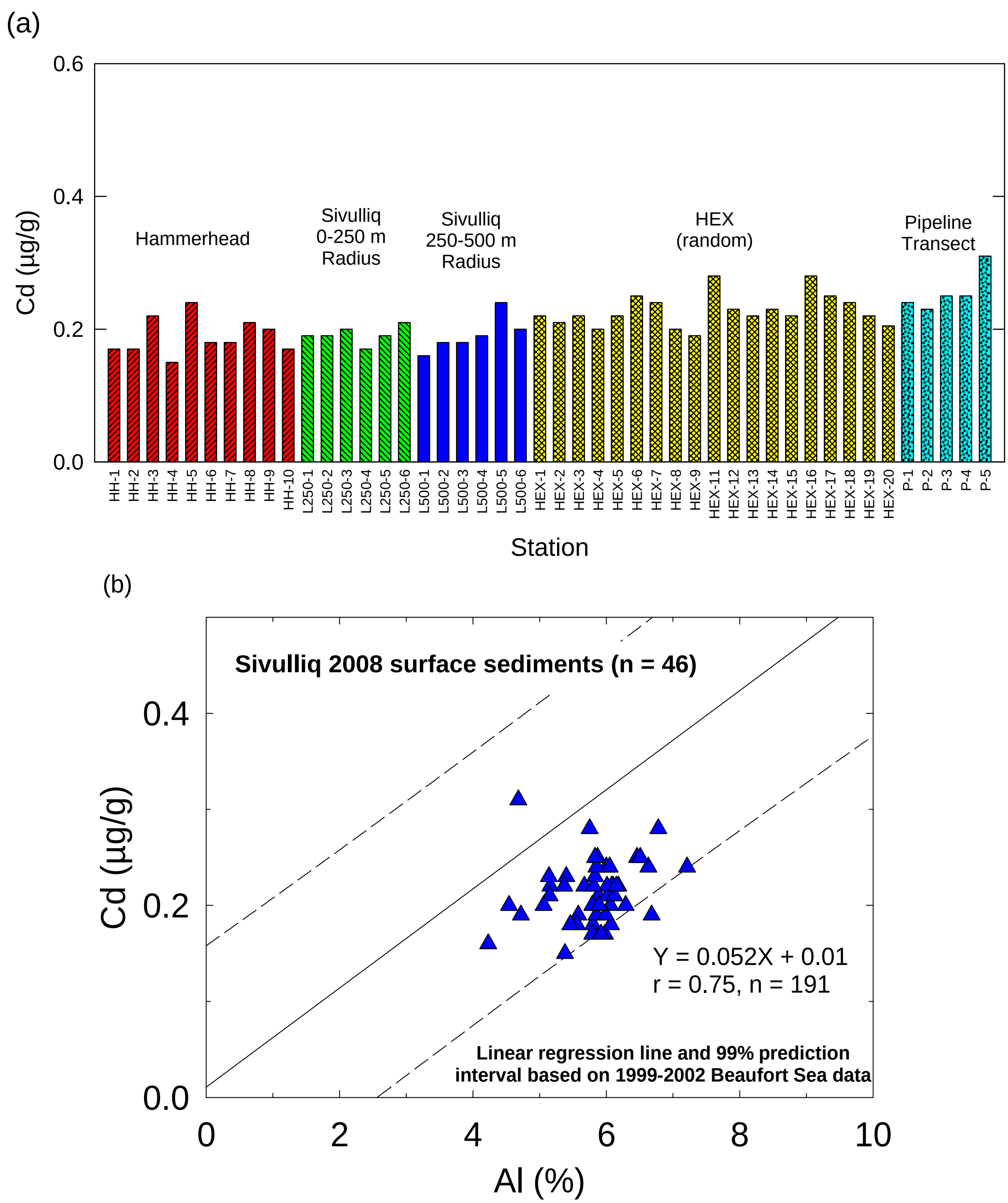


Figure 3.7. (a) Values for total Cd and (b) concentrations of total Cd versus Al for surface sediments from the 2008 study of Camden Ba. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

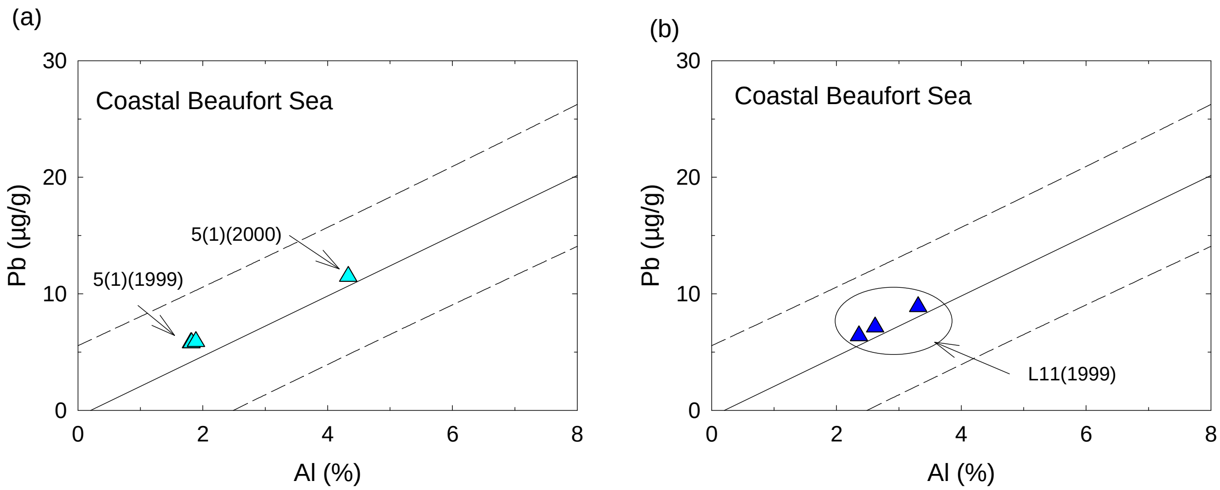


Figure 3.8. Concentrations of total Pb versus Al for samples from the coastal Beaufort Sea showing (a) variations in concentrations at the same site during two different sampling years and (b) variations in metal concentrations during repeated sampling at the same site on the same day (from Trefry et al., 2004).

The normalization to Al process for metals has been shown to be critical to identifying and interpreting changes in metal concentrations over time, even for background samples with no contamination. For example, the sediment Pb concentration from one station in the Beaufort Sea (ANIMIDA project, Brown et al., 2004) was 5.8 µg/g in 1999 and 11.5 µg/g in 2000 (Figure 3.8a). The sandy sediment collected following a storm in 1999 was covered with finer-grained silts and clay from spring runoff prior to sampling in 2000 (Figure 3.8a). Such shifts in sediment grain size are consistent with the dynamics of shallow-water sediments. However, the two-fold increase in sediment Pb concentrations that could have been explained as being due to anthropogenic inputs was actually shown to be a natural artifact of changes in sediment grain size using the metal/Al graphs (Figure 3.8a). Metal versus Al plots also normalize within-site variability during a given year. For example, triplicate samples from station 5(1) in 1999 contained Pb at 5.8, 5.8 and 5.9 µg/g and plot closely together on Figure 3.8a. In contrast, Pb values of 6.4, 8.9 and 7.4 were obtained for station L11 in 1999, yet they plot along the same slope of the Pb/Al ratio in Figure 3.8b. Fortunately, the Pb versus Al graph normalizes most of the sample variability in these instances of natural variation so that they will not be interpreted as being caused by anthropogenic inputs of Pb.

At 42 of 46 stations, Ba values were at background concentrations (Figure 3.9a). Three surface sediments from the 2008 survey of Camden Bay, all from the HH area, had Ba concentrations that were as much as ~30 times above background values of about 600 µg/g (Figure 3.9a and Table 3.3). These three data points are for HH stations 4, 5 and 8. One additional sediment sample from station HH-10 contained Ba at 828 µg/g (Figure 3.9a).

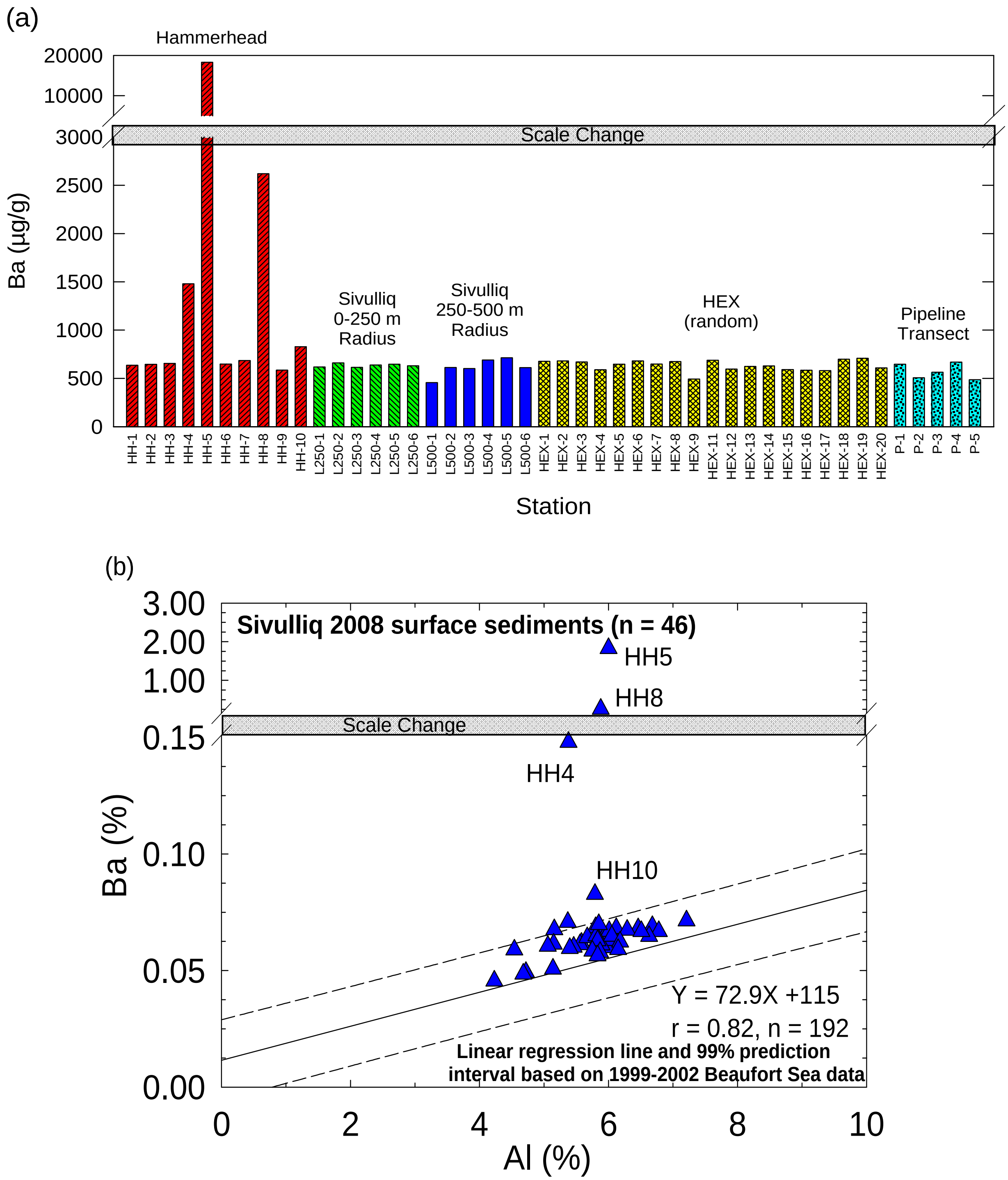


Figure 3.9. (a) Values for total Ba and (b) concentrations of total Ba versus Al for surface sediments from the 2008 study of Camden Bay. A Ba value of 600 µg/g on (a) is equal to 0.06% on (b). The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

Table 3.3. Summary data for metals in surface sediments from (1) the Hammerhead (HH) area, (2) the cumulative data from the HEX, L250, L500 and P areas in this study and (3) the coastal Alaskan Beaufort Sea. SD = standard deviation and RSD = relative standard deviation.

Area	Statistic	Ag (µg/g)	Al (%)	As (µg/g)	Ba (µg/g)	Cd (µg/g)	Cr (µg/g)	Cu (µg/g)	Fe (%)	Hg (µg/g)	Mn (µg/g)	Pb (µg/g)	Se (µg/g)	V (µg/g)	Zn (µg/g)
HH (n = 10)	Mean	0.16	5.86	15.2	2680	0.19	86.5	25.5	2.93	0.047	329	18.3	0.54	126	90.9
	SD	0.09	0.20	3.4	5517	0.03	17.7	11.5	0.12	0.006	26	10.9	0.55	5	6.3
	RSD (%)	56	3	22	205	16	20	45	4	13	8	60	102	4	7
	Max	0.40	6.09	21.1	18300	0.24	135	58.3	3.22	0.062	386	49.2	2.02	131	106
	Min	0.10	5.38	10.5	585	0.15	72.6	20.6	2.78	0.042	295	14.3	0.25	113	80.9
HEX, L250, L500, P (n = 36)	Mean	0.13	5.78	15.6	623	0.22	78.7	21.6	2.97	0.050	368	14.8	0.35	123	88.4
	SD	0.02	0.64	3.5	61	0.03	8.3	3.1	0.30	0.01	93	1.8	0.09	16	9.7
	RSD (%)	14	11	22	10	14	11	14	10	21	25	12	27	13	11
	Max	0.18	7.21	21.8	714	0.31	95.8	27.4	3.56	0.083	622	18.4	0.62	156	108
	Min	0.10	4.23	9.5	456	0.16	59.3	15.1	2.27	0.028	287	9.9	0.25	87	64.5
Coastal Alaskan Beaufort Sea[1] (n = 241)	Mean	0.10	3.81	10.3	414	0.19	58.8	17.7	2.21	0.039	325	9.7	-	96	69.9
	SD	0.05	1.44	3.6	146	0.09	21.3	8.8	0.77	0.021	131	4.0	-	28	27.3
	RSD (%)	50	38	35	35	47	36	50	35	54	40	41	-	29	39
	Max	0.42	7.26	23.2	863	0.75	104	45.8	3.91	0.113	789	21.5	-	173	136
	Min	0.01	1.06	1.0	142	0.03	12.7	3.6	0.72	0.003	62	2.8	-	27	15

[1]Trefry et al. (2003).

These four stations were all within about 60 to 100 m of the location of the 1985 Hammerhead drill site (station HH-5 on Figure 3.10). The elevated concentrations of Ba were most likely due to residual barite ($BaSO_4$) from drilling mud and cuttings that were discharged at the site in 1985. Elevated Ba concentrations do not necessarily indicate the presence of all components of the drilling mud mixture because differences in dispersion, settling and dissolution can separate the various components. In some cases the whole mud is deposited and buried and stays relatively intact. No data on the method of discharge is available at this time. None of the other six HH stations sampled contained elevated concentrations of sediment Ba and thus the instances of sediments with Ba enrichment were found only within ~100 m of the 1985 drill site (Figure 3.9 and 3.10).

The Ba anomalies discussed above also can be identified on the Ba versus Al plot (Figure 3.9b). The linear regression line and prediction interval, as in previous metal versus Al plots for this study, are from a 1999-2002 data base for the coastal Beaufort Sea (Figure 3.9b). Four surface samples had Ba concentrations that plotted above the upper prediction interval (Figure 3.9b). The highest Ba concentration in surface sediments was 18,300 µg/g (1.83%) at station HH-5 (Figure 3.8b); thus, a scale change was added to the graph. Industrial barite contains an average of ~53% Ba (Trefry et al., 2007) and thus the surface sediment sample from station HH-5 contained ~3.4% barite. Discussion of possible ecological implications of observed Ba concentrations at the HH stations will be presented below in Section 3.5.

Elevated concentrations of Ba have been found near drill sites in other areas of the coastal Beaufort Sea (Snyder-Conn et al., 1990; Crecelius et al., 1991). The highest sediment Ba concentrations reported by Snyder-Conn et al. (1990) were 5,000 to 6,600 µg/g for exploratory drill sites near Cross Island and Alaska Island, respectively. These values are most likely 10 to 20 times less than the total Ba values because the acid treatment used to prepare samples for analysis would remove only a small fraction of the total Ba. Trefry et al. (2003) reported concentrations of Ba as high as 1100 µg/g in sediments from two locations near drill sites in western Harrison Bay; these data points plotted above the upper limit of the 99% prediction interval for Ba versus Al.

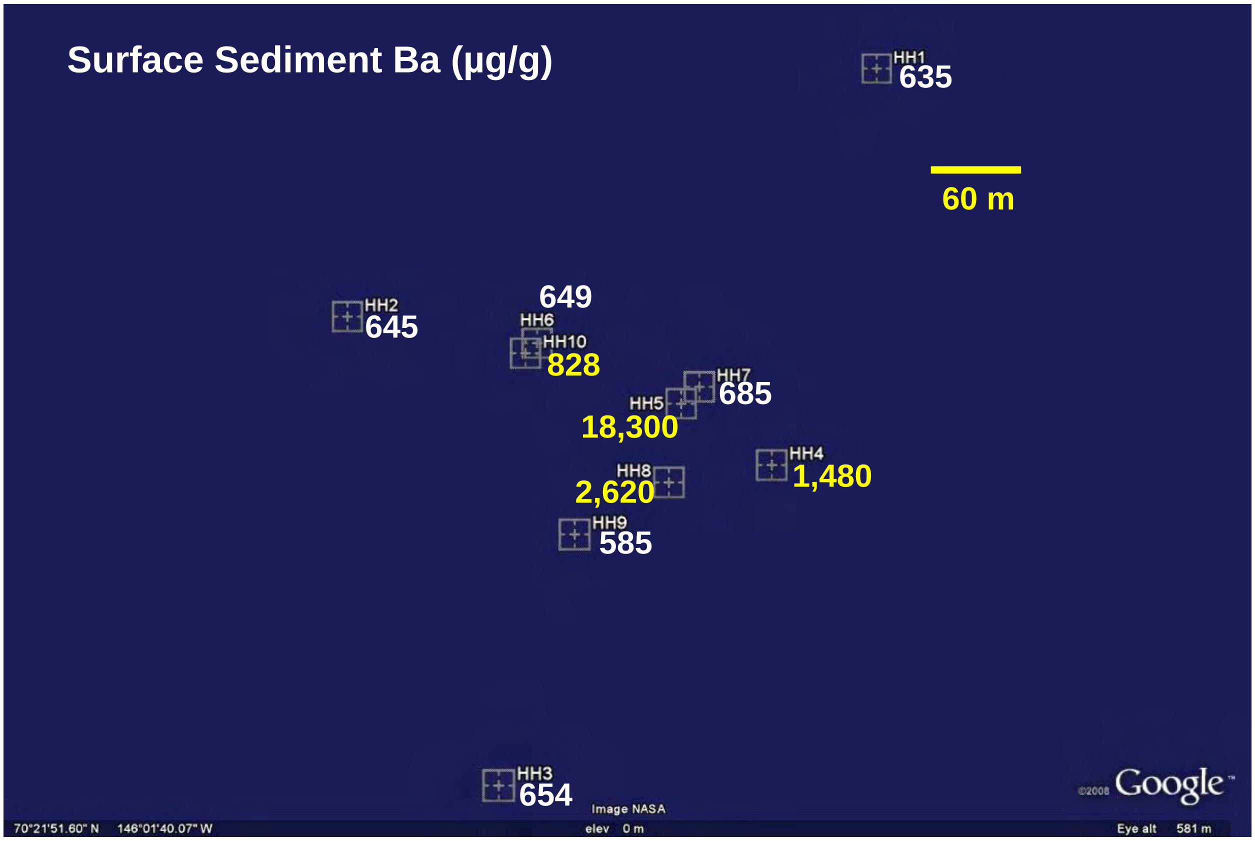
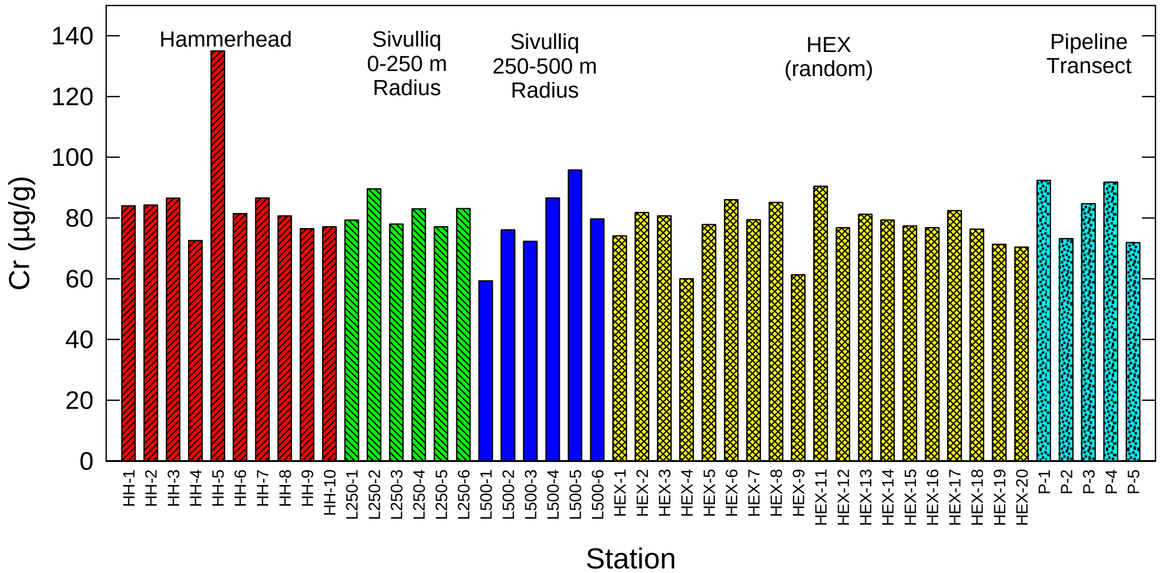


Figure 3.10. Concentrations of total Ba in surface sediments on a map of the Hammerhead area.

Concentrations of Cr were at background values of ~80 µg/g in all surface sediments except at station HH-5 where the value of 135 µg/g plotted above the upper prediction interval established for the coastal Beaufort Sea (Figure 3.11). During the 1980s, chromium lignosulfonate was sometimes added to drilling fluids as a thinner. Snyder-Conn et al. (1990) found concentrations of Cr as high as 331 µg/g near Cross Island where drilling was carried out in 1983-84. Concentrations of Cr also were previously found to be elevated in western Harrison Bay and in western Camden Bay as reported by Crecelius et al. (1991) and Trefry et al. (2003). This excess Cr may have been derived from chromium lignosulfonate. However, this chromium additive has not been used in drilling mud for more than 20 years as Cr was replaced with Fe and other metals that have a much lower potential for toxicity. Concentrations of Cr did not correlate with concentrations of Ba, suggesting that additions of barite and a Cr-bearing compound were not necessarily occurring at the same time or that some separation occurred following discharge.

(a)



(b)

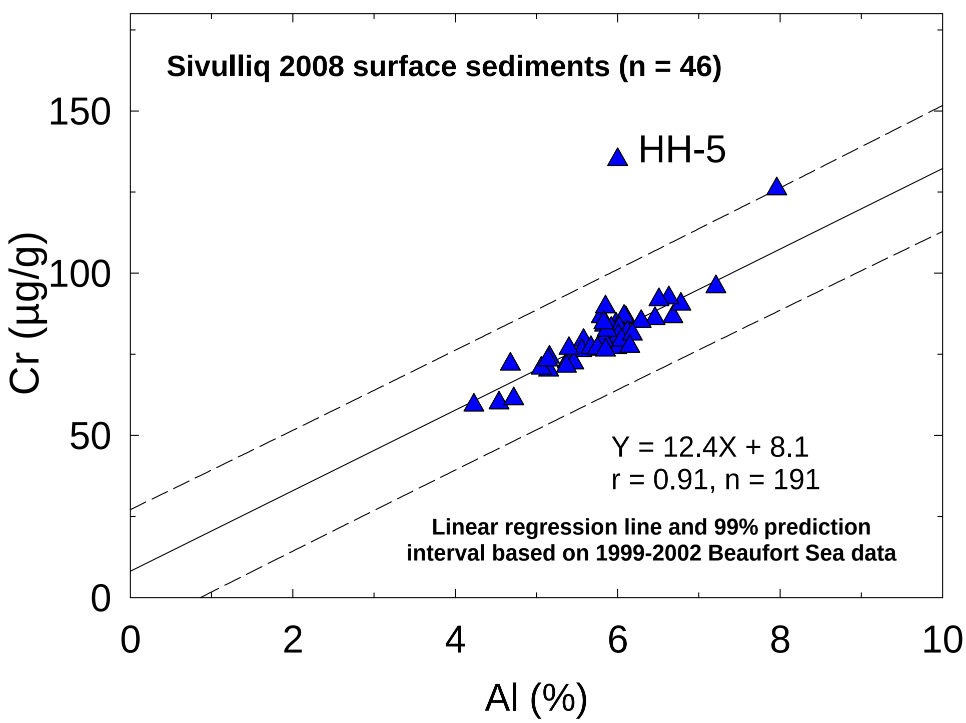


Figure 3.11. (a) Values for total Cr and (b) concentrations of total Cr versus Al for surface sediments from the 2008 study of Camden Bay. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

Trends for total Cu, Pb and Ag were similar to those observed for total Cr in that only the surface sample from station HH-5 had concentrations that exceeded the upper prediction intervals for each metal on the respective metal versus Al plots (Figures 3.12, 3.13 and 3.14). The magnitude of enhancement of these three elements was 2 to 4 times above background and much less than observed for Ba. The ecological implications of these metal anomalies in the HH area are discussed in Section 3.5.

Background concentrations of total As in the coastal Beaufort Sea are variable and high relative to average marine sediment (Figure 3.15a and Table 3.2). This point was previously noted throughout the Beaufort Sea by Valette-Silver et al. (1999) and Trefry et al. (2003). This sediment As enrichment is believed to be due higher As concentrations for incoming river particles (an average of 15 ± 5 μg/g) and to upwelling of As-rich water to the coastal Beaufort Sea, accompanied by scavenging of As by iron oxides. The prediction interval established for As versus Al in sediments from the coastal Beaufort Sea is wide relative to the other metals discussed, most likely a function of variability in As scavenging (Figure 3.15). Nine data points for As plotted above the upper prediction interval based on sediment metal data for the coastal Beaufort Sea (Figure 3.15). Arsenic enrichment in the top layers of the sediment is most likely a natural diagenetic effect whereby As was remobilized in subsurface sediments and re-precipitated in surface, oxic sediments as described by Farmer and Lowell (1986) and observed by Trefry et al. (2003) in the coastal Beaufort Sea. Instances of enhanced As scavenging and remobilization may be greater in the deeper, farther offshore waters of Camden Bay. Additional discussion of As is presented with the sediment core data in Section 3.3.

Concentrations of total Hg in sediments from Camden Bay were relatively uniform with no data points that plotted above the upper prediction interval on the Hg versus Al graph (Figure 3.16b). Previous analyses of methyl mercury in sediments from the coastal Beaufort Sea (Boehm et al., 2001) showed that sediments contained an average methyl mercury concentration of 0.39 ± 0.36 ng/g that was about 0.8% of total sediment Hg values of 48 ± 38 μg/g (48,000 ± 38,000 ng/g). These very low values for methyl mercury are at or below reported values for pristine locations (Trefry et al., 2007). As stated previously, total concentrations of metals are reported for this 2008 survey of Camden Bay so that accurate assessments of the presence or absence of contaminated sediments can be determined using metal versus graphs.

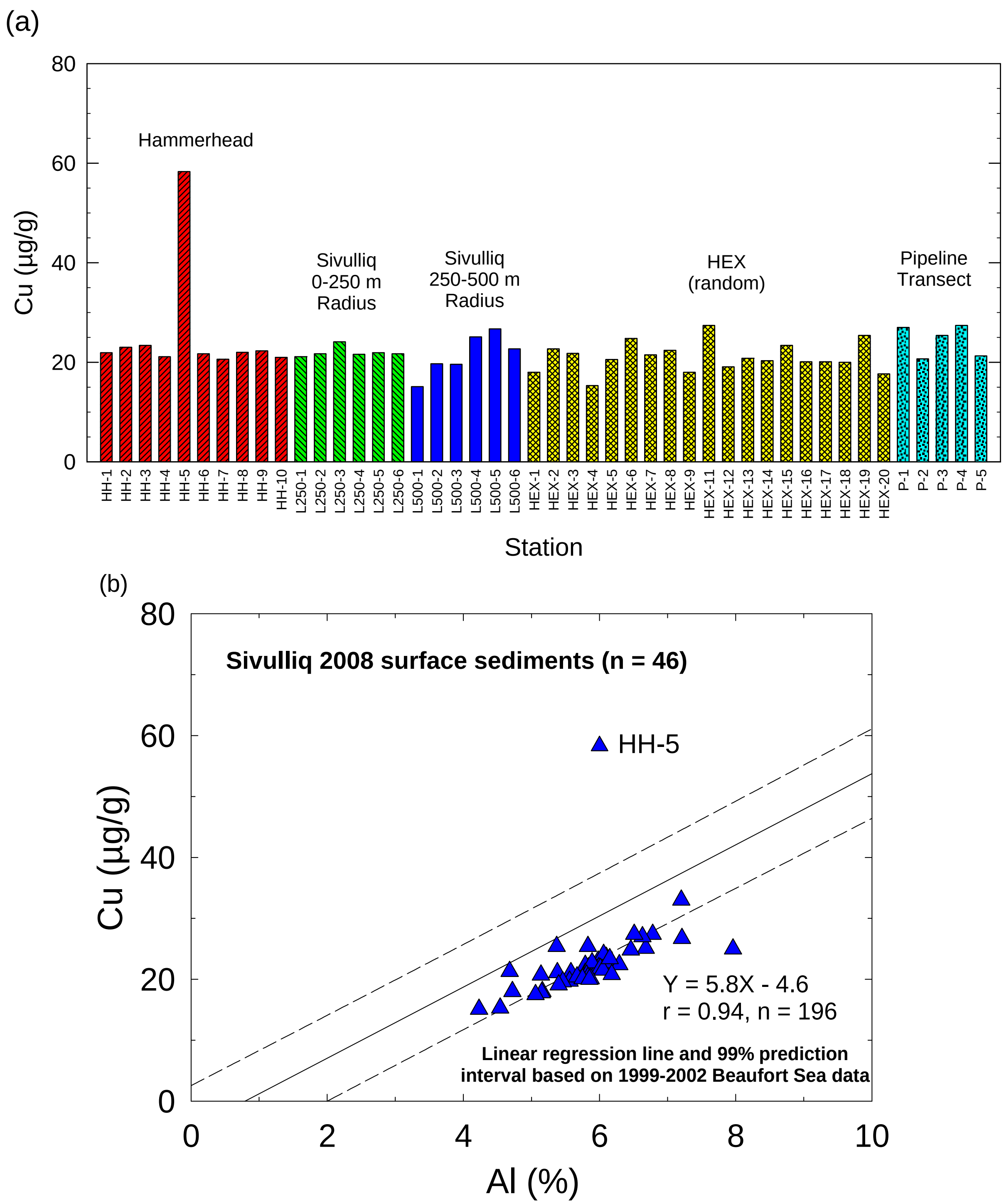


Figure 3.12. (a) Values for total Cu and (b) concentrations of total Cu versus Al for surface sediments from the 2008 study of Camden Bay. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

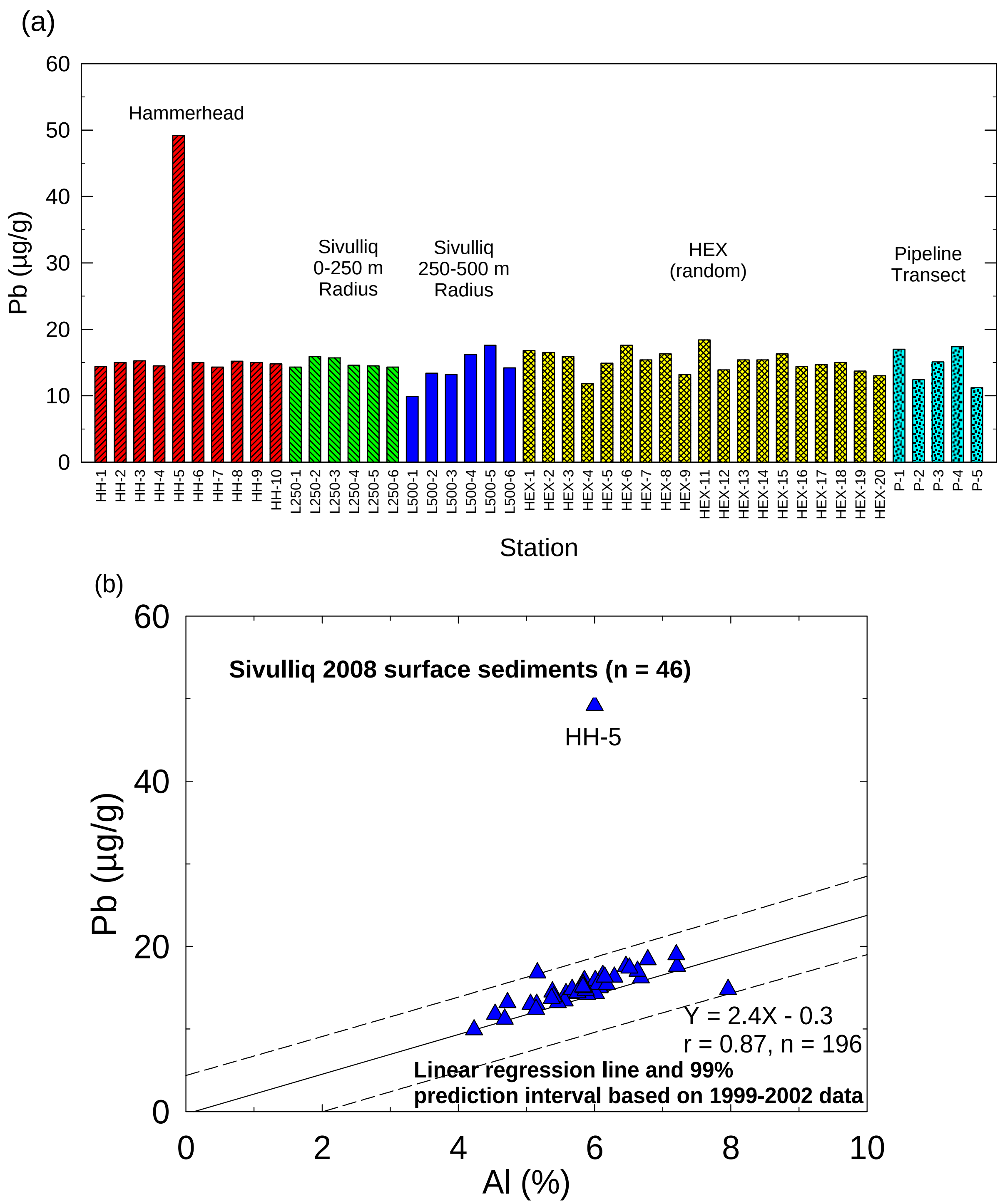


Figure 3.13. (a) Values for total Pb and (b) concentrations of total Pb versus Al for surface sediments from the 2008 study of Camden Bay. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

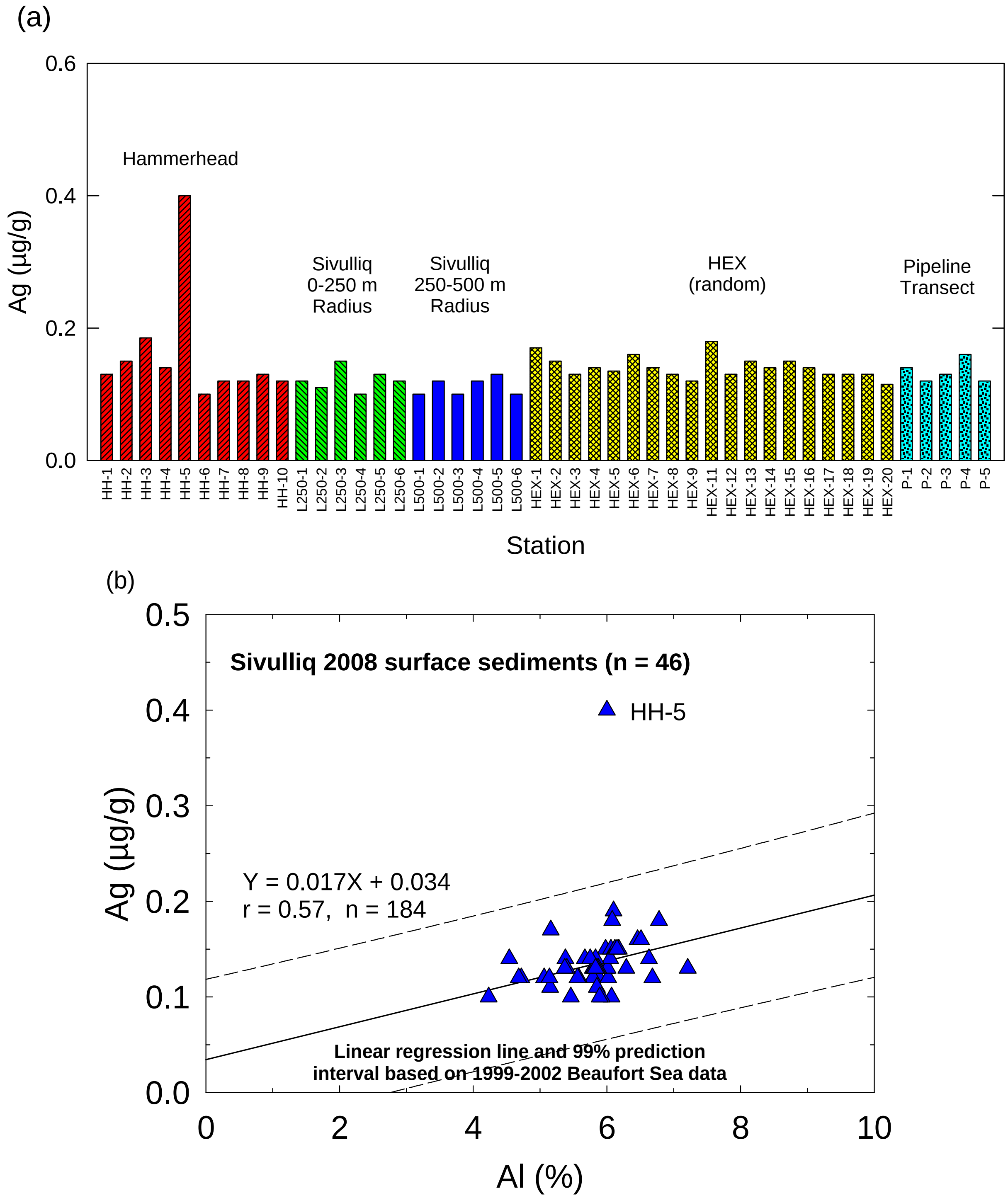
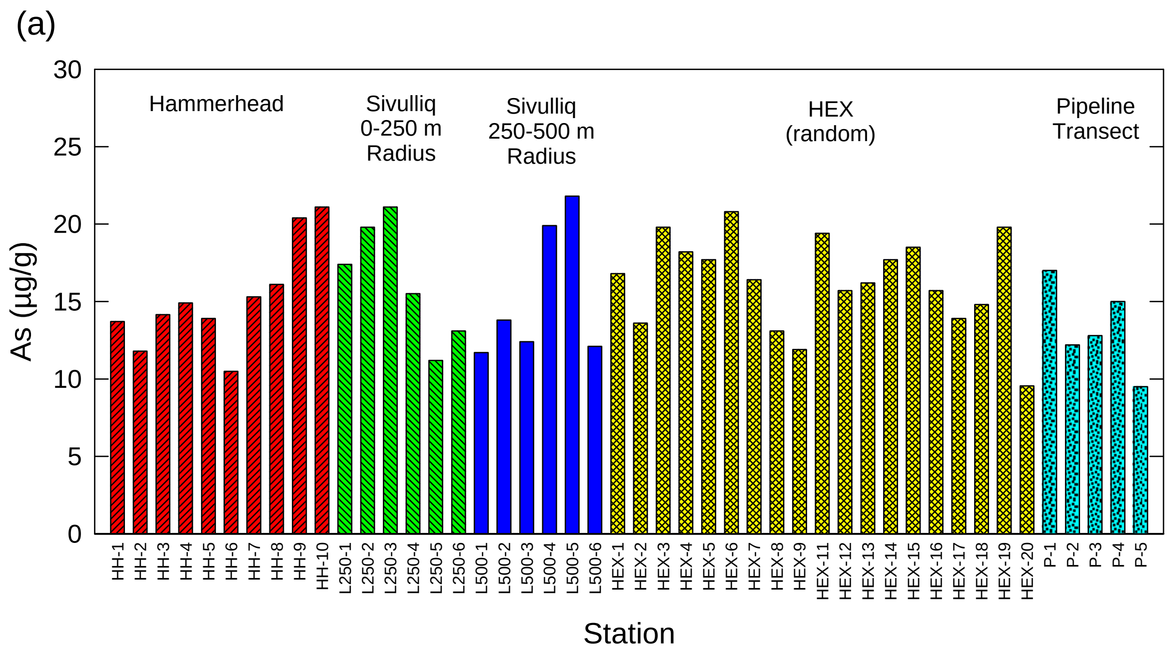


Figure 3.14. (a) Values for total Ag and (b) concentrations of total Ag versus Al for surface sediments from the 2008 study of Camden Bay. The 2008 data from Camden Bay are plotted on a template with linear regression line and prediction interval established for the coastal Beaufort Sea by Trefry et al. (2003).



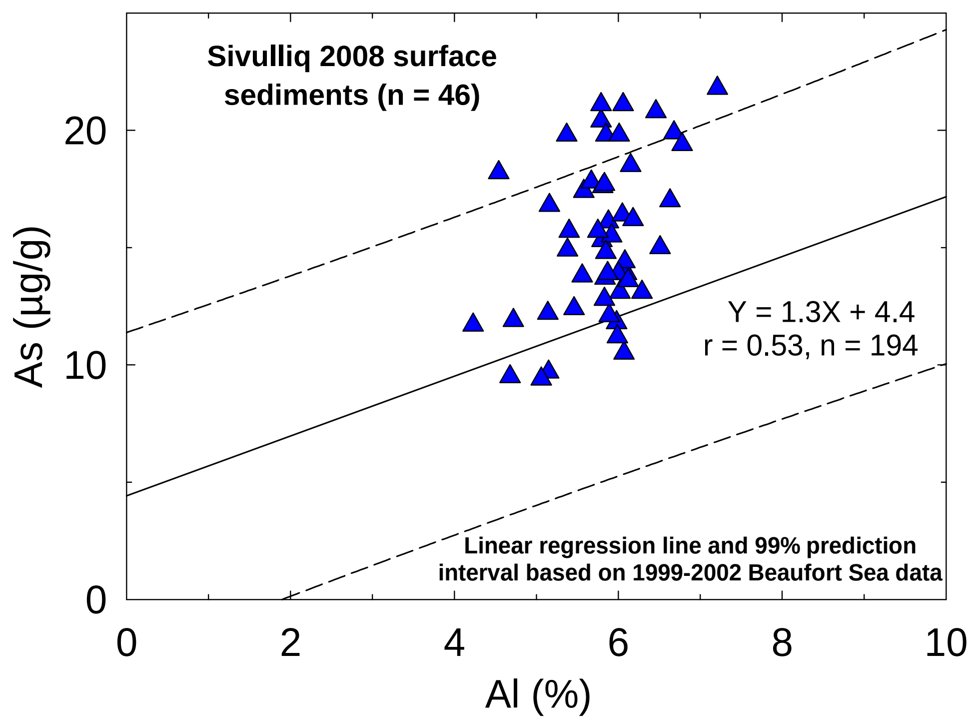


Figure 3.15. (a) Values for total As and (b) concentrations of total As versus Al for surface sediments from the 2008 study of Camden Bay. The 2008 data from Camden Bay are plotted on a template with linear regression line and prediction interval established for the coastal Beaufort Sea by Trefry et al. (2003).

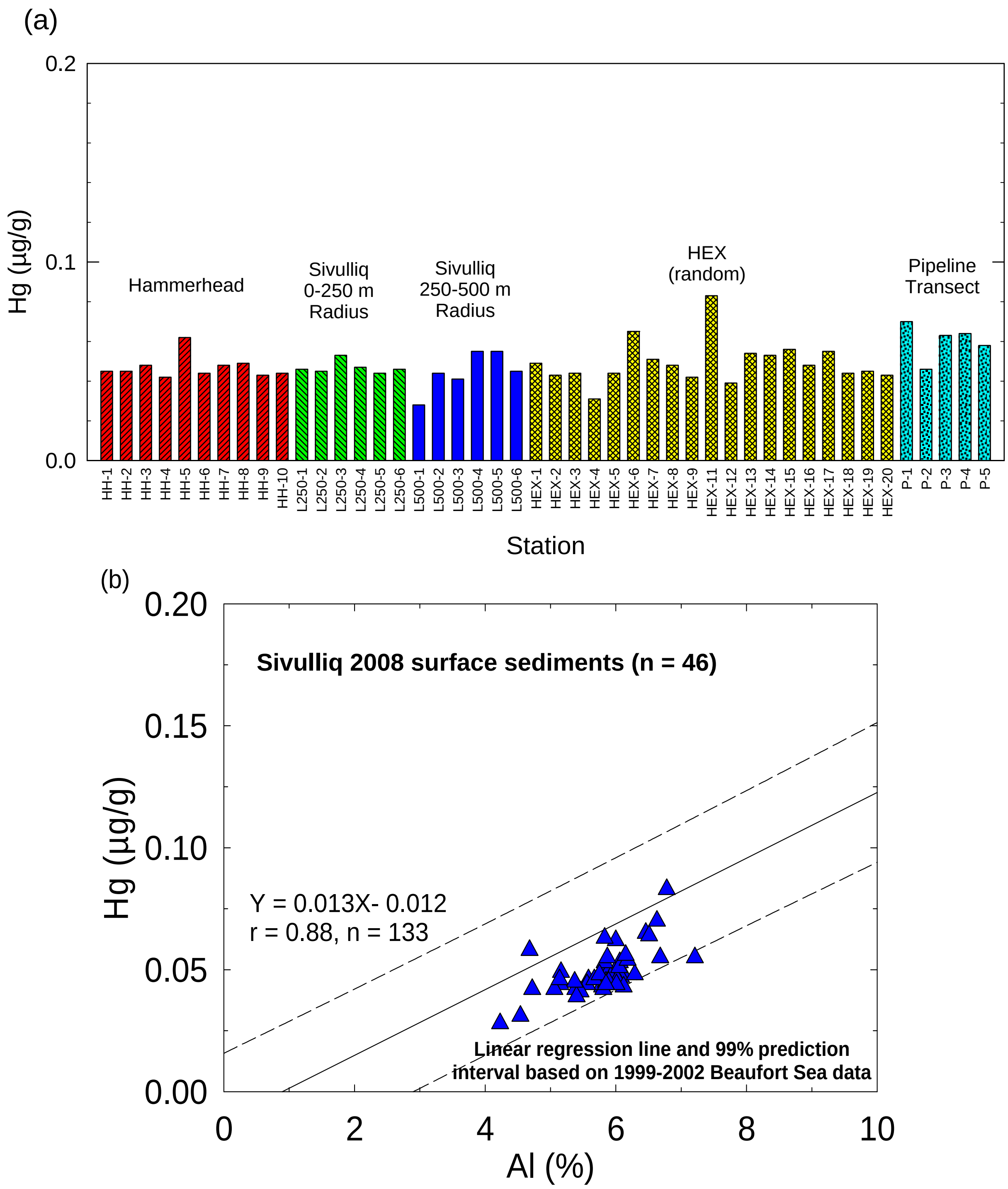
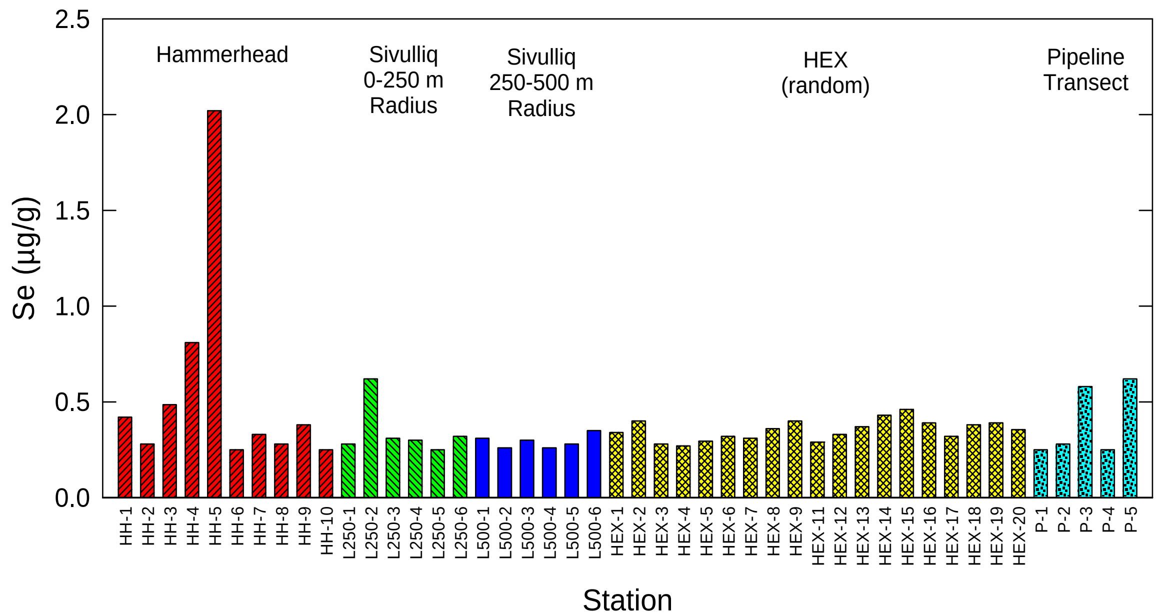


Figure 3.16. (a) Values for total Hg and (b) concentrations of total Hg versus Al for surface sediments from the 2008 study of Camden Bay. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

Concentrations of Se averaged 0.35 ± 0.09 µg/g for the HEX, L250, L500 and P locations (Table 3.1 and Figure 3.17a). The surface sediment sample from station HH-5 contained Se at 2.0 µg/g, almost six times higher than the mean value for the background locations. Selenium was not included as an analyte in previous sediment studies of the coastal Beaufort Sea and thus no linear regression and prediction interval are available to provide perspective on the data for Se in Camden Bay. Concentrations of Se also were elevated at >0.8 µg/g in the surface sample from station HH-4 (Figure 3.17). Selenium enrichment in surface sediments can be caused by diagenetic reactions similar to those described above for As. These may have been enhanced in the slight more organic-rich sediments at station HH-5 as described in Section 3.3.

The overall average Mn concentration for the background areas (HEX, L250, L500 and P) was 368 ± 93 µg/g (Table 3.1). Surface sediments from five locations (HH-4, L500-2, L500-3, P-3 and P-5) had Mn concentrations that averaged about two standard deviations above the mean for the other stations at 599 ± 20 µg/g. Natural diagenetic reactions in sediment can lead to either Mn-depleted sediment (relative to incoming suspended sediment) or to Mn-rich layers at the sediment surface (Trefry and Presley, 1982; Gobeil et al., 1997). Previous values for the Mn/Al ratio for sediments from the coastal Beaufort Sea averaged 65 ± 19. Most sediment samples from Camden Bay fit the trend observed for the coastal Beaufort Sea. The five samples with higher Mn values have an average Mn/Al ratio of 112 ± 11. In these five cases, Mn^{2+} most likely formed from dissolution of MnO_2 under mildly reducing conditions in subsurface sediments. This Mn^{2+} would diffuse upward toward the seafloor and precipitate as a manganese oxide at the sediment-water interface, thereby leading to natural enhancement of Mn concentrations in surface sediments (e.g., Trefry and Presley, 1982). Samples of sediment interstitial water and sediment redox conditions would be needed to confirm this likely cycle.

(a)



(b)

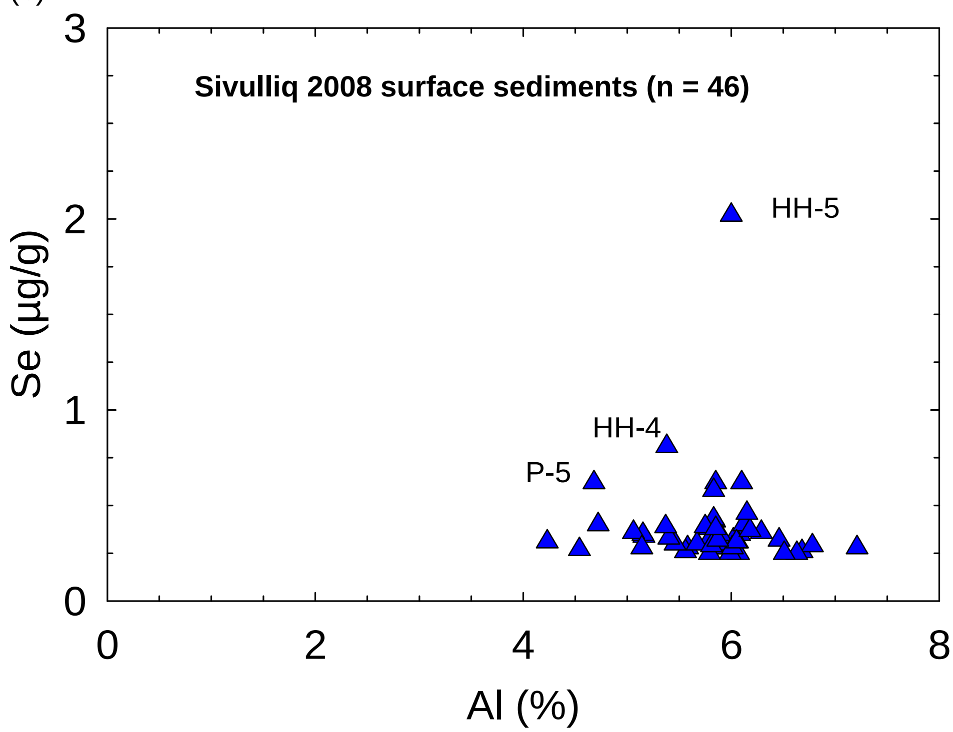


Figure 3.17. (a) Values for total Se and (b) concentrations of total Se versus Al for surface sediments from the 2008 study of Camden Bay.

3.3. Metals in Sediment Cores

Short sediment cores (7-10 cm long) were collected at the following 10 stations: HH-1 to HH-8, L250-2 and L500-2 by subsampling the Van Veen grab with a 7-cm diameter plastic tube. Metal concentrations were determined for 4 to 5 layers in four of the cores (stations L250-2, L500-2, HH-5 and HH-8) and sediment geochronology (age dating) was carried out for two cores (stations L250-2 and HH-5). Sediment ages and sedimentation rates were determined using the man-made radionuclide ^{137}Cs (first introduced to Earth by bomb testing during the early 1950s; half-life = 30.1 yr) in tandem with excess ^{210}Pb (a naturally occurring decay product of ^{226}Ra; half-life ^{210}Pb = 22.3 yr). By using two different radioisotopes, sedimentation rates can be independently verified.

The geochronology results for station L250-2 yielded a sedimentation rate of 0.12 cm/yr using ^{137}Cs and 0.11 cm/yr using excess ^{210}Pb (Figure 3-18). The agreement between the two different sedimentation rates was very good considering the small length of the cores collected using a grab sampler. However, possible downward mixing of the isotopes can distort the sedimentation rate and the values reported above are most likely maximum rates. Nevertheless, the results support a net accumulation of only ~2.5 cm of sediment at this location in Camden Bay since 1985 when the HH drill site was occupied.

Past efforts to reconstruct recent geochronology for coastal sediments in the Beaufort Sea have encountered difficulty because the area has been characterized as a net erosional environment (Reimnitz and Wolf, 1998). For example, Naidu et al. (2001) reported no excess ^{210}Pb and no detectable ^{137}Cs in Simpson Lagoon (and therefore no recent sedimentation) whereas they found excess ^{210}Pb at only 0.9 to 1.2 dpm/g and ^{137}Cs activities of 0.2 dpm/g near Pole Island. Trefry et al. (2003) reported sedimentation rates of non-detectable to 0.04 cm/yr east of the Endicott development to 0.11 cm/yr in Prudhoe Bay.

The ^{137}Cs profile for station HH-5 showed that no activity was detected below 4 cm (Figure 3.19). This depth of zero ^{137}Cs is shallower than the depth of 7 cm found at station L250-2 (Figure 3.18) and may be influenced by the presence of drilling mud and cuttings in the 4 to 8 cm (bottom) section of the core as discussed below. The data for excess ^{210}Pb showed detectable values for only the top three data points to a depth of <2 cm. Drilling mud and cuttings contain no ^{137}Cs and no excess ^{210}Pb because they are far older than 1950 (first presence of ^{137}Cs on Earth) or the 80 to 100 years that excess ^{210}Pb can be detected in Beaufort Sea sediments. In fact, the observed absence of ^{137}Cs and excess ^{210}Pb below 2 to 4 cm help support the presence of drilling mud and cuttings in the bottom of the core from station HH-5, relative to the core from station L250-2.

Metal concentrations in the sediment core from station L250-2 were very uniform and very similar to data for surface sediments from Camden Bay (Table 3.4 and Figures 3.20-3.23). No data points for the sediment core from station L250-2 were above the upper prediction interval on any of the metal versus Al graphs in support of background values for all metals at this site (Figure 3.24 and 3.25). Vertical profiles for the various metals show that the

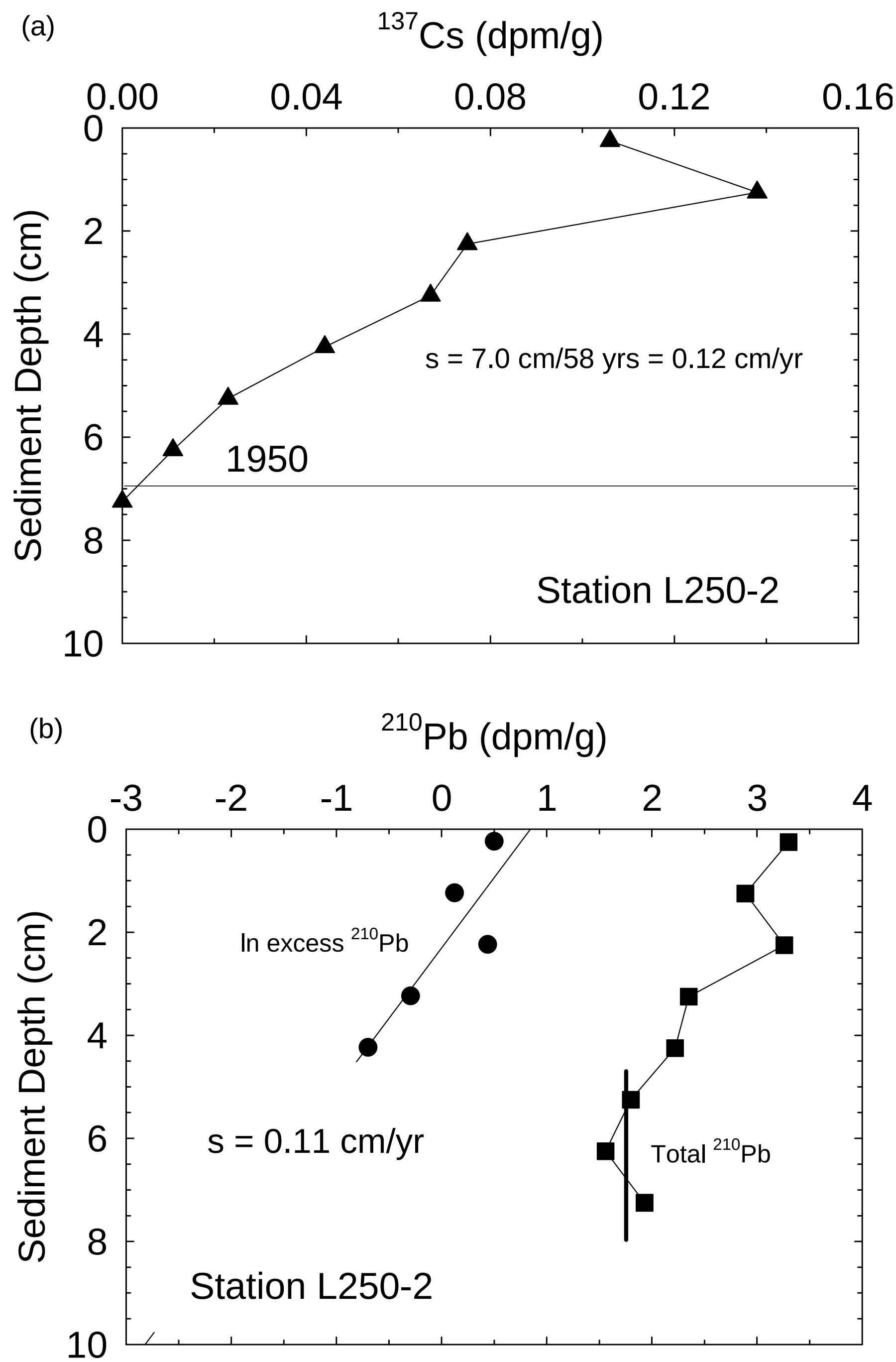


Figure 3.18. Vertical profiles for (a) ^{137}Cs and (b) ln excess ^{210}Pb and total ^{210}Pb for sediments from station L250-2. Sedimentation rates (s) were determined independently using data for ^{137}Cs and ln excess ^{210}Pb.

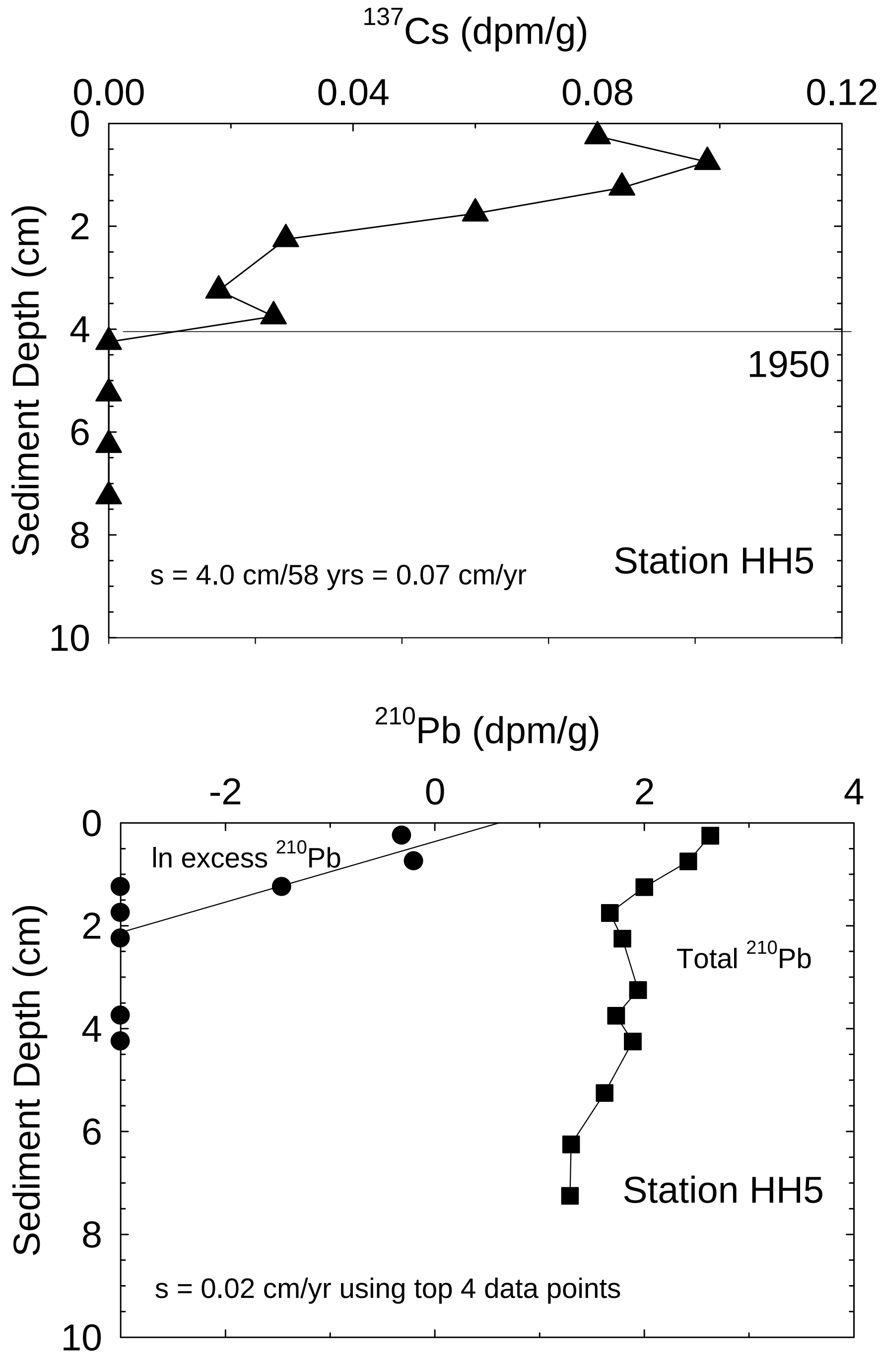


Figure 3.19. Vertical profiles for (a) ^{137}Cs and (b) excess and total ^{210}Pb for sediments from station HH-5. Sedimentation rates (s) were calculated using data for ^{137}Cs and ln excess ^{210}Pb.

Table 3.4. Summary data for metals in sediment cores from stations L250-2, L500-2, HH-5 and HH-8 along with data from surface sediments from the HEX, L250, L500 and P areas. SD = standard deviation. LOI = Loss on Ignition at 550°C.

Area	Statistic	Ag (µg/g)	Al (%)	As (µg/g)	Ba (µg/g)	Cd (µg/g)	Cr (µg/g)	Cu (µg/g)	Fe (%)	Hg (µg/g)	Mn (µg/g)	Pb (µg/g)	Se (µg/g)	Zn (µg/g)	LOI (%)	$CaCO_3$ (%)
Core L250-2 (n = 5)	Mean	0.13	6.55	18.3	657	0.23	86.4	23.6	3.20	0.052	307	16.5	0.30	95.2	6.8	6.9
	SD	0.004	0.27	1.5	31	0.01	4.0	1.3	0.14	0.003	33	0.7	0.092	4.2	0.4	1.9
	Max	0.14	6.78	19.9	706	0.23	90.6	24.8	3.31	0.055	352	17.3	0.33	98.6	7.2	10.3
	Min	0.13	6.08	16.1	625	0.21	82.0	22.0	3.01	0.048	275	15.5	0.28	88.8	6.4	5.6
Core L500-2 (n = 4)	Mean	0.11	6.09	11.7	667	0.19	83.7	21.1	2.99	0.051	277	14.8	0.25	90.2	6.4	6.1
	SD	0.01	0.49	4.5	68	0.02	6.8	2.0	0.14	0.006	17	1.1	0.02	6.6	0.3	0.6
	Max	0.12	6.58	18.1	757	0.20	92.5	23.0	3.13	0.058	300	16.0	0.27	97.5	6.7	6.6
	Mean	0.10	5.56	8.2	605	0.16	76.8	18.7	2.83	0.046	260	13.4	0.24	82.4	6.0	5.3
Core HH-5 (n = 5)	Mean	0.16	5.69	14.8	46300	0.31	133	37.9	3.26	0.076	342	40.2	0.88	106	7.6	5.8
	SD	0.02	1.09	3.6	44900	0.06	26	5.3	0.68	0.008	26	21.9	0.19	19	0.3	0.8
	Max	0.17	6.83	19.6	124000	0.39	175	46.4	3.91	0.083	374	72.1	1.06	122	8.1	7.0
	Min	0.12	3.91	9.5	15200	0.25	103	34.0	2.18	0.063	301	10.5	0.57	77	7.2	4.9
Core HH-8 (n = 5)	Mean	0.13	6.06	15.8	817	0.24	80.0	21.4	2.99	0.049	282	15.8	0.39	88.9	6.0	6.4
	SD	0.004	0.27	0.9	127	0.02	4.9	1.0	0.10	0.003	14	0.8	0.04	3.6	0.7	0.4
	Max	0.14	6.40	16.7	955	0.27	87.9	22.6	22.6	0.052	300	16.7	0.43	93.8	7.2	6.8
	Min	0.13	5.70	14.8	686	0.22	75.9	20.4	20.4	0.045	267	14.9	0.36	84.0	5.3	5.7
Surface HEX, L250, L500, P	Mean	0.13	5.78	15.6	623	0.22	78.7	21.6	2.97	0.05	368	14.8	0.35	88.4	6.2	7.4
	SD	0.02	0.64	3.5	61	0.03	8.3	3.1	0.30	0.01	93	1.8	0.09	9.7	0.8	2.5
	Max	0.18	7.21	21.8	714	0.31	95.8	27.4	3.56	0.083	622	18.4	0.62	108	7.6	17.3
	Min	0.10	4.23	9.5	456	0.16	59.3	15.1	2.27	0.028	287	9.9	0.25	64.5	4.0	4.6

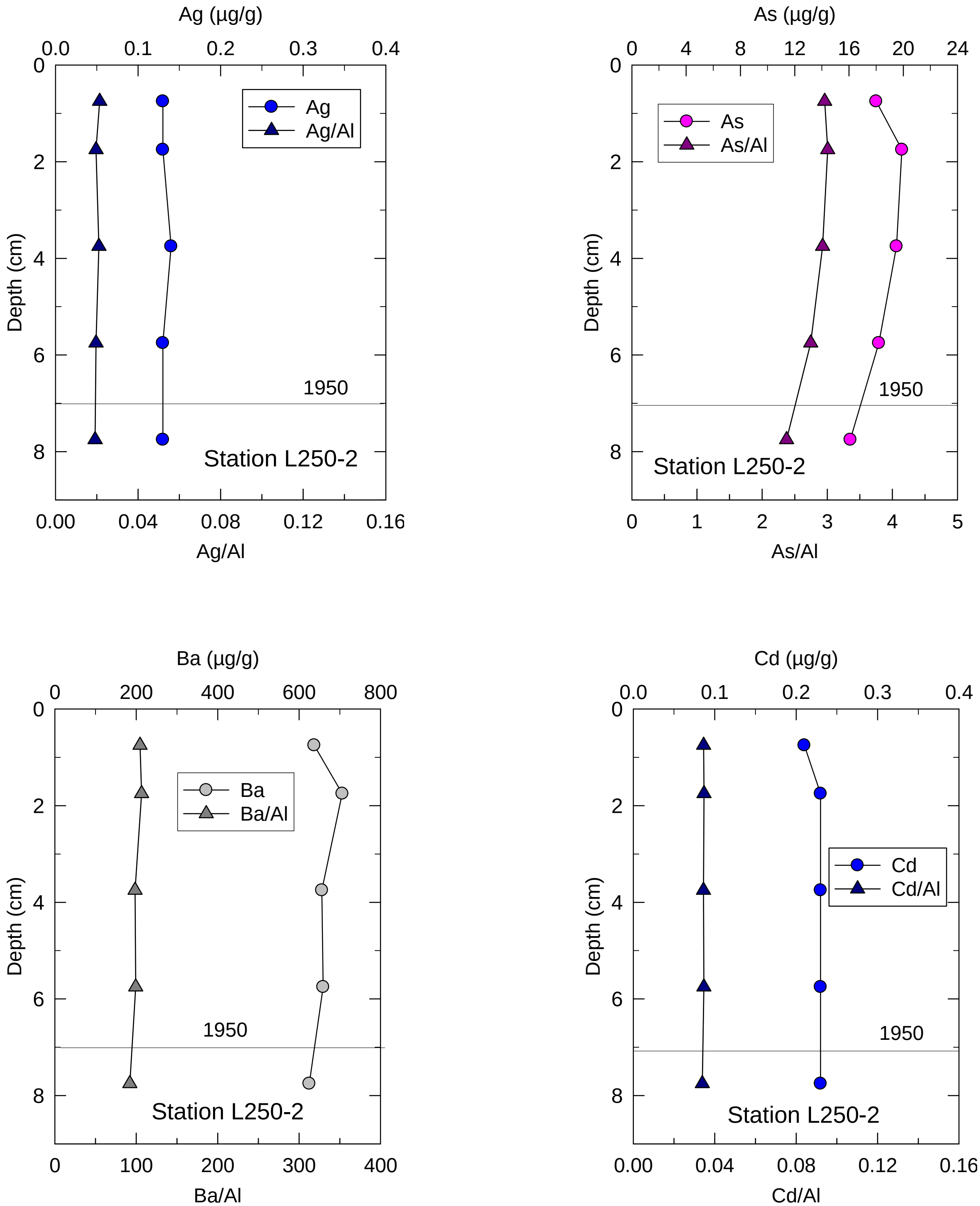


Figure 3.20. Vertical profiles of total Ag, As, Ba and Cd and their ratios to Al in sediments from station L250-2 in Camden Bay.

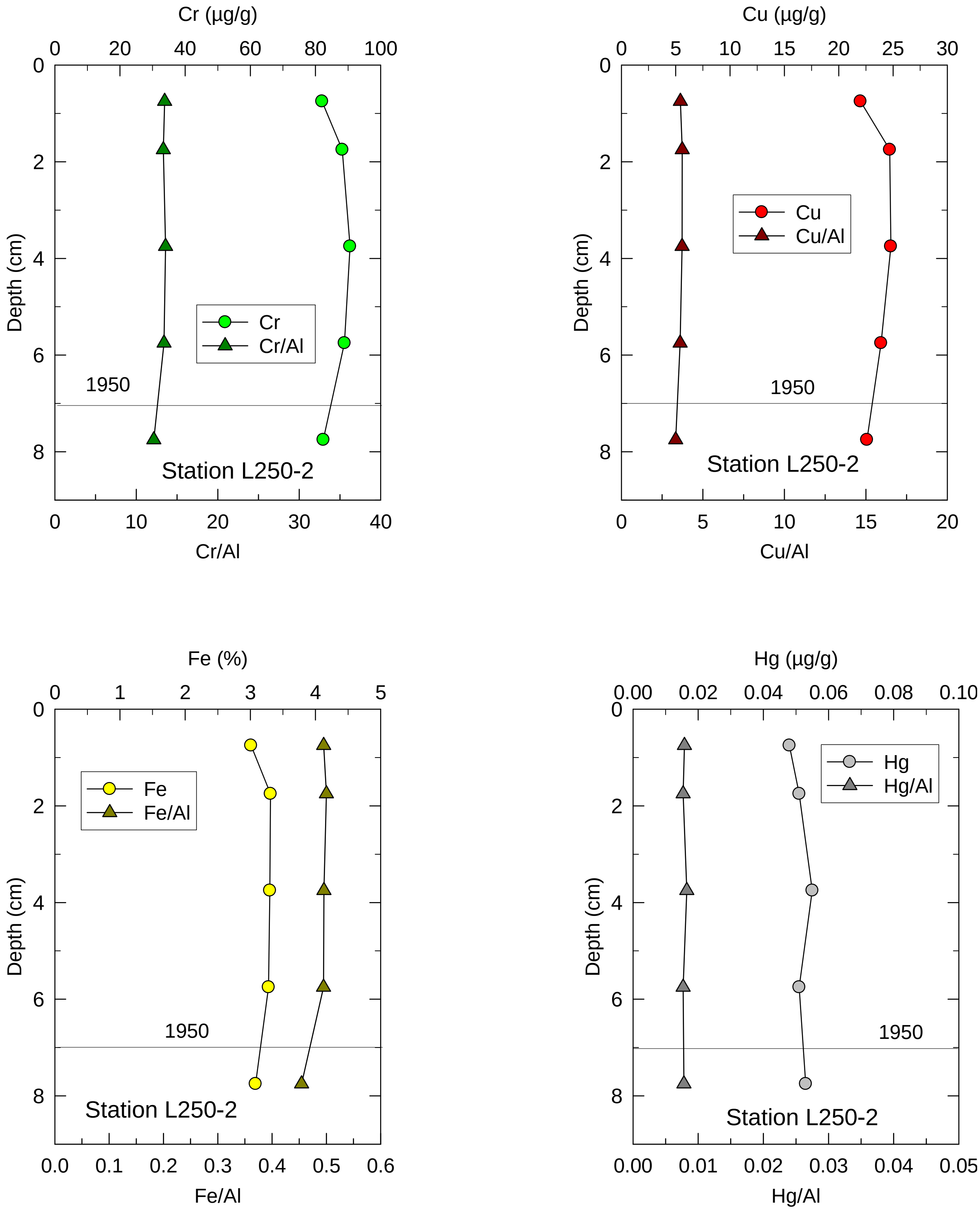


Figure 3.21. Vertical profiles of total Cr, Cu, Fe and Hg and their ratios to Al in sediments from station L250-2 in Camden Bay.

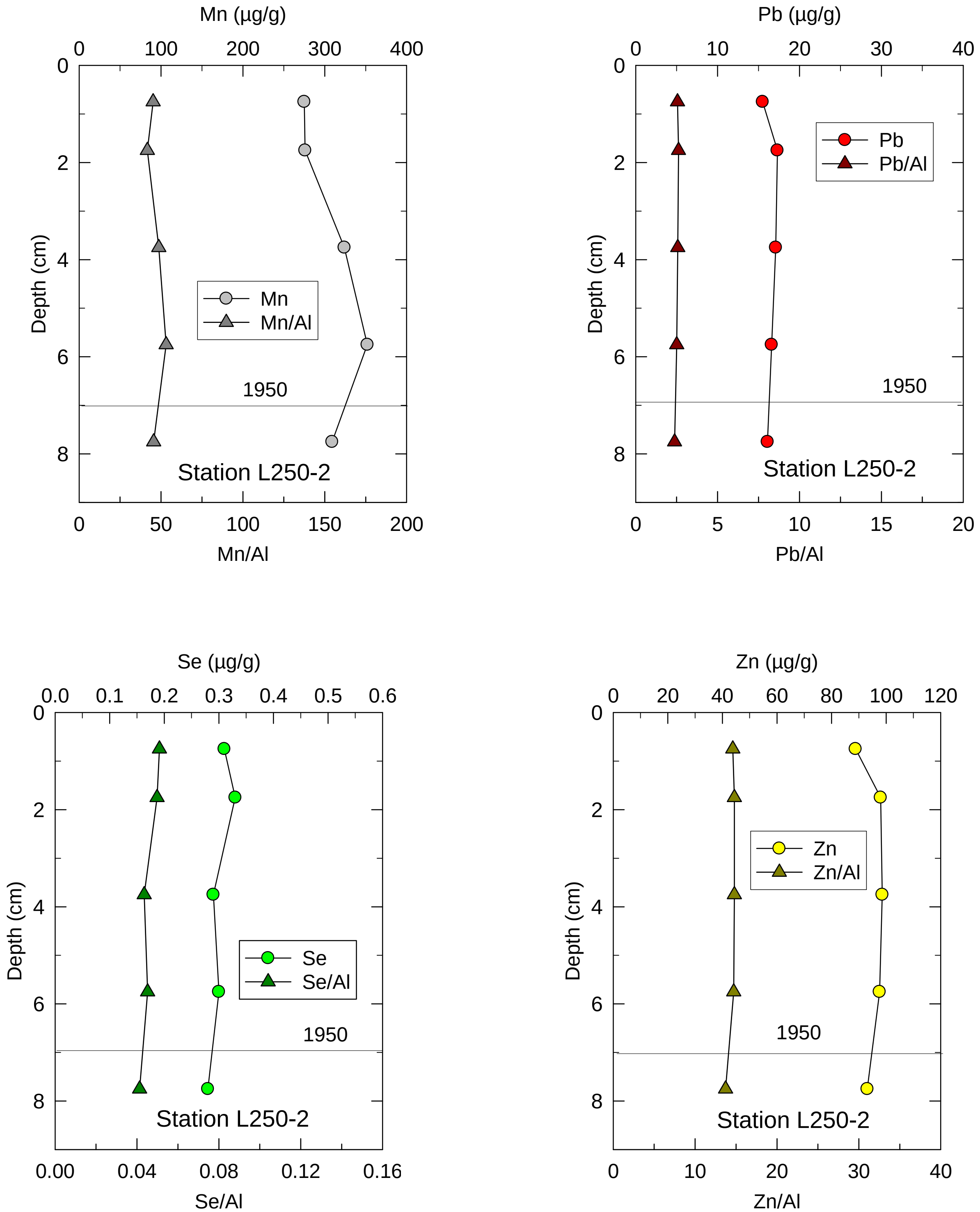


Figure 3.22. Vertical profiles of total Mn, Pb, Se and Zn and their ratios to Al in sediments from station L250-2 in Camden Bay.

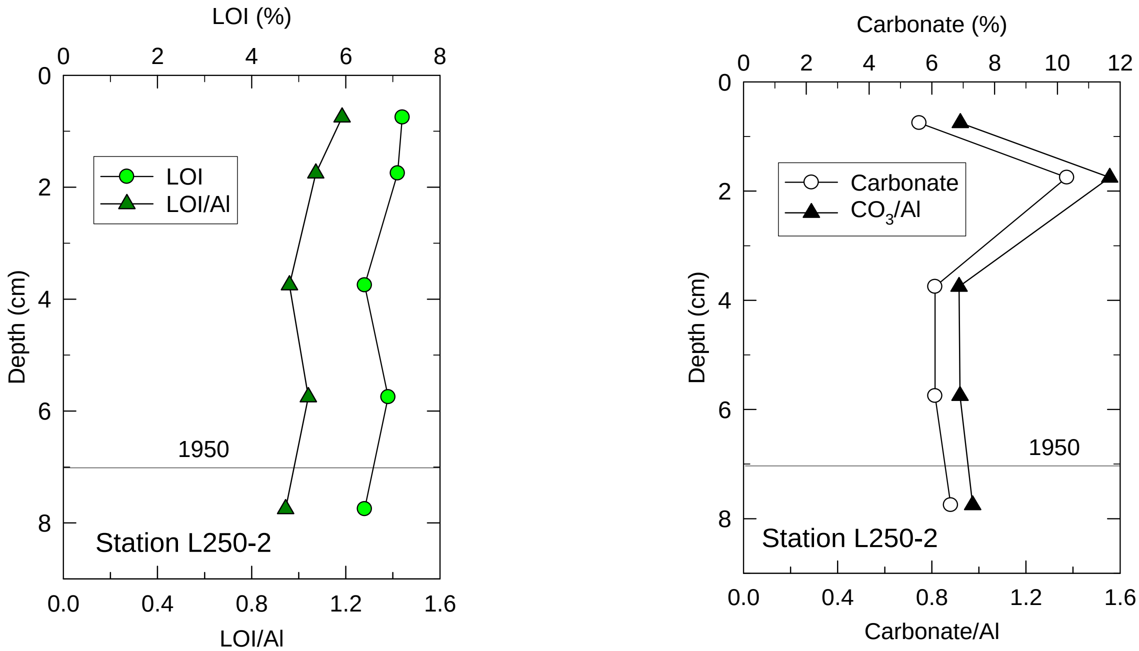


Figure 3.23. Vertical profiles for loss on ignition (LOI) and carbonate and their ratios to Al in sediments from station L250-2 in Camden Bay.

metal/Al ratios were uniform over the 8-cm length of the core that dates back to about 1950 (Figures 3.20-3.22). This age pre-dates the onset of industrial activity in the area and supports the absence of anthropogenic metals in sediments at station L250-2. Some minor shifts in metal concentrations were observed in the core from station L250-2 (Figures 3-20 to 3-22); however, the metal/Al ratios are uniform throughout the core. A shift in carbonate content was observed in the 1.5-2 cm interval (Figure 3-23); however, this shift of about 4% carbonate was not large enough to yield a discernible shift in metal values in that layer.

Similar to observed for station L250-2, no data points from the sediment core from station L500-2 plotted above the upper prediction interval on the metal versus Al graphs (Figures 3.24 and 3.25), in support of background values for all metals at this site. Vertical profiles for the various metals (Figures 3-26 to 3-28) show that the metal/Al ratios were uniform over the 9-cm length of the core. One minor exception to the trends described above was observed for As in the 1 to 2 cm layer of the core from station L500-2 (Figure 3.26). The spike in As concentrations and the As/Al ratio at the top of the core is balanced by lower As/Al ratios (relative to station L250-2) in the bottom three layers of the core (Figures 3.26 and 3.20). This shift most likely resulted from the previously discussed diagenetic process in the core that most likely led to reductive dissolution of As deeper in the core with precipitation of upwardly diffusing As in the top layer of oxic sediments.

Collectively, the data for cores from stations L250-2 and L500-2 show that normalized concentrations of all metals studied, excluding the previously discussed natural diagenetic

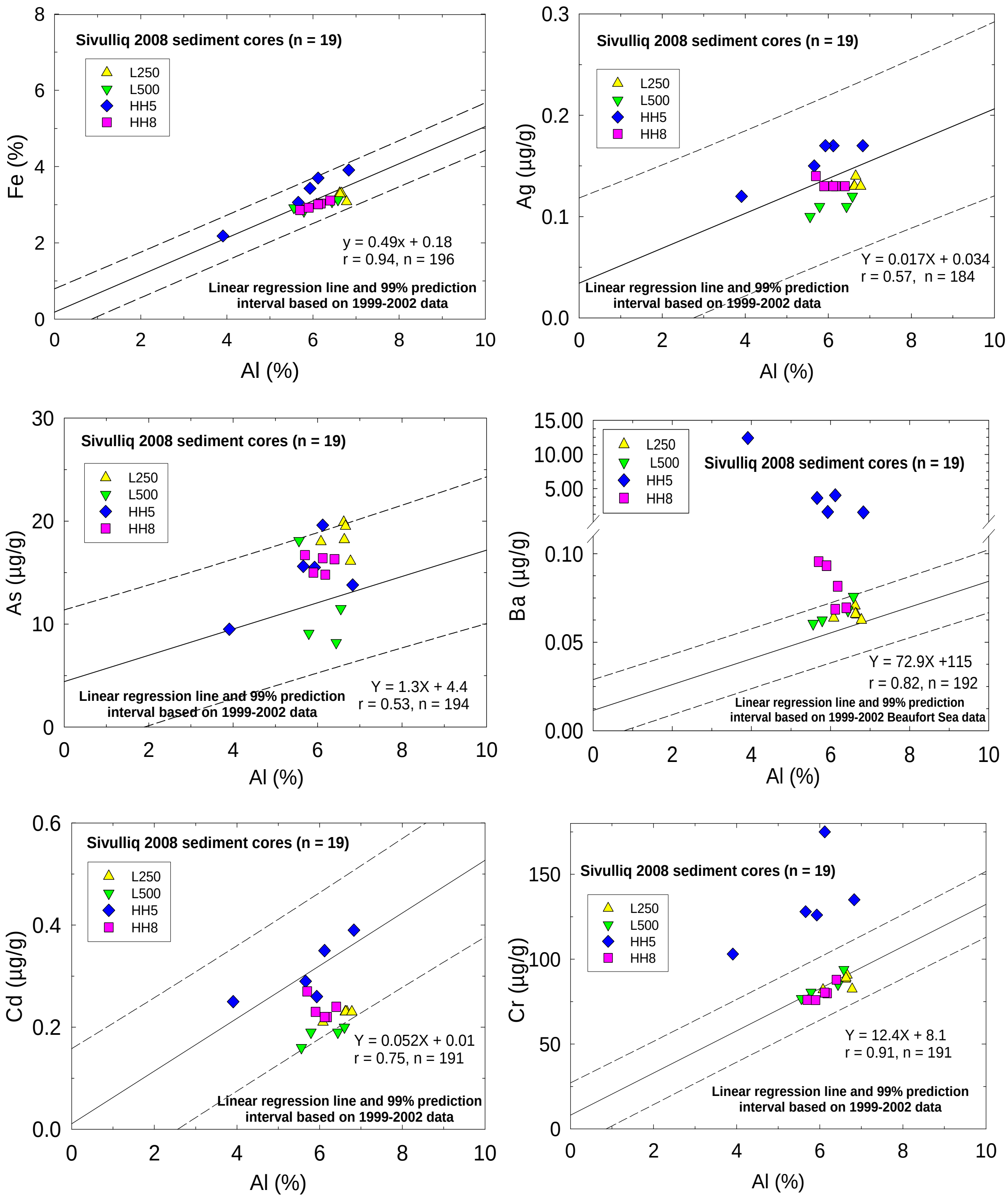


Figure 3.24. Values for total concentrations of Fe, Ag, As, Ba, Cd and Cr versus Al for sediment cores from the 2008 study of Camden Bay. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

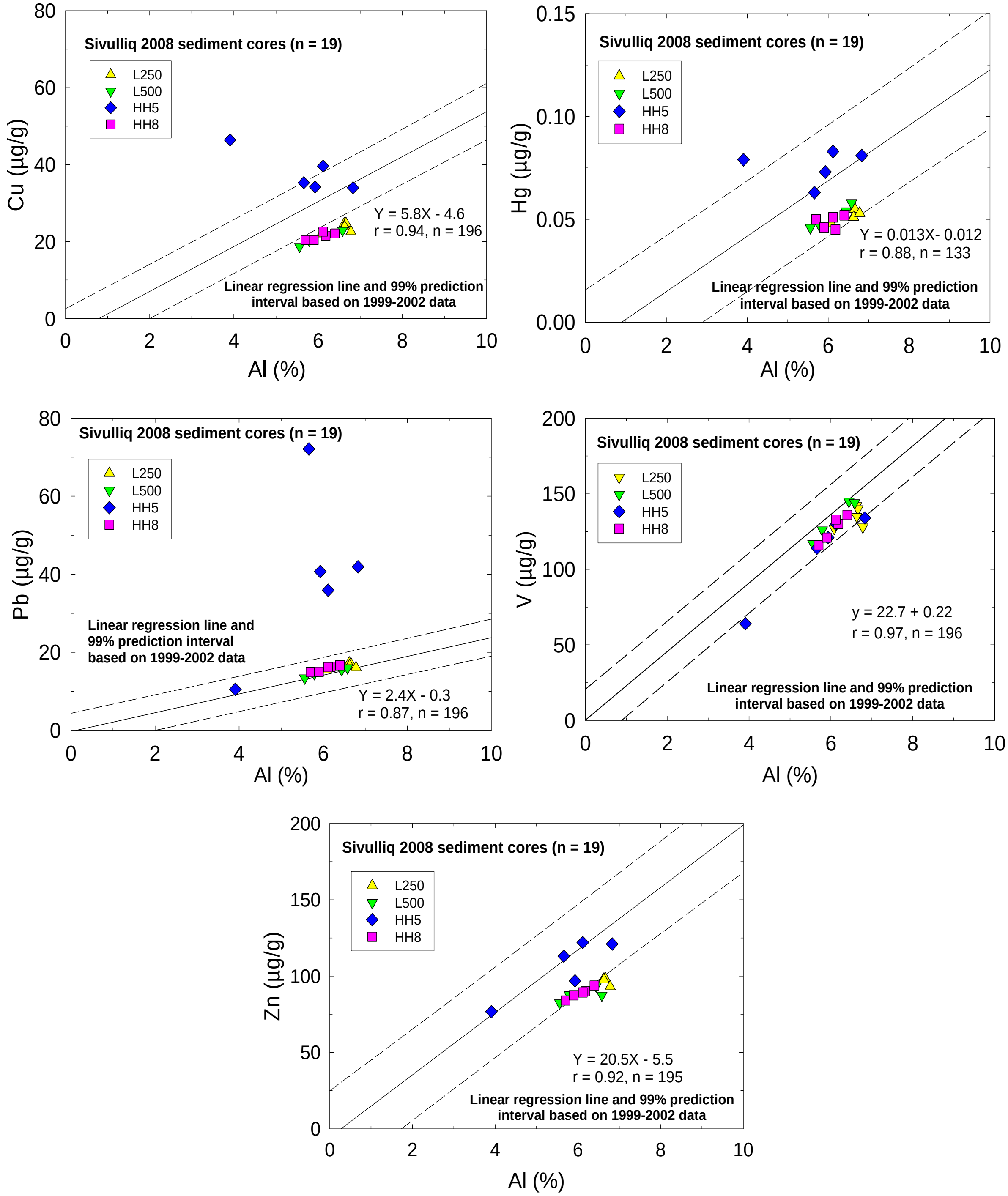


Figure 3.25. Values for total concentrations of Cu, Hg, Pb, V and Zn versus Al for sediment cores from the 2008 study of Camden Bay. The 2008 data from Camden Bay were plotted on a template with a linear regression line and prediction interval that were determined using background sediments from the coastal Beaufort Sea (Trefry et al., 2003).

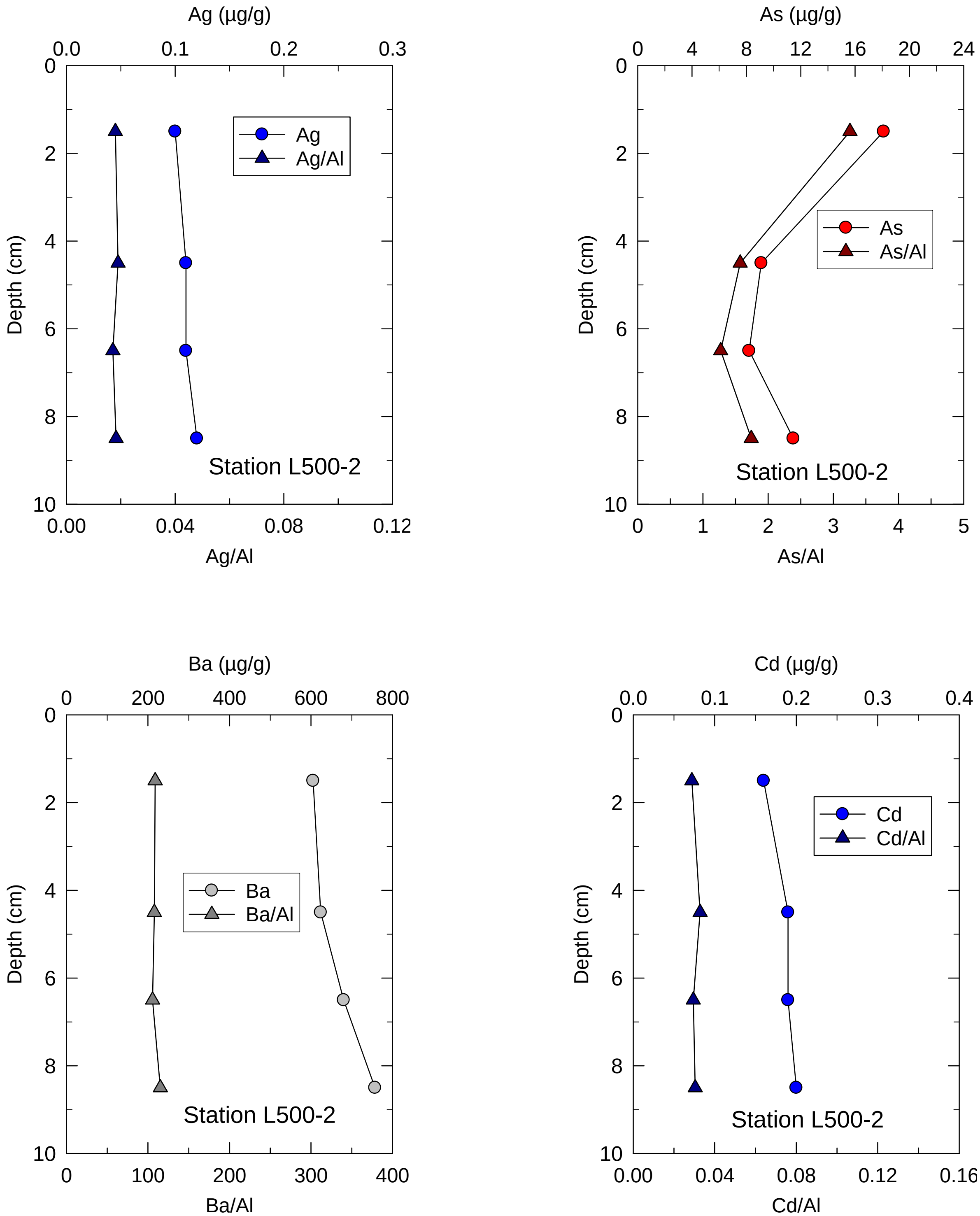


Figure 3-26. Vertical profiles of total Ag, As, Ba and V and their ratios to Al in sediments from station L500-2 in Camden Bay.

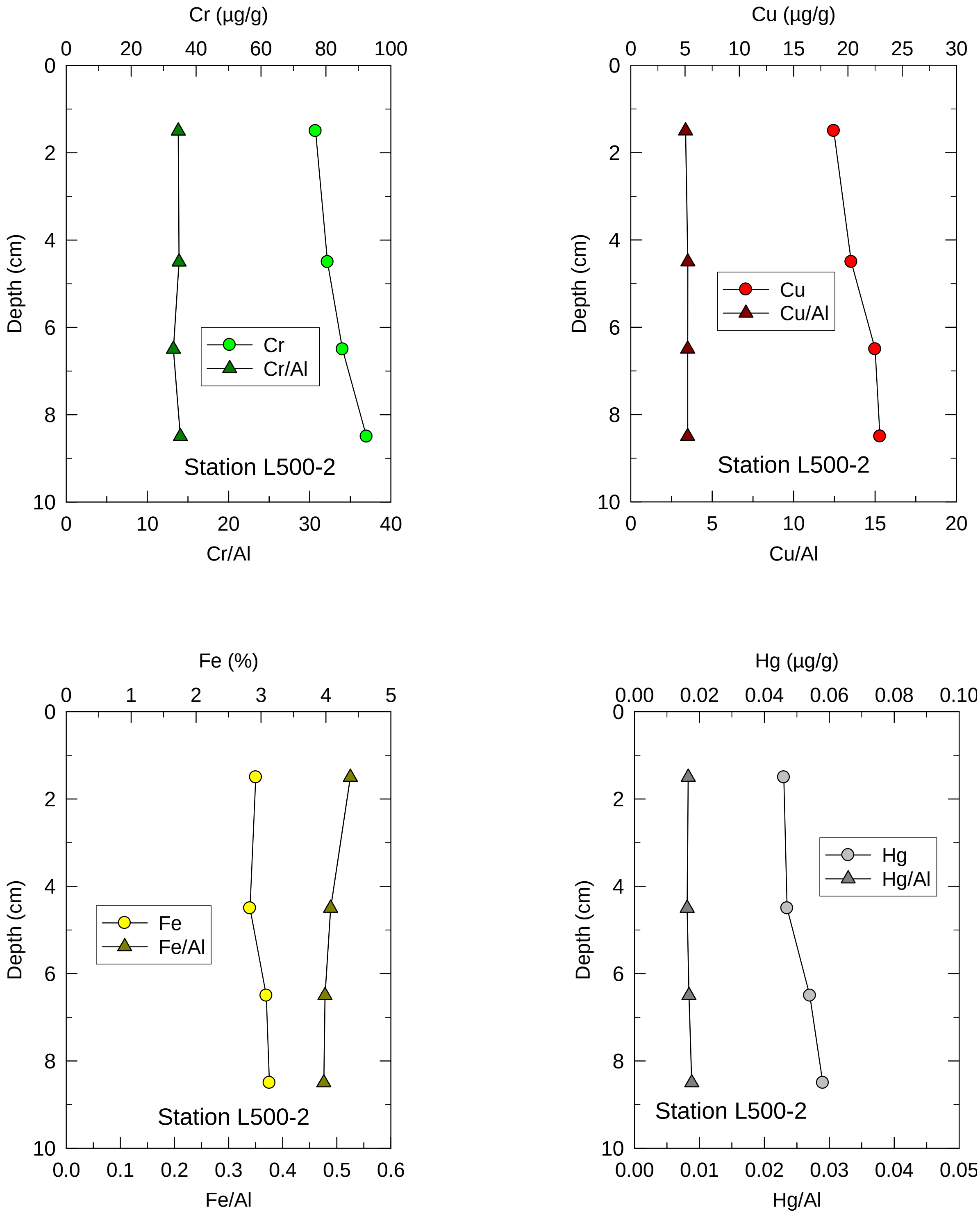


Figure 3.27. Vertical profiles of total Cr, Cu, Fe and Hg and their ratios to Al in sediments from station L500-2 in Camden Bay.

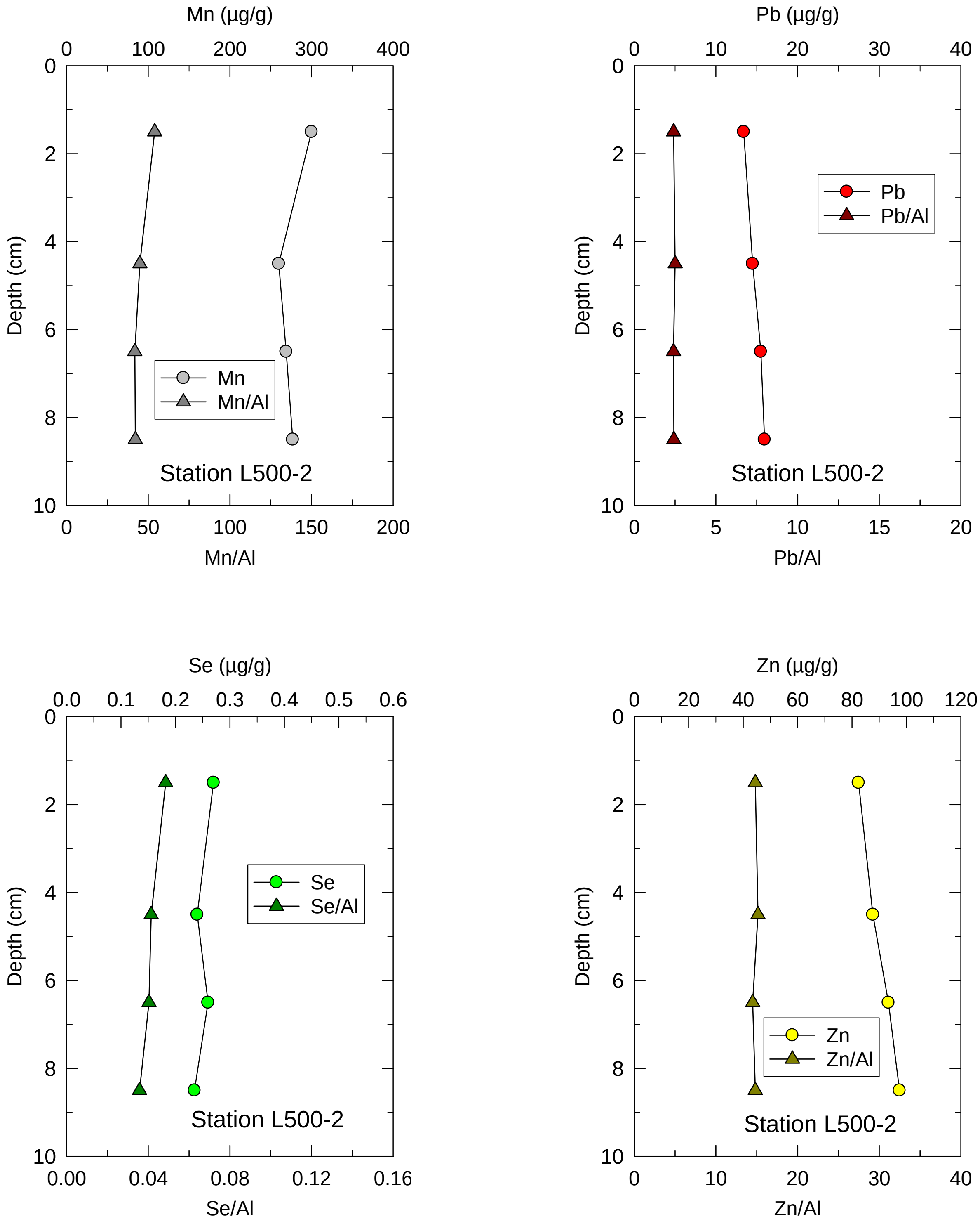


Figure 3.28. Vertical profiles of total Mn, Pb, Se and Zn and their ratios to Al in sediments from station L500-2 in Camden Bay.

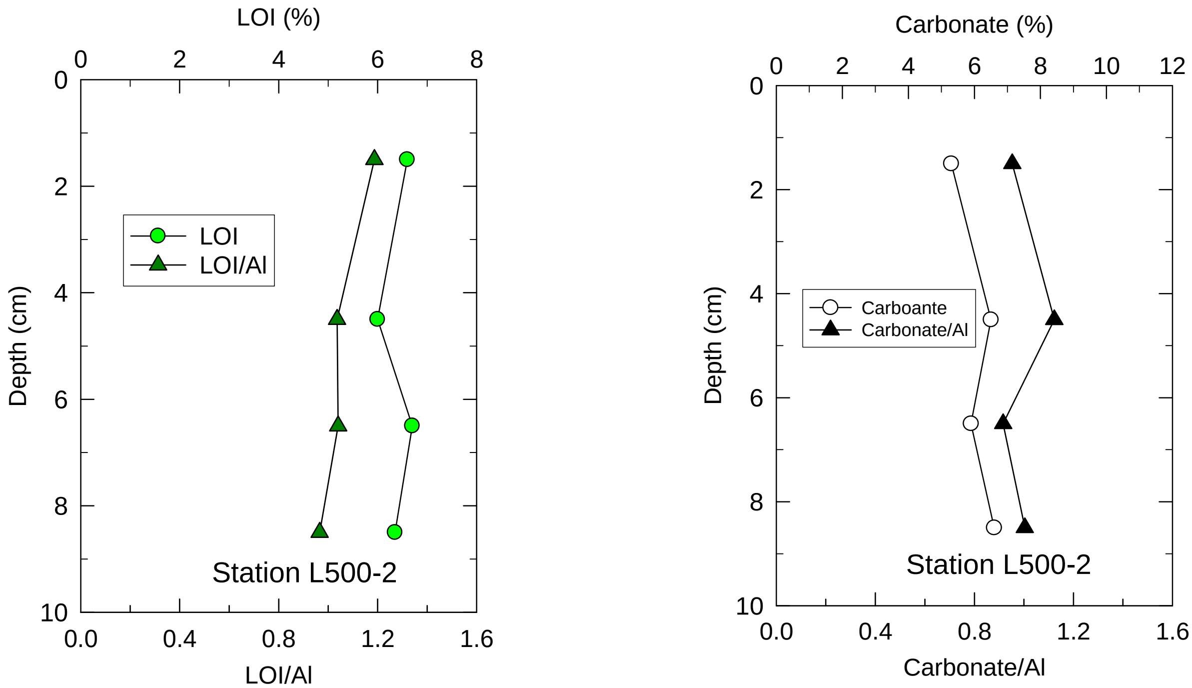


Figure 3.29. Vertical profiles of loss on ignition at 550° C (LOI) and carbonate and their ratios to aluminum (Al) in sediments from station L500-2 in Camden Bay.

effect for As, are constant with time, supporting no detectable anthropogenic inputs of metals.

No anomalous concentrations or metal/Al ratios were found for total Ag, As, Cd, Fe, Hg, Mn and Zn throughout the core from station HH-5 (Figures 3.24 and 3.25). Vertical dashed vertical lines on metal profiles for station HH-5 show that the metal/Al ratios obtained for these seven metals at station HH-5 (Figures 3.30-3.32) are in agreement with results for L250-2 and L500-2 (Figures 3.30 to 3.32); thus, the metal/Al ratios for these metals for station HH-5 are at background values throughout the core.

The sediment core from station HH-5 contained anomalously high concentrations of Ba, Cr and Se throughout the core with values for Pb and Cu that were elevated in four and two layers, respectively (i.e., data points above the upper prediction interval on metal/Al graphs, Figures 3.24 and 3.25). Based on data for Ba, sediments from station HH-5 contained remnants of drilling mud throughout the 8-cm core (Figures 3.30). The highest concentration of Ba (12.4%) was in the bottom layer of the core and was most likely deposited during drilling operations in 1985 (Figure 3.34). Based on the sediment geochronology for station L250-2 (Figure 3.18), about 2.5 cm of sediment could have been deposited in the HH area since 1985. Excess ^{210}Pb was observed only in the top 2 cm of the core from station HH-5 (Figure 3.19). The activity of ^{137}Cs in the top 2 cm of the core from station HH-5 was 20 to 40% lower than in the core from station L250-2 (Figures 3.18 and 3.19). In addition, the

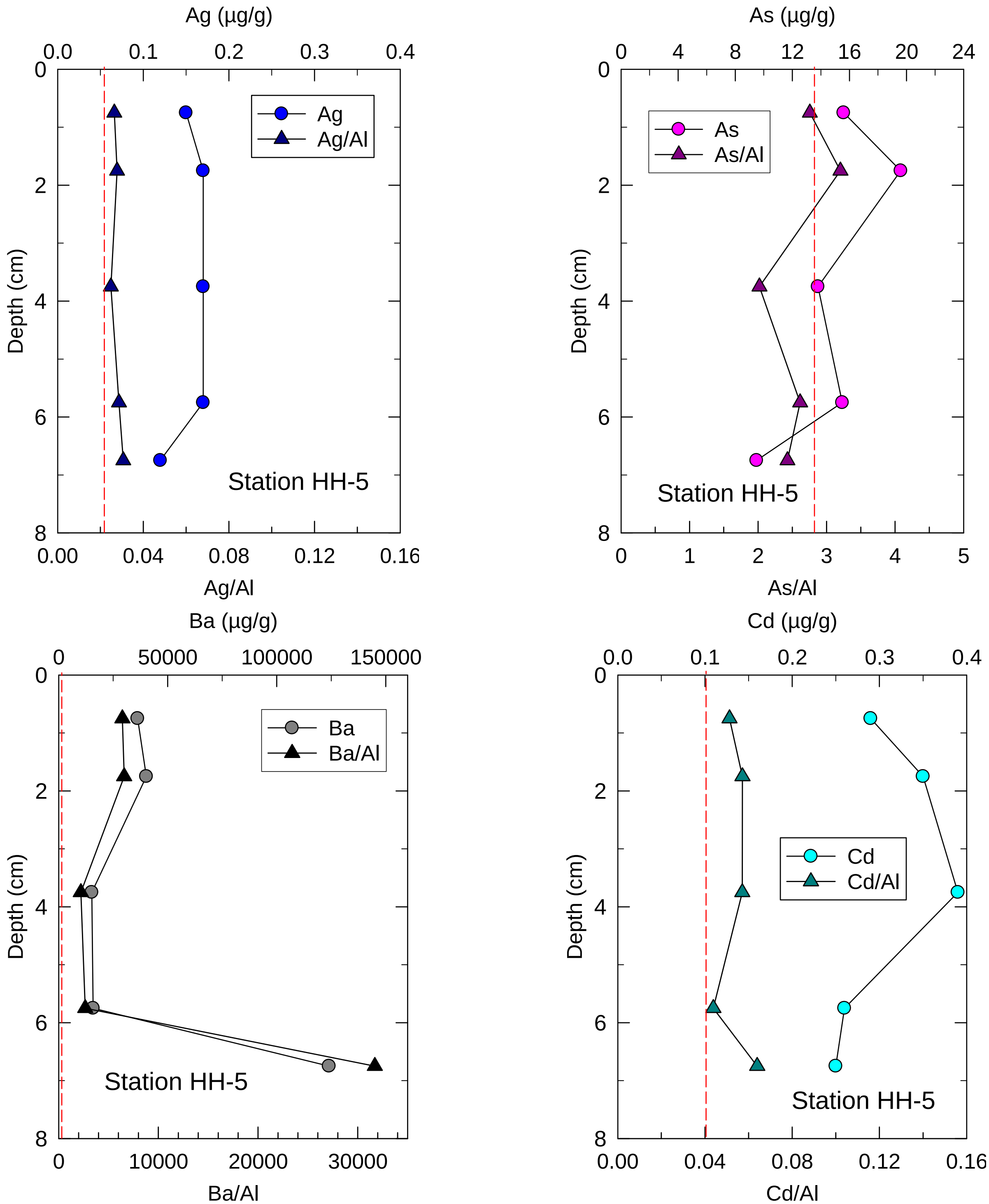


Figure 3.30. Vertical profiles of total Ag, As, Ba and Cd and their ratios to Al in sediments from station Hammerhead 5 (HH-5) in Camden Bay. Dashed vertical lines show metal/Al ratios for background stations L250-2 and L500-2.

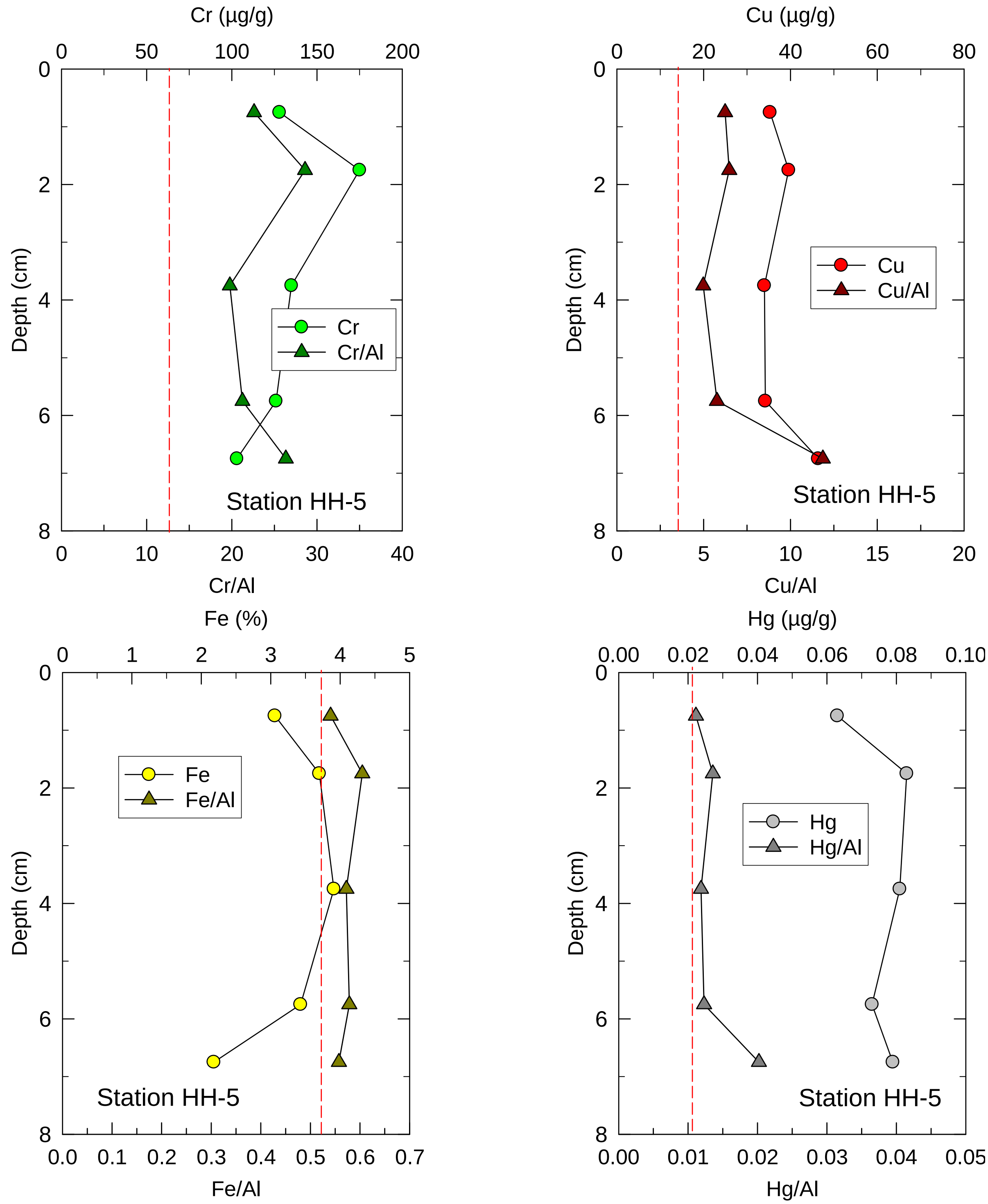


Figure 3.31. Vertical profiles of total Cr, Cu, Fe and Hg and their ratios to Al in sediments from station Hammerhead 5 (HH-5) in Camden Bay. Dashed vertical lines show metal/Al ratios for background stations L250-2 and L500-2.

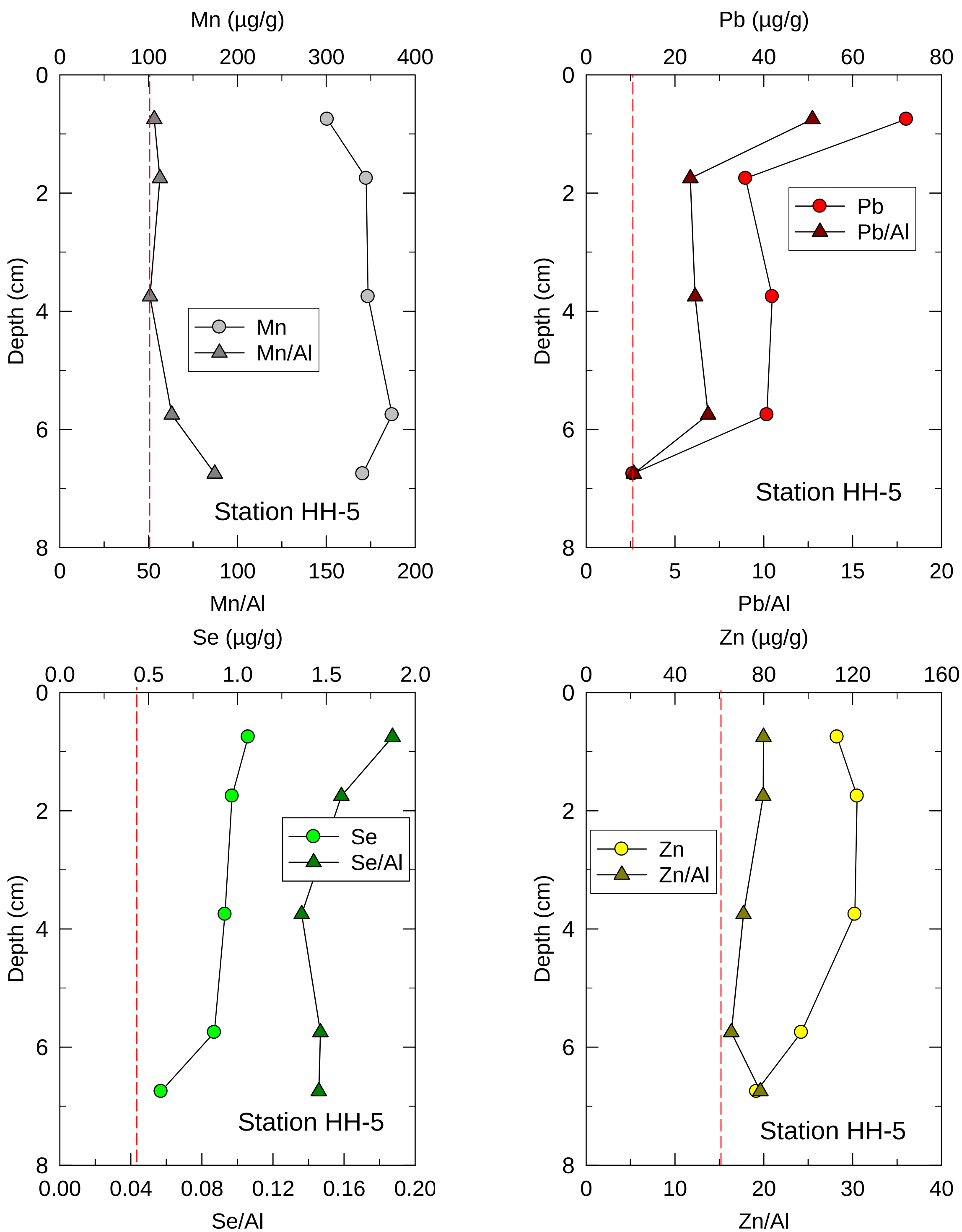


Figure 3.32. Vertical profiles of total Mn, Pb, Se, and Zn and their ratios to Al in sediments from station Hammerhead 5 (HH-5) in Camden Bay. Dashed vertical lines show metal/Al ratios for stations L250-2 and L500-2.

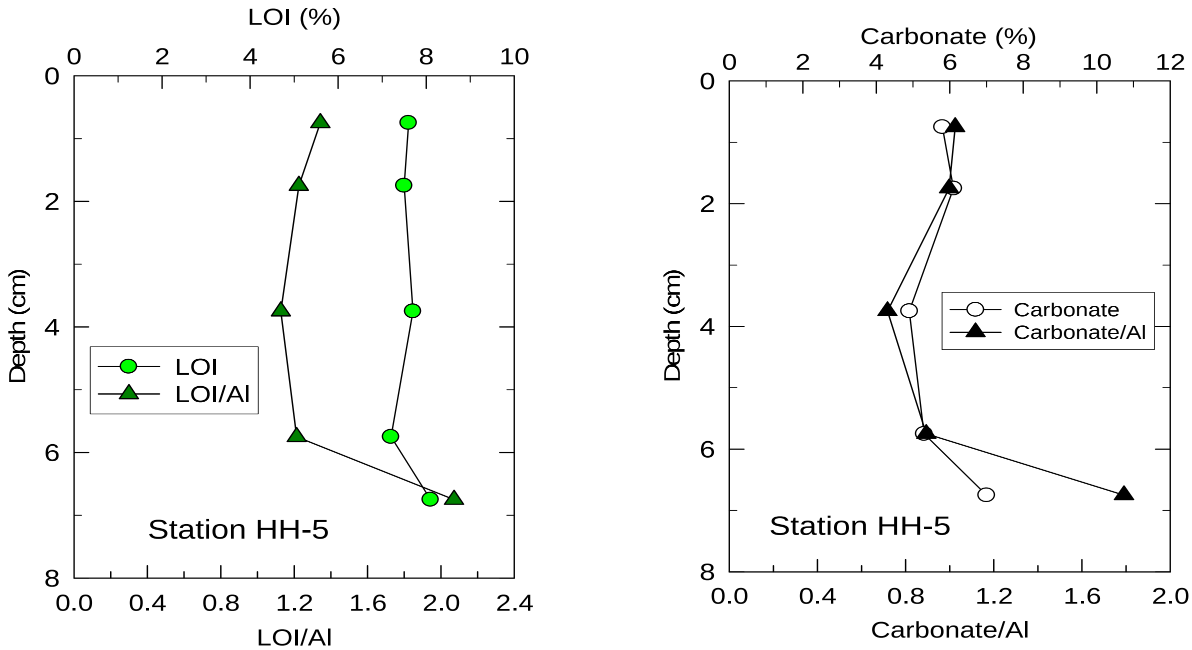


Figure 3.33. Vertical profiles for loss on ignition at 550° C (LOI) and carbonate and their ratios to aluminum (Al) in sediments from station Hammerhead 5 (HH-5) in Camden Bay.

the activity of ^{137}Cs in the core from station HH-5 decreased sharply in the 2 to 4 cm sections and was not detectable below 4 cm (Figure 3.34). These observations, along with elevated concentrations of Ba in the top 2 cm of the core from station HH-5, support physical or biological mixing of recent sediment with drilling mud and cuttings during the past 23 years. Concentrations of naturally occurring ^{226}Ra were lowest in the Ba-rich layer at the base of the core, reflecting the lower abundance of ^{226}Ra in drilling mud.

The Pb concentration in the top layer of the core was ~7 times greater than in the Ba-rich layer at the base of the core (Figure 3.34); this observation suggests that the excess Pb was related to an unknown source other than drilling discharges in 1985 or that the Pb-bearing components of the drilling mud were separated from the Ba and mixed inhomogeneously in the sediment column. The vertical profile for Cr was similar to that for Pb in that the highest Cr value was in the top of the core (Figure 3.34). The deposition and mixing of drilling mud constituents with recent, background sediment in the sediment column at station HH-5 are complex and additional coring studies are needed to better explain the observed metal and radionuclide profiles.

Concentrations of all metals in the core from station HH-8 were at background values (Figures 3.24, 3.25, 3.35-3.37), except for Ba in the top three samples (0 to 4 cm). Barium concentrations in the top 4 cm of the core ranged from 816 to 955 µg/g relative to background values of 600 to 700 µg/g (Figure 3.35). These higher Ba values from station

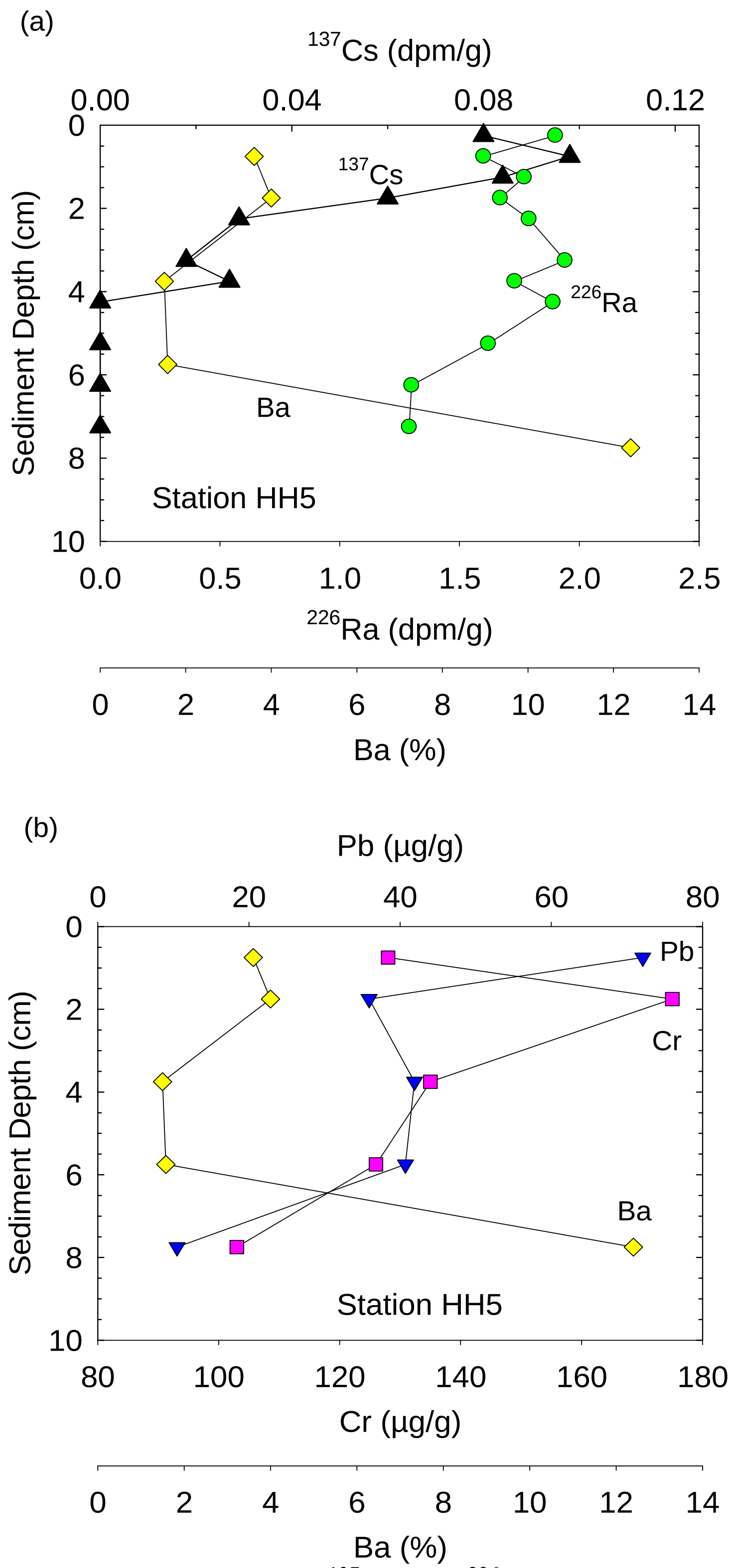


Figure 3.34. Vertical profiles for (a) Ba, ^{137}Cs and ^{226}Ra and (b) Ba, Pb and Cr for the sediment core from station HH-5.

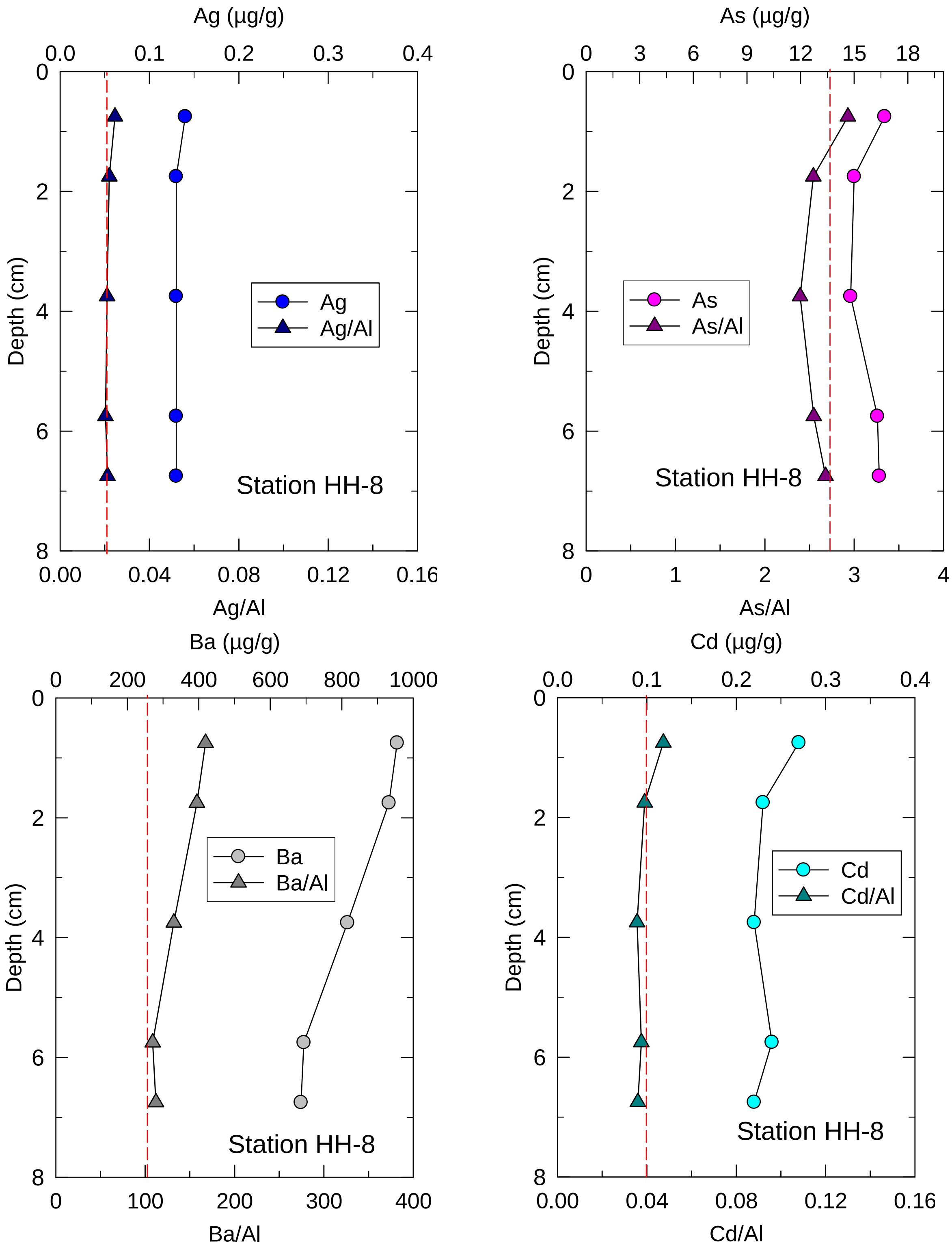


Figure 3.35. Vertical profiles of total Ag, As, Ba and Cd and their ratios to Al in sediments from station Hammerhead 8 (HH-8) in Camden Bay. Dashed vertical lines show metal/Al ratios for stations L250-2 and L500-2.

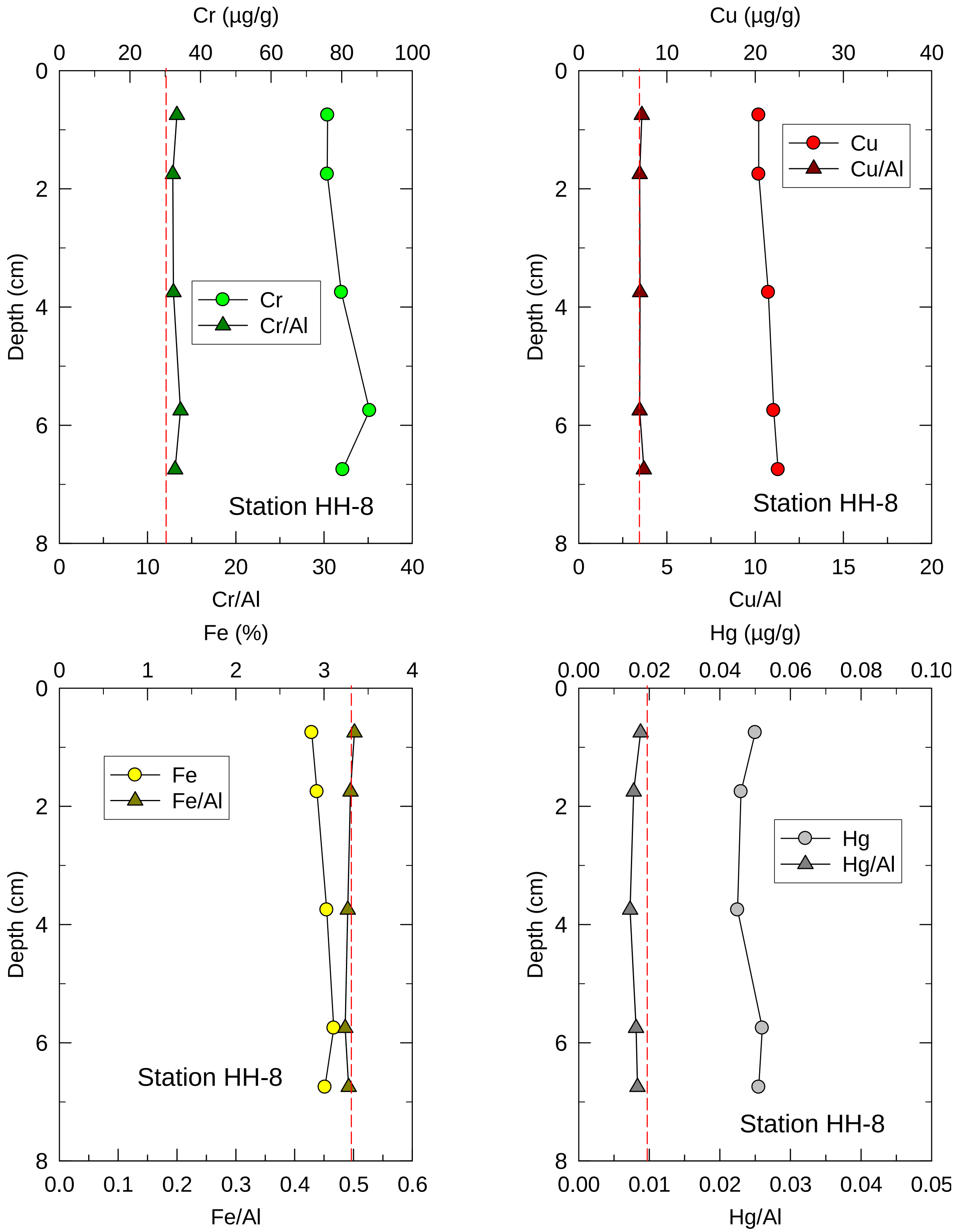


Figure 3.36. Vertical profiles of total Cr, Cu, Fe and Hg and their ratios to Al in sediments from station Hammerhead 8 (HH-8) in Camden Bay. Dashed vertical lines show metal/Al ratios for stations L250-2 and L500-2.

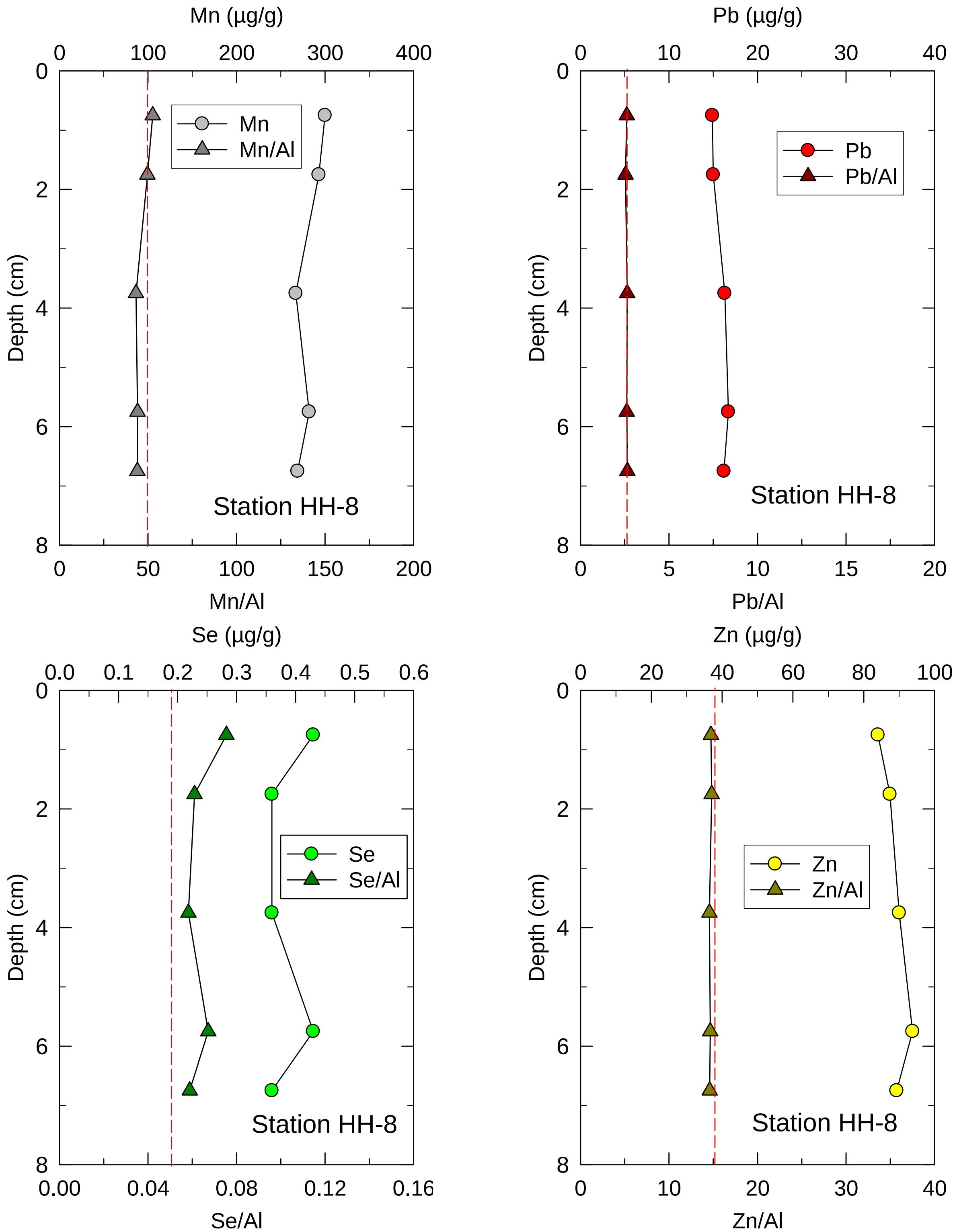


Figure 3.37. Vertical profiles of total Mn, Pb, Se, and Zn and their ratios to Al in sediments from station Hammerhead 8 (HH-8) in Camden Bay. Dashed vertical lines show metal/Al ratios for stations L250-2 and L500-2.

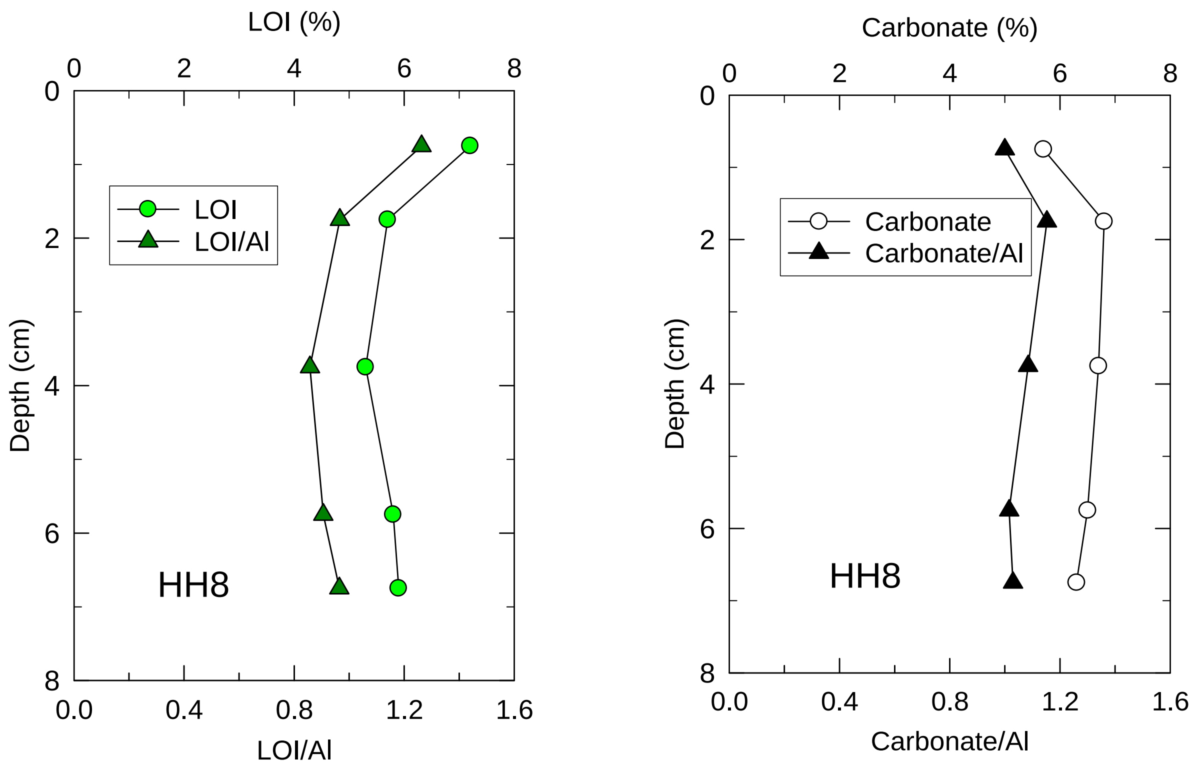


Figure 3.38. Vertical profiles of loss on ignition at 550° C (LOI) and carbonate and their ratios to aluminum (Al) in sediments from station Hammerhead 5 (HH-8) in Camden Bay.

HH-8 are 15 to more than 100 times lower than the Ba values for sediments in the core from station HH-5 (Figure 3.34). No Ba enrichment was found in the core from station HH-8 below 4 cm. Thus, a very minor amount of barite may have settled out at station HH-8 or it is possible that a diagenetic process in the sediment column led to enrichment of Ba in the top portion of the core from (McManuw et al. 1994; Torres et al., 1995).

3.4. Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons in Surface Sediments

Concentrations of total petroleum hydrocarbons (TPH) were determined for 46 surface sediments from the 2008 study area in Camden Bay. Concentrations of TPH in the HEX, L250, L500 and P areas averaged 34 ± 12 µg/g and ranged from 12 to 66 µg/g (Figure 3.39 and Tables 3.5 and 3.6; the complete data set with concentrations of the individual compounds is available in the Appendices on CD). Surface sediments from 9 of 10 stations in the HH area had an average TPH concentration of 39 ± 6 µg/g, a value that was not significantly different (t-test, 2-tailed, α=0.05) from the grand mean for the other four areas in Camden Bay. At station HH-5, the TPH value for the surface sediment was 192 µg/g or about 5 times greater than found at the other stations in the 2008 study of Camden Bay. As previously introduced, the surface sediment sample from station HH-5 had elevated concentrations of total Ag, Ba, Cr, Cu, Pb and Se.

Values for TPH in the 2008 study of Camden Bay (excluding the sample from station HH-5) correlated with sediment grain size (r = 0.66, Figure 3.40a). Several of the samples from the HEX area had the lowest values for silt + clay and TPH (Figure 3.40a). Likewise, samples from only the HEX area had significantly lower average concentration of TPH (t-test, 2-tailed, α = 0.05) than observed for each of the other three areas (L, HH and P, Figure 3.39, Table 3.5). Thus, grain size certainly accounts for part of the lower average TPH values for the HEX area (Figure 3.39). In this study, TOC was more weakly correlated with TPH (r =

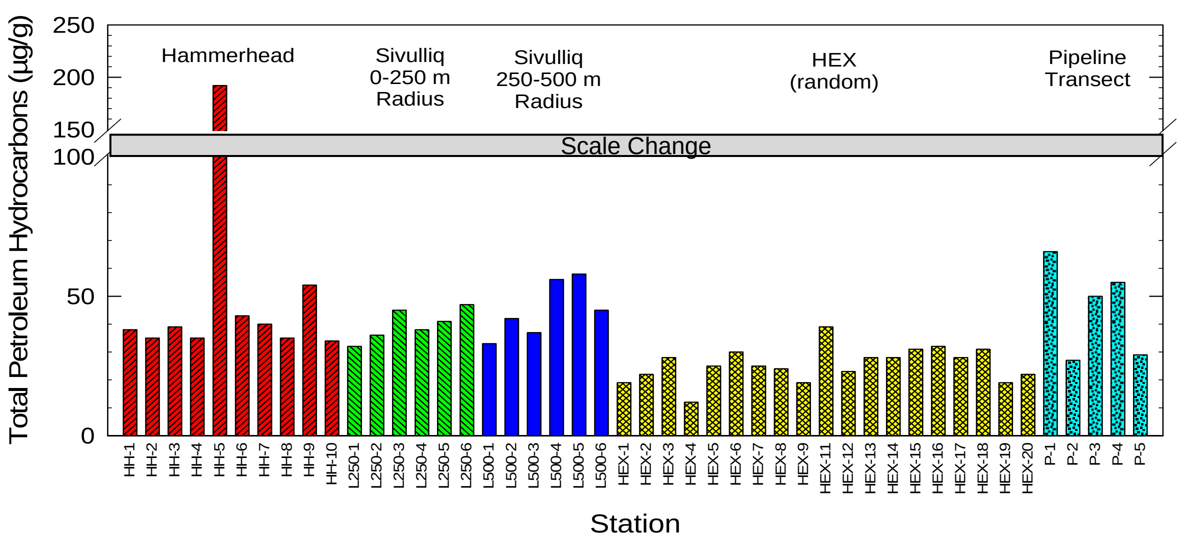


Figure 3.39. Values for total petroleum hydrocarbons in surface sediments for the 2008 survey in Camden Bay.

Table 3.5. Summary data for total petroleum hydrocarbons (TPH), total polycyclic aromatic hydrocarbons (TPAH), selected components of TPAH, total organic carbon and silt + clay for sediments in HEX, L250, L500 and Pipe areas from 2008 study of Camden Bay. (SD = standard deviation, RSD = relative standard deviation).

Area	Statistic	TPH (µg/g)	TPAH (ng/g)	Phenan-threne (ng/g)	Pyrene (ng/g)	BaP (ng/g)	Perylene (ng/g)	TOC (%)	Silt + Clay (%)
HEX (n = 19)	Mean	26	880	26	12	4	92	0.8	62
	SD	6	154	5	2	0.8	19	0.2	14
	RSD (%)	24	18	19	17	19	20	25	23
	Max	39	1110	32	15	6	127	1	87
	Min	12	544	15	8	3	55	0.6	29
L250 L500 (n = 12)	Mean	42	916	31	11	4	94	0.7	57
	SD	8	191	6	2	0.9	19	0.1	10
	RSD (%)	19	21	20	22	21	20	15	17
	Max	58	1310	45	16	6	130	1.0	73
	Min	32	542	19	6	2	58	0.5	38
PIPE (n = 5)	Mean	45	744	27	8	3	83	1.05	69
	SD	17	178	5	3	1	26	0.2	14
	RSD (%)	37	24	19	30	36	31	24	21
	Max	66	924	34	11	4	108	1.2	83
	Min	27	494	21	5	1	45	0.7	52

Table 3.6. Summary data for total petroleum hydrocarbons (TPH), total polycyclic aromatic hydrocarbons (TPAH), selected individual TPAH, total organic carbon and silt + clay for sediments in the combined HEX, L250, L500 and Pipe areas, the Hammerhead area and from 2005 study of Camden Bay. (SD = standard deviation, RSD = relative standard deviation).

Area	Statistic	TPH (µg/g)	TPAH (ng/g)	Phenan-threne (ng/g)	Pyrene (ng/g)	BaP (ng/g)	Perylene (ng/g)	TOC (%)	Silt + Clay (%)
HEX, L250, L500, P (n = 36)	Mean	34	873	28	11	4	91	0.8	60
	SD	12	174	6	2	1	19	0.2	12
	RSD (%)	37	20	20	22	25	21	24	21
	Max	66	1310	45	16	6	130	1.3	87
	Min	12	494	15	5	1	45	0.5	29
HH (n = 10)	Mean	54	1213	32	16	6	165	0.8	60
	SD	49	824	3	11	4	214	0.1	5
	RSD (%)	89	68	10	69	72	129	13	9
	Max	192	3540	35	47	18	773	0.9	68
	Min	34	843	26	11	4	88	0.6	50
Camden Bay 2005 (n = 21)[1]	Mean	18	961	34	11	3	99	0.7	69
	SD	9	334	13	3	0.8	46	0.4	13
	RSD (%)	50	35	38	25	25	46	50	19
	Max	42	1650	61	18	4	241	1.8	92
	Min	11	430	17	6	1	50	0.4	39

[1]Brown et al. (2009)

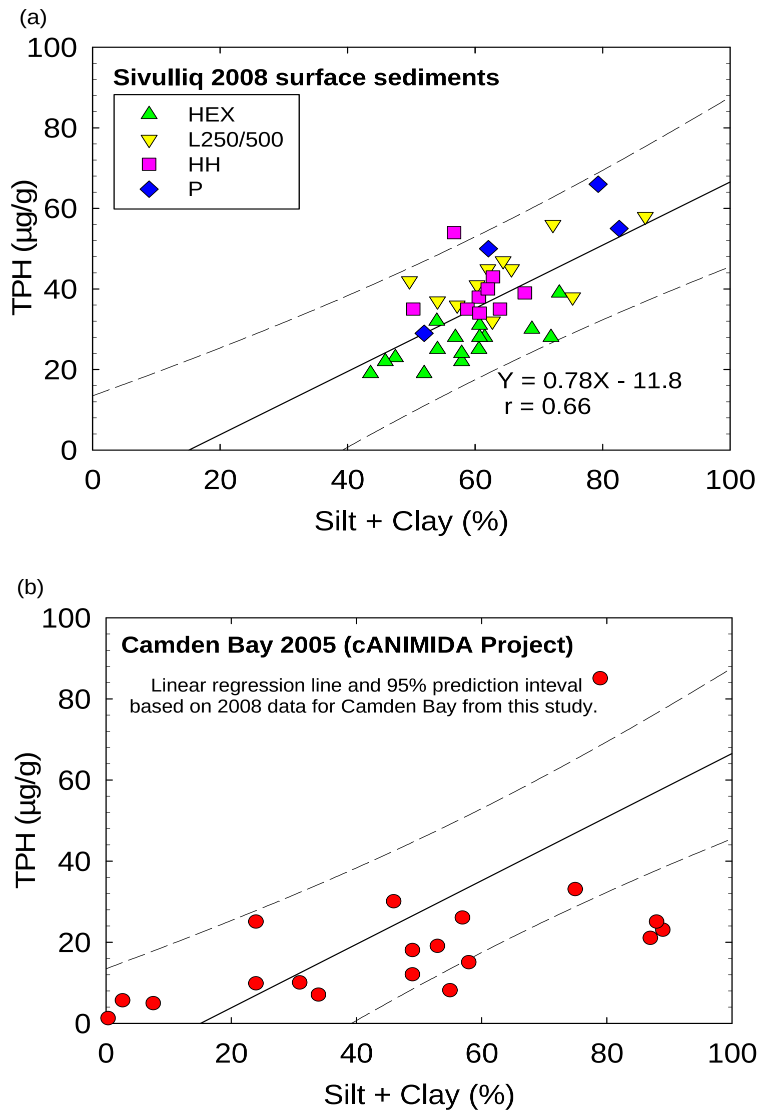


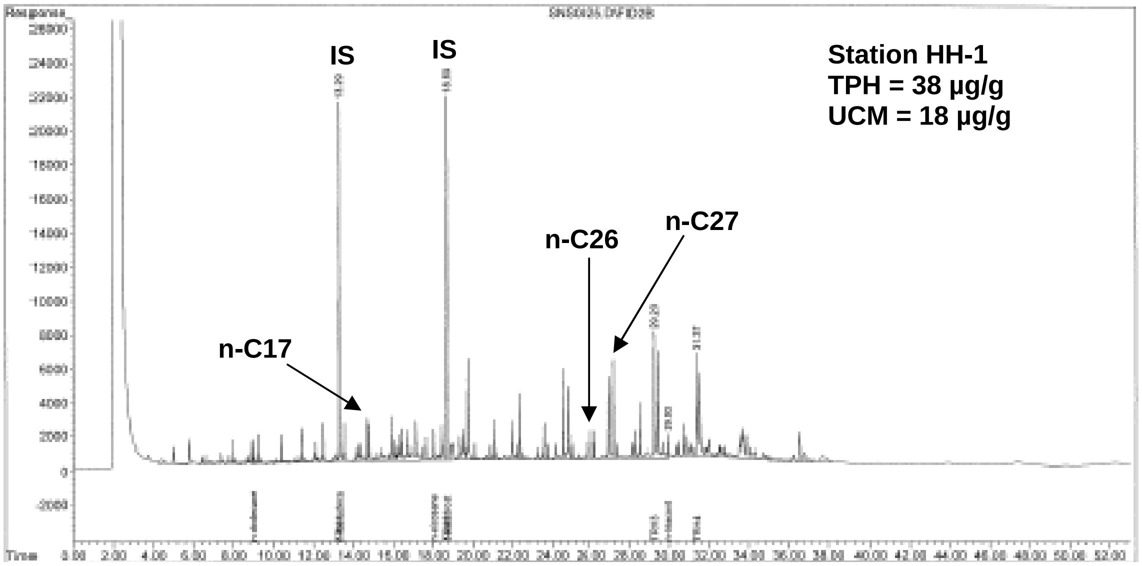
Figure 3.40. Values for TPH versus silt + clay for (a) 2008 sediments from Camden Bay (excluding station HH-5) and (b) 2005 samples for Camden Bay from Brown et al. (2009) . The linear regression line and 95% prediction interval on each graph are from the 2008 data for Camden Bay.

0.45) and thus would seem to play a lesser role in controlling concentrations of TPH. Furthermore, TPH makes up an average of only ~0.07% of the TOC (or ~0.02% of the organic matter where the organic carbon content of the organic matter is 40%).

Concentrations of TPH in 21 sediment samples that were collected during 2005 (cANIMIDA project) from shallower water in Camden Bay (water depths 4 to 22 m) averaged 18 ± 9 µg/g with a range of 11 to 42 µg/g (Figure 3.40b, Table 3.6 includes this data from Brown et al., 2009). As previously mentioned, water depths in Camden Bay for the 2008 samples ranged from 22 to 37 m with an average depth of 32 ± 3 m relative to maximum depths of ~13 m and many depths <8 m in the cANIMIDA study. Several of the cANIMIDA samples from Camden Bay (Figure 3.40b) had very little clay or silt and correspondingly low values for TPH. Clearly, sediment grain size is a primary variable controlling background concentrations of TPH.

Values for the carbon preference index for hydrocarbons (CPI = $[C_{21,23,25,27,29,31}/C_{22,24,26,28,30,32}]$) were >2, including station HH-5, and indicate that the resolvable aliphatic hydrocarbons (with odd carbon number preference) were mainly from terrigenous plant inputs (e.g., Wakeham and Carpenter, 1976). The odd carbon preference and the low values for aliphatic carbons in the background samples can be seen in the chromatogram for station HH-1 (CPI = 2.6) and HH-5 (CPI = 2.3, Figure 3.41). In contrast, the chromatogram for sediment from station HH-5 has a distinct unresolved complex mixture (UCM) or "hump" in the n-C10 through n-C30 carbon range (Figure 3.41b). The calculated concentration of the UCM for the sample from station HH-5 was 160 µg/g relative to 18 µg/g for station HH-1 (Figure 3.41). The UCM accounted for 83% of the TPH for the sample from station HH-5 relative to 47% for the sediment from station HH-1 (Figure 3.41). Thus, trace amounts of excess aliphatic hydrocarbons were present in the surface sediment from station HH-5. Based on the UCM for sediment from station HH-5, the trace amount of additional TPH may be due to a petroleum residue. The abundance of higher molecular weight hydrocarbons (>n-C27) suggests that this residue was heavier than diesel oil. Data for hydrocarbons are only available for surface sediments (0-1 cm). The high value for TPH in the surface sediment layer may be more similar to the trends observed for Pb and Cr than Ba; however, no more detailed conclusion about the layering of the various chemicals can be made at this time.

(a)



(b)

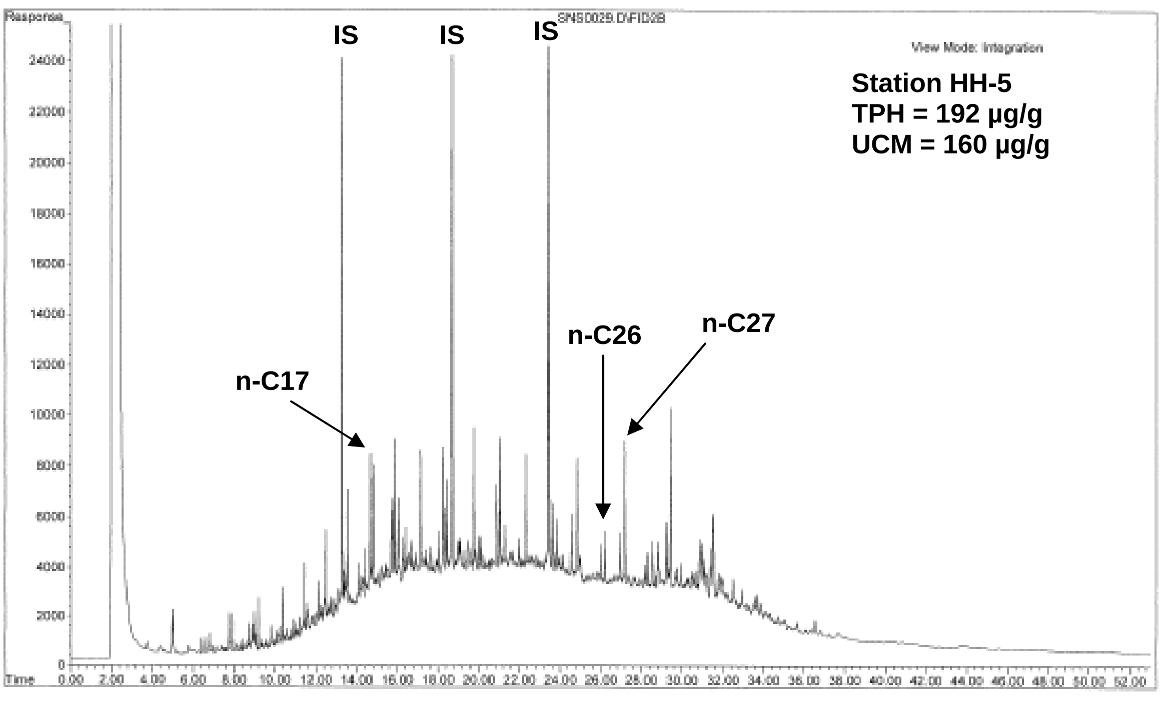


Figure 3.41. Chromatograms showing saturated aliphatic hydrocarbons in sediments from (a) station HH-1 and (b) station HH-5. (IS = internal standard; TPH = total petroleum hydrocarbons; UCM = unresolved complex mixture)

Concentrations of TPAH for the 36 surface samples from the HEX, L250, L500 and P areas averaged 873 ± 174 ng/g and ranged from 494 at station P-5 to 1310 at station L500-5 (Figure 3.42a, Table 3.5). Values for TPAH in surface sediments from 9 of 10 stations in the HH area averaged 954 ± 98 ng/g, not significantly different ($p<0.05$) than found for the other four areas. At station HH-5, the TPAH concentration was 3540 ng/g, about four times greater than the overall average for the other 45 stations and similar to the 5-fold enrichment in TPH at station HH-5 relative to the other stations (Figure 3.42a and Table 3.6 where maximum values listed for the HH area are for station HH-5). Concentrations of TPAH also increased as the percent silt + clay increased (Figure 3.42b) as previously discussed for the TPH data. When the 2005 data for Camden Bay from the cANIMIDA project were added to the silt+ clay plot for the 2008 data, 15 of 21 data points fit within the 95% prediction interval established by the linear regression for the 2008 data from Camden Bay (Figure 3.42b).

The distribution of individual PAH at the 45 stations with background values for TPAH were similar to those for station HH-1 (Figure 3.43 and Tables 3.5 and 3.6). Data for the distribution of individual PAH in the 2005 data set for nearshore Camden Bay are similar to the ranges observed for the 2008 data (Tables 3.5 and 3.6).

Some examples of these similarities between the 2008 and 2005 PAH data for Camden Bay are shown graphically in Figures 3.40 and 3.41. The good correlations among concentrations of different individual PAH and TPAH suggest that the sediments have a common natural source of PAH with variations in concentrations that are controlled by partly sediment grain size (or particle surface area) and possible differences in diagenesis among sites.

The fraction of TPAH that was petrogenic (versus pyrogenic) was 77.1 ± 0.3% for the L and HH stations, excluding station HH-5 that was 84.7% petrogenic (petrogenic and pyrogenic PAH are identified in Table 2.2). At the HEX and P stations, 73.8 ± 0.5 and 79.5 ± 1.7% of the PAH, respectively, were petrogenic. Thus, the small additional amount of PAH at station HH-5 was probably petroleum derived. The sediment from station HH-5 also was somewhat different from the other 45 samples collected during 2008 in the distribution of individual PAH. The most notable difference was in the fraction of TPAH that was made up by perylene. An average of about 10% of the TPAH at the 45 background stations was perylene and 22% of the TPAH at station HH-5 was perylene (Figure 3.40). The most likely explanation for the disproportionate amount of perylene at station HH-5 is diagenesis of trace amount of other organic substances.

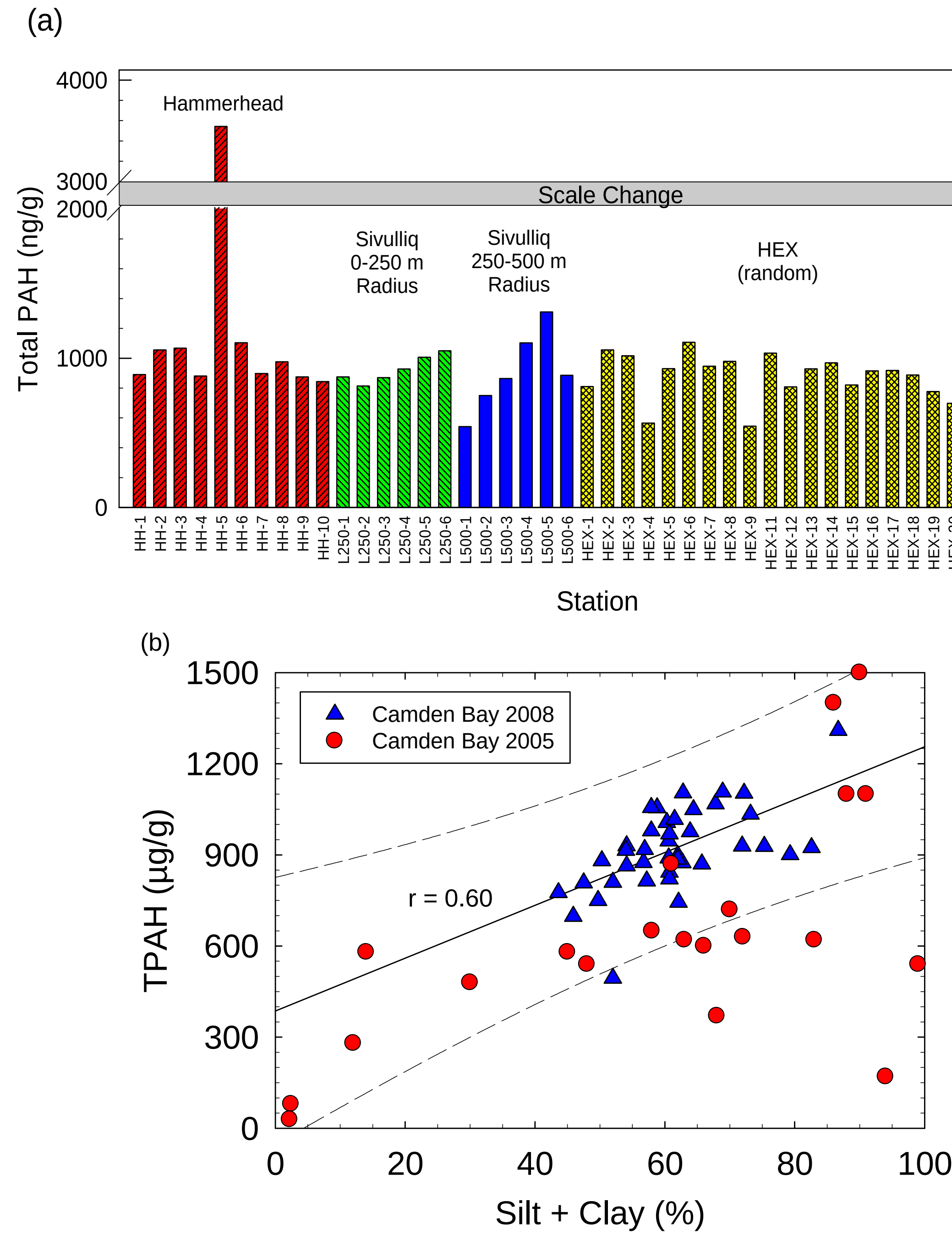


Figure 3.42. Values for (a) total polycyclic aromatic hydrocarbons (TPAH) in surface sediment from the 2008 study area in Camden Bay and (b) TPAH versus silt + clay for the 2008 and 2005 (Brown et al., 2009) sediments from Camden Bay. The linear regression line, 95% prediction interval and correlation coefficient (r) are for the 2008 data from Camden Bay, the triangles in (b).

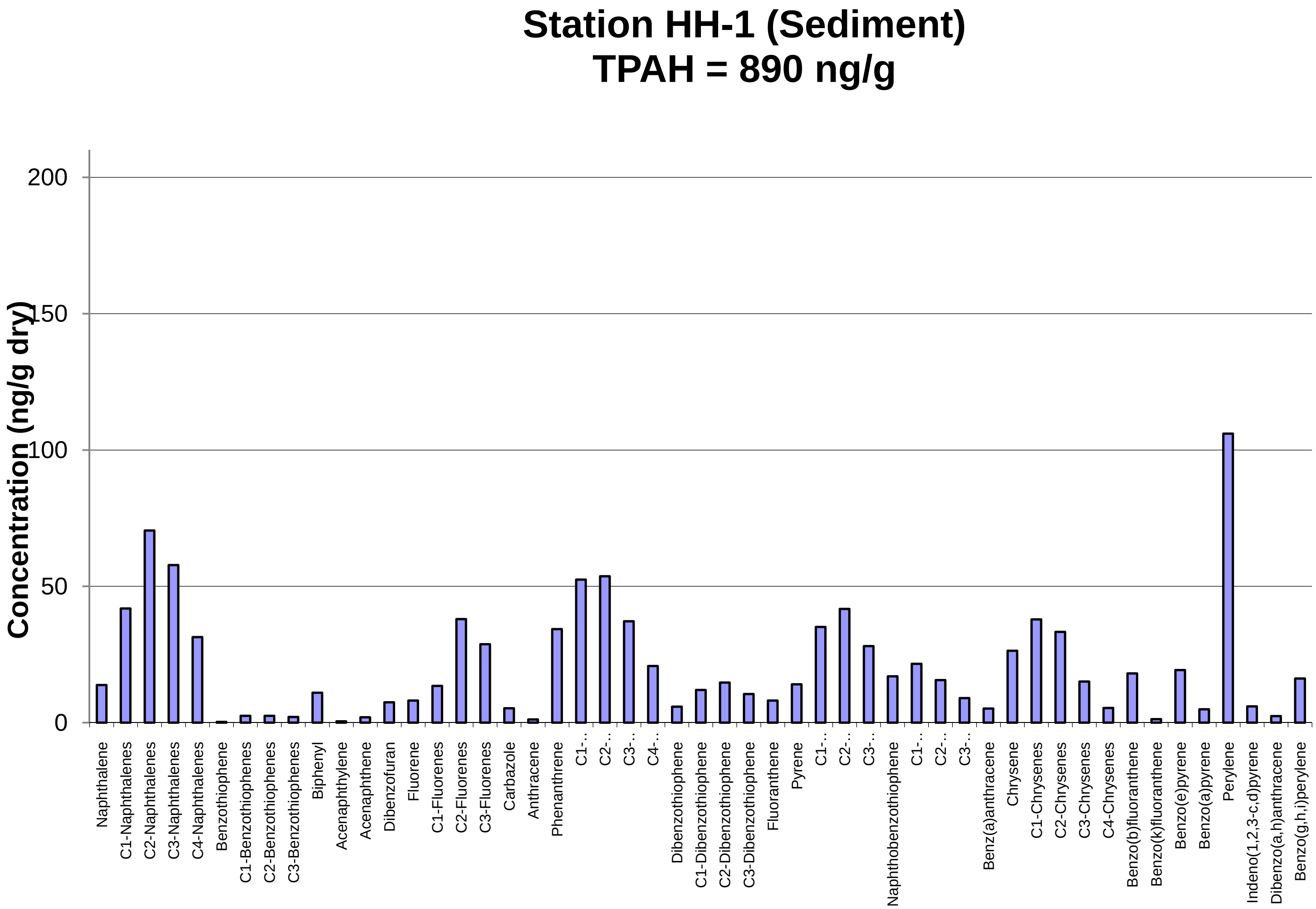


Figure 3.43. Concentrations of individual polycyclic aromatic hydrocarbons (PAH) in surface sediment from station HH-1.

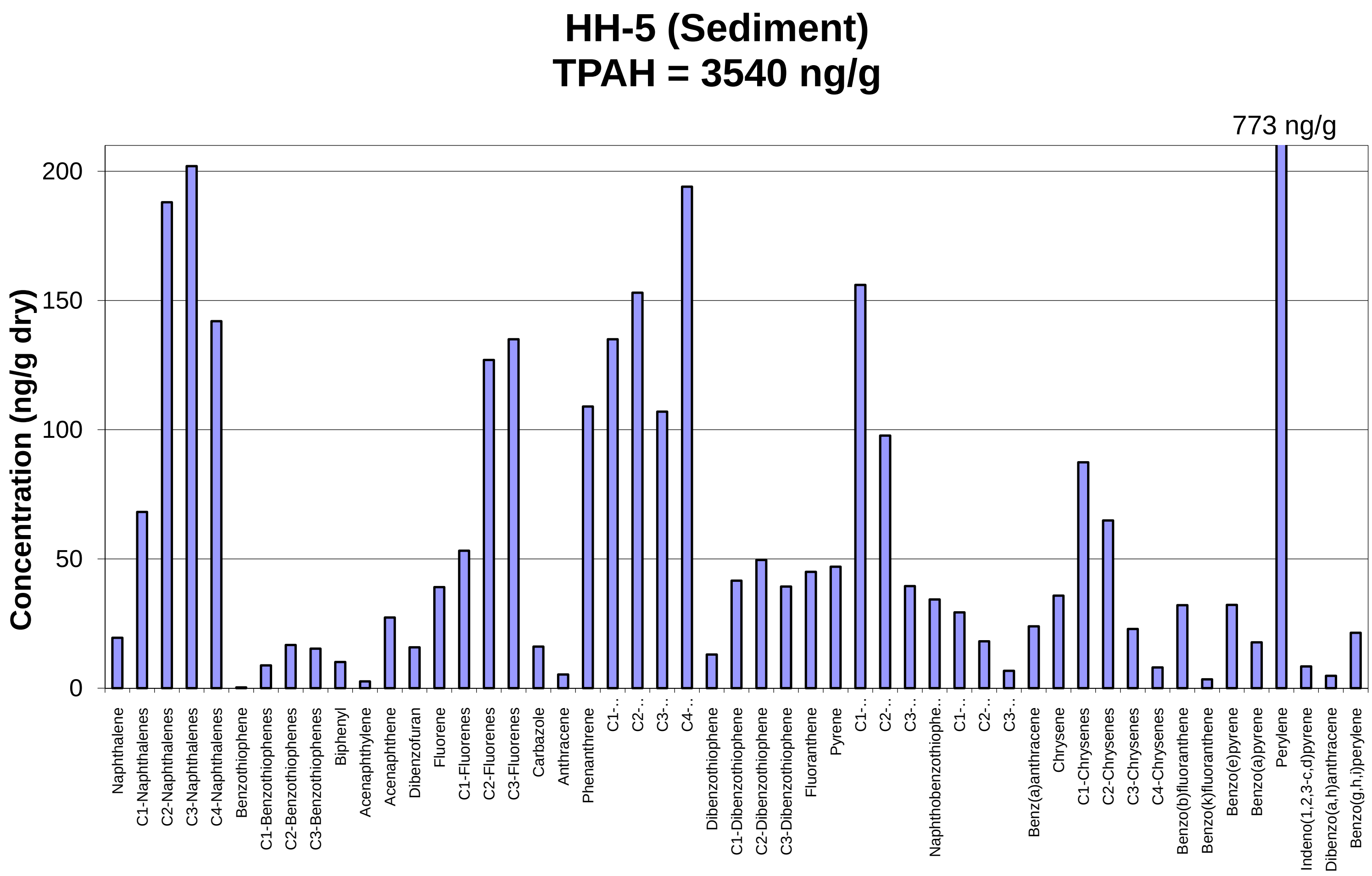


Figure 3.44. Concentrations of individual polycyclic aromatic hydrocarbons (PAH) in surface sediment from station HH-5.

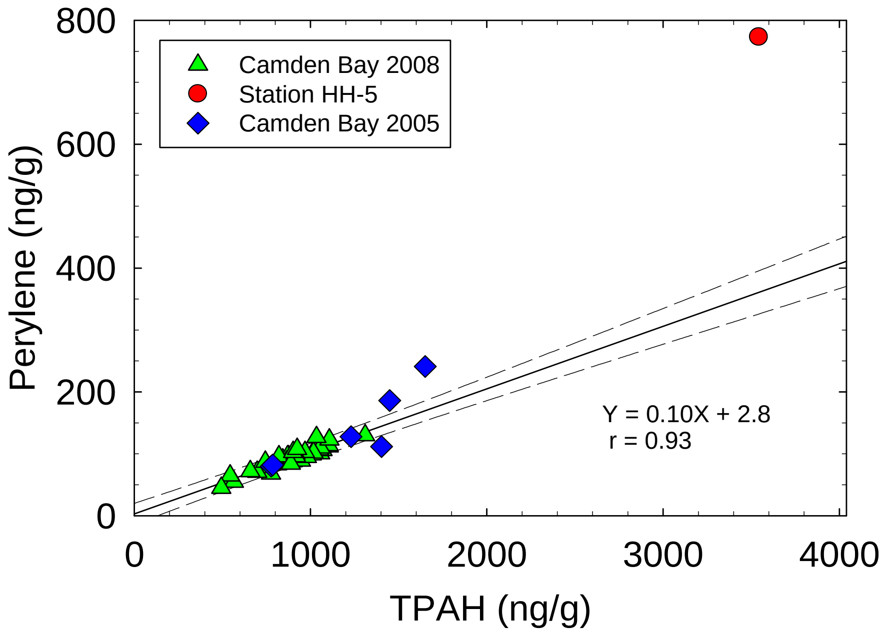
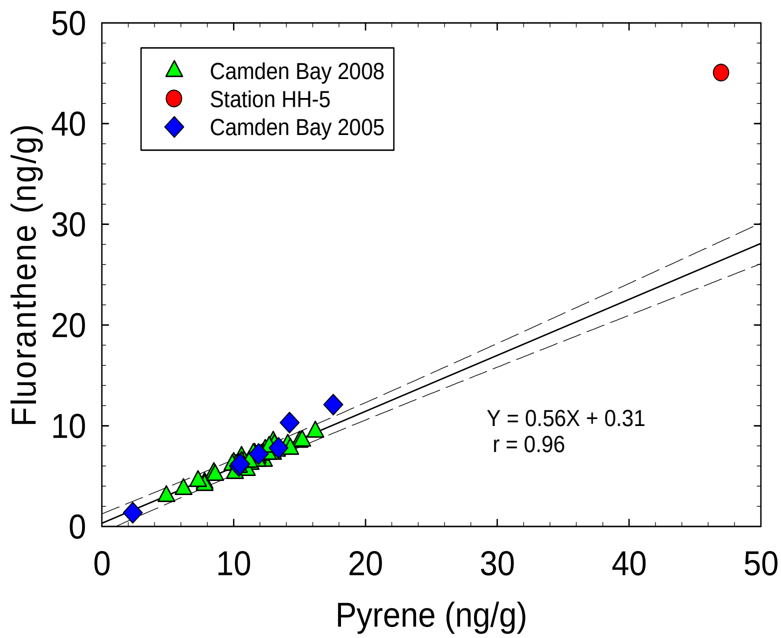


Figure 3.45. Concentrations of total polycyclic hydrocarbons (TPAH) versus perylene. Linear regression lines, 95% prediction intervals and correlation coefficients (r) are for 2008 data from Camden Bay (triangles).



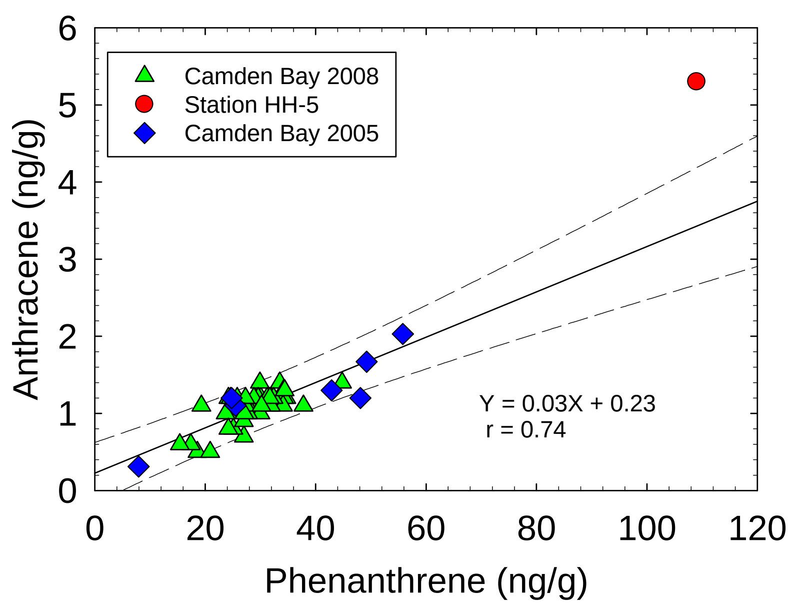


Figure 3.46. Concentrations of (a) fluoranthene versus pyrene and (b) anthracene versus phenanthrene. Linear regression lines, 95% prediction intervals and correlation coefficients (r) are for 2008 data from Camden Bay (triangles).

3.5 Ecological Implications of Chemical Data

The ecological implications of the chemical data from the 2008 survey of Camden Bay will be discussed here from the following two perspectives: (1) comparison with sediment quality guidelines developed from toxicity data that provide a very general range of concentrations at which adverse effects may be observed and (2) the sediment biological data from the companion study by Dunton et al. (2009).

When data points plot above the upper prediction interval on a metal versus Al graph or are identified as above background values for organic substances, a common question that follows is "Do those concentrations produce adverse biological effects?" Various investigators have developed sediment quality guidelines to help assess possible adverse biological effects from sediment contaminants (e.g., Long et al., 1995; MacDonald et al., 1996; Field et al., 1999). The guidelines introduced by Long et al. (1995) use an Effects Range Low (ERL) and Effects Range Median (ERM) that are based on field, laboratory, and modeling studies conducted in North America that coupled concentrations of contaminants in sediment with adverse biological effects. The ERL is defined as the concentration of a substance that adversely affects 10% of the test organisms. The ERM is defined as the concentration of a substance in the sediment that results in an adverse biological effect in more than 50% of the test organisms.

Several authors have noted that sediment quality guidelines should be used cautiously with an appropriate understanding of their limitations. For example, Field et al. (2002) noted that the ERL is not a concentration threshold for a chemical in sediment, above which toxicity is possible and below which toxicity is impossible. Instead, according to O'Connor (2004), the ERL is a concentration "at the low end of a continuum roughly relating bulk chemistry with toxicity." O'Connor (2004) also stated that concentrations of more than one chemical that are above the ERL do not increase the probability of toxicity. The utility of the sediment quality criteria is to call attention to a specific site where additional study, such as determining benthic biomass and community structure, may be warranted. The application of ERLs and ERMs to the 2008 sediment data from Camden Bay are presented here with these caveats and in conjunction with the 2008 biological assessment by Dunton et al. (2009).

Five metals (Ag, Cd, Hg, Pb and Zn) of the 12 trace metals investigated during this study have been assigned realistic ERL and ERM concentrations by Long et al. (1995). These guidelines are continually evolving as demonstrated by the extensive efforts of Field et al. (1999, 2002) to validate values for Hg, Pb and Zn. Some difficulties still exist with ERL values for As, Cr and Cu as discussed below.

Overall, concentrations of Cd, Hg, V and Zn in sediments were at background values at all 46 stations (Table 3.7). Concentrations of Ag, Cr, Cu, Pb and Se were above background values at one of the 46 locations, station HH-5 (Table 3.7). All concentrations of Ag, Cd, Hg and Zn were below the ERL (Table 3.7). One value of 49 µg/g for Pb from station HH-5 was above the ERL of 46.7 µg/g (Table 3.7).

Table 3.7. Summary data for metals showing stations where values for surface sediments were above background, maximum values from this study, values for the Effects Range Low (ERL) and Effects Range Median (ERM) from Long et al. (1995) and identification of stations with metal values that exceeded the ERL.

Metal	Stations with Values>Background (of n = 46 stations)	Maximum (this study (µg/g)	ERL (µg/g)	ERM (µg/g)	Sites with Values >ERL
Ag	1 (HH5)	0.40	1.0	3.7	None
As	None	22	-	-	-
Ba	4 (HH-4,5,8,10)	18,300	None	None	N/A
Cd	None	0.31	1.2	9.6	None
Cr	1 (HH5)	135	-	-	-
Cu	1 (HH-5)	58	-	-	-
Hg	None	0.83	0.15	0.71	None
Pb	1 (HH-5)	49	46.7	218	1 (HH5)
Se	1 (HH5)	2.0	None	None	N/A
V	None	156	None	None	N/A
Zn	None	108	150	410	None

No sediment quality criteria are available for Ba. Toxicity studies using barite are limited; however, Starczak et al. (1992) found no significant differences in the growth rates for the polychaete *Mediomastus ambiseta* between natural sediments and sediments containing 10% barite (Ba ~50,000 µg/g). Only the sample from station HH-5, at a sediment depth of ~8 cm, contained Ba at >10%, the highest value tested in a study where no effects were observed.

As mentioned previously, there are difficulties with values for the ERL (Long et al., 1995) for Cr and Cu because the ERL concentrations are lower than concentrations in typical continental crust (Wedepohl, 1995). The published ERLs for Cr and Cu are is 81 µg/g and 34 µg/g (Long et al., 1995). These values are close to or less than values for average marine sediment or average continental crust (Table 3.2) For example, the average concentration of Cr in continental crust is 126 µg/g. Background Cr and Cu values for sediments in Camden Bay average ~80 µg/g and ~22 µg/g (Tables 3.1 and 3.2). The choice of ERL values for Cr and Cu were most likely taken from a database compiled by Long et al. (1995) that used metal concentrations from an acid leach of the sediment rather than a total digestion. For example, only a minor fraction (<25%) of the total Cr is removed by a strong acid leach (Trefry and Presley, 1976; Sinex et al., 1980). Thus, a leachable Cr value equal to the ERL level of 81 µg/g is more likely comparable with a total Cr level of >300 µg/g, a value considerably higher than Cr values for continental crust or any samples from this study. O'Connor (2004) notes that the original ERL for Cu was 70 µg/g in Long and Morgan (1990). Clearly, the ERL values for Cr and Cu need to be revised in future iterations of the sediment quality criteria. Similarly, the ERL for As of 8.2 µg/g is close to the value for of 7.7 µg/g for average marine sediments (Table 3.2).

All 46 samples from the 2008 survey of Camden Bay contained concentrations of TPAH that were below the ERL and ERM (Table 3.8). Concentrations of 9 or 11 individual PAH were below the ERL and ERM for all 46 stations; two substances (acenapthene and fluorene) were present at concentrations slightly above the ERL at one location, station HH-5 (Table 3.8).

Field work for the complementary biological study by Dunton et al. (2009) was carried out at the same time and locations as the chemical study. In the biological study, sediments were collected at the same 46 stations and sieved to obtain sediment organisms. Based on data for the HEX, HH, and L stations, Dunton et al. (2009) concluded that no measurable differences in benthic community abundance or structure were discernible at the Hammerhead stations relative to the other locations. The authors further state that if the benthic community at HH-5 had been disrupted during drilling in 1985, the site has progressed well towards recovery over the past 20 years. The nearer shore, shallower water, P stations were characterized by lower biomass and density of infaunal organisms; this difference was explained as a possible consequence of frequent physical disturbance by deep-draft ice as well as differences in the benthic substrate (Dunton et al., 2009).

Table 3.8. Summary data for organic substances showing stations where values for surface sediments were above background, maximum values from this study, values for Effects Range Low (ERL) and Effects Range Median (ERM) from Long et al. (1995) and identification of stations with values for organic substances that exceeded the ERL.

Organic Substance	Values > Background (n = 46)	Background this study (ng/g)	Maximum this study at station HH-5 (ng/g)	ERL (ng/g)	ERM (ng/g)	Sites with Values >ERL
Acenapthene	1 (HH5)	1.4	27	16	500	1
Acenaphthylene	1 (HH5)	0.6	2.6	44	640	None
Anthracene	1 (HH5)	1	5	85	1100	None
Fluorene	1(hh5)	6	39	19	540	1
Naphthalene	1(HH5)	9	19	160	2100	None
Phenanthrene	1 (HH5)	26	35	240	1500	None
Benzo(a)pyrene	1(HH5)	5	18	430	1600	None
Chrysene	1(HH5)	31	36	384	2800	None
Dibenzo(a,h)anthracene	1(HH5)	3	5	63	260	None
Fluoranthene	1 (HH5)	6	45	600	5100	None
Pyrene	1 (HH5)	12	47	665	2600	None
Total PAH	1(HH5)	860	3,540	4,020	44,800	None

3.6. Water Column Hydrography and Chemistry

Eight water column stations were occupied in Camden Bay during the August 2008 cruise (Figure 3.47). The eight stations form a cross-shelf transect of stations from a water depth of 38 m at station HEX-19 to a water depth of 22 m at station P-5. A vertical profile for salinity, temperature, pH, dissolved oxygen and turbidity was obtained at each station. Selected profiles are show in Figures 3.48-3.54 and will be discussed in more detail below. Discrete water samples also were collected at the following three depths at each of the eight stations: (1) 2 or 3 m, (1) 10 m and (3) 18 to 25 m, depending on bottom depth. Water samples were collected through a Tygon tube attached to a peristaltic pump. The water samples were filtered aboard ship (0.4 µm pore size membrane filter) and analyzed for the following parameters: total suspended solids (TSS) and particulate organic carbon (POC). The samples were collected over a four-day period (August 19-22, 2008).

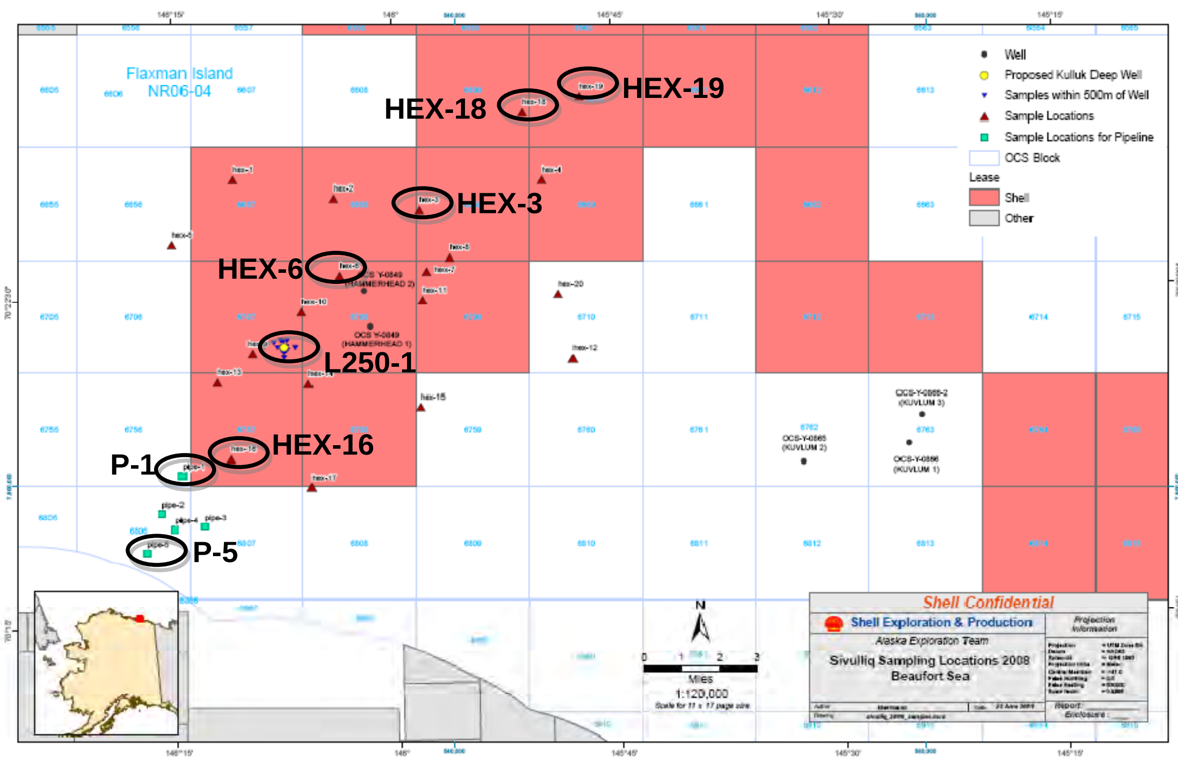


Figure 3.47. Map showing water sampling sites in Camden Bay.

The vertical profiles for salinity and temperature showed strong stratification at the four northern-most stations HEX-19, HEX-18, HEX-3 and HEX-6 where water depths were 33 to 38 m (map in Figure 3.47, profiles in Figures 3.48 to 3.51 and data summary in Table 3.9). Surface water temperatures at these four stations were about 6° C, decreasing to about 0.3° C at depths greater than 20 to 25 m. Similarly, salinity was 27 to 28 in surface water, increasing toward 31 to 32 at depths below 25 m. In contrast with these four stations, the four stations that were nearer to shore and at water depths of about 22 to 31 m showed a much lesser degree of stratification for salinity than the four stations discussed above (Figures 3.51 to 3.54). At the southernmost station (P-5), the temperature was relatively uniform at 4 to 5° C (Figure 3.54); however, the shallower water station was only at a water depth of 22 m and lower temperatures at the offshore stations were generally found at water depths >25 m.

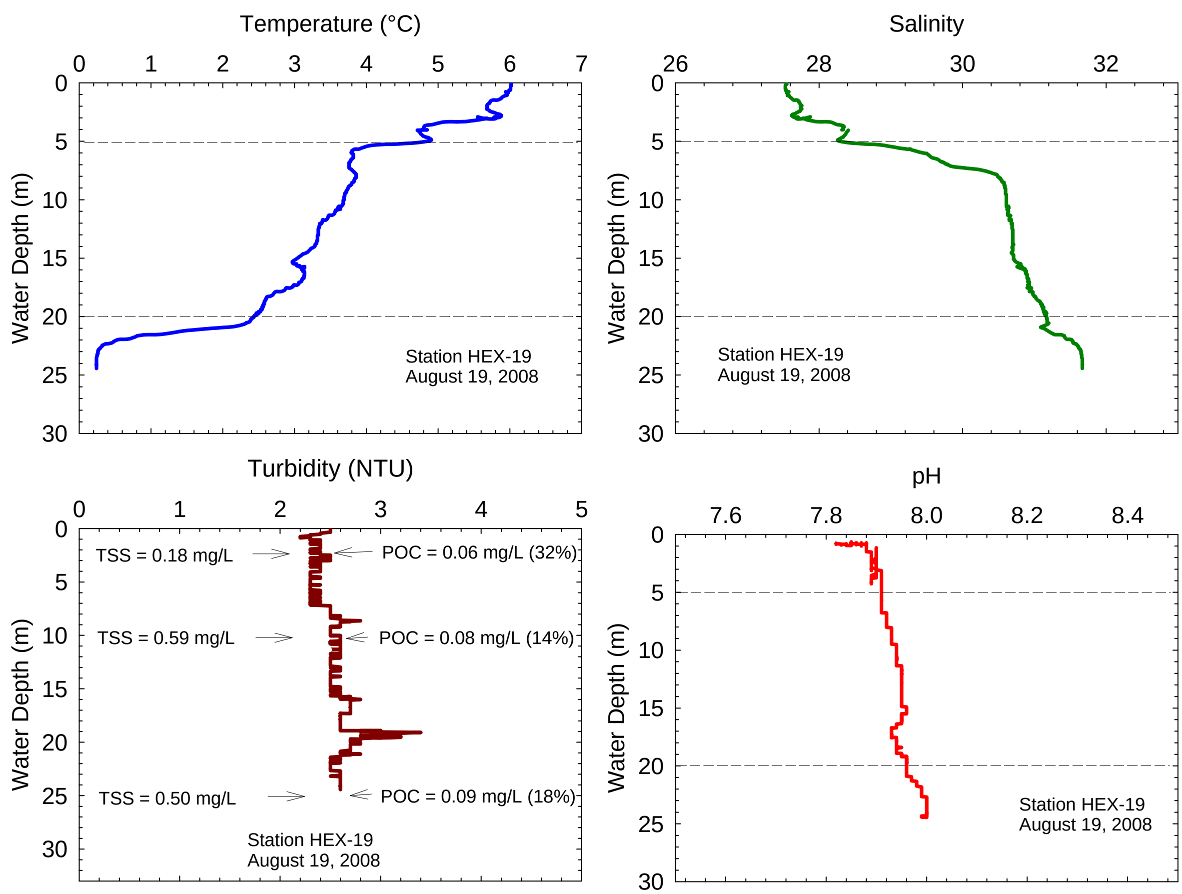


Figure 3.48. Vertical profiles for temperature, salinity, turbidity and pH for station HEX-19.

Table 3.9. Summary data from vertical profiles for selected parameters in surface water and in near-bottom water at depths ≥25 m.

Parameter	Surface Water	Bottom Water (≥25 m)
Salinity	25.3 to 29.2	29.7 to 31.7
Temperature (°C)	4.3 to 6.4	0.24 to 0.38
Turbidity (NTU)	1.8 to 2.6	2.0 to 3.0
pH	7.8 to 8.4	7.7 to 8.0
Dissolved Oxygen (mg/L)	9.5 to 10.4	11 to 12.2
% Oxygen Saturation	89 to 98	96 to 104

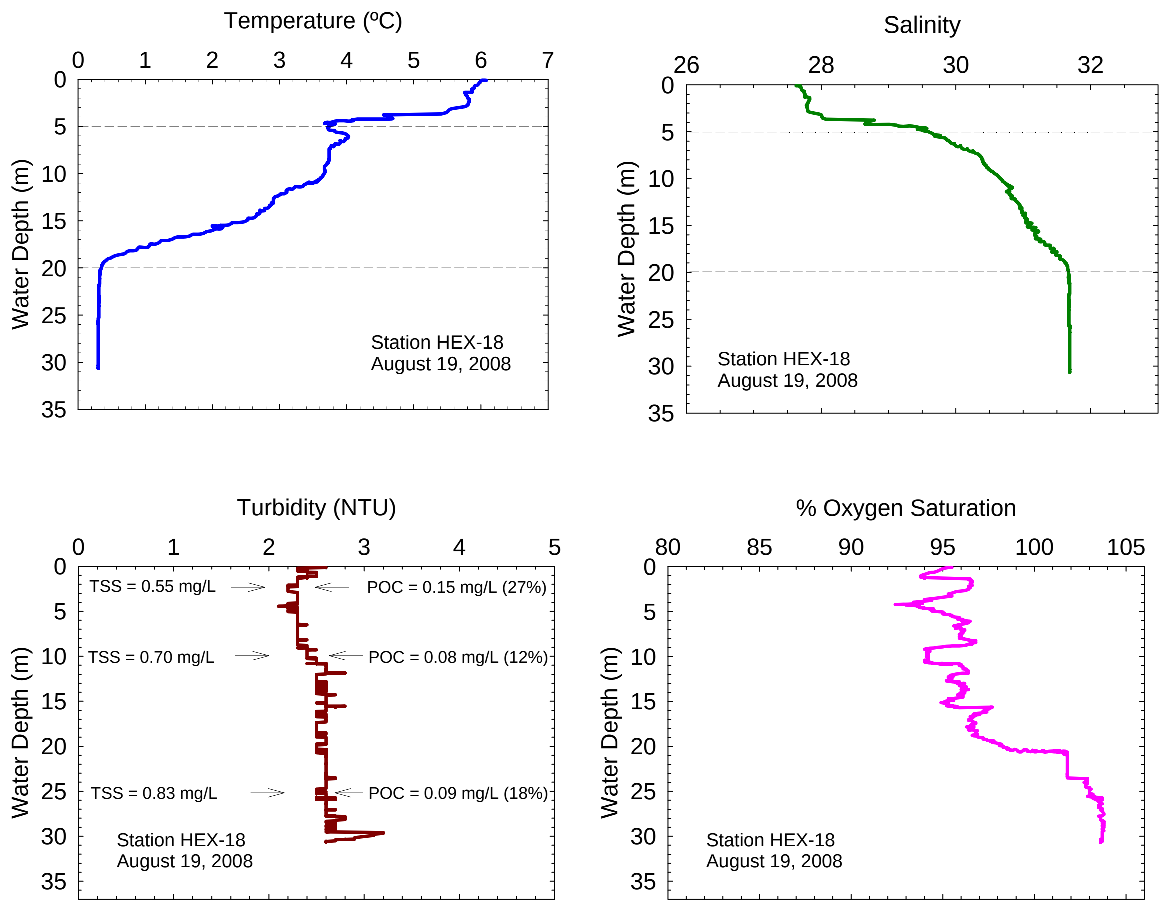


Figure 3.49. Vertical profiles for temperature, salinity, turbidity and % oxygen saturation for station HEX-18.

Overall, concentrations of dissolved oxygen ranged from 9.5 to 10.4 mg/L in surface water and 11.0 to 12.2 mg/L in water at depths >25m. The degree of oxygen saturation was 89 to 98% in the surface water and 96 to 104% at deeper than 25 m (Table 3.9). The pH ranged from 7.8 to 8.4 in the surface water and 7.7 to 8.0 at >25 m (Table 3.9)

One key purpose of the water column work was to determine water column turbidity under open-water conditions with no drilling activity. Concentrations of TSS were relatively low with an overall average of 0.58 ± 0.35 mg/L and a range of 0.16 to 1.56 mg/L (Table 3.10). Average concentrations of TSS in surface water samples (0.26 ± 0.13) averaged 2.3 to 2.8 times lower and were significantly different ($p<0.01$) than TSS values found at 10 m and 18-25 m (Table 3.10). The TSS values for the 2008 Camden Bay study were low relative to typical data for the coastal Beaufort Sea because most of the other data were for shallower water (<12 m), closer to shore (Table 3.10). At these nearshore locations, relative to the deeper water sites in the 2008 study area, the influence of wind speed on concentrations of TSS is much greater. During winds that are calm to ~2.5 m/sec (~5 kts), concentrations TSS in nearshore waters of the Beaufort Sea are typically 1 to 4 mg/L as shown for such conditions during 2006 (Table 3.10).

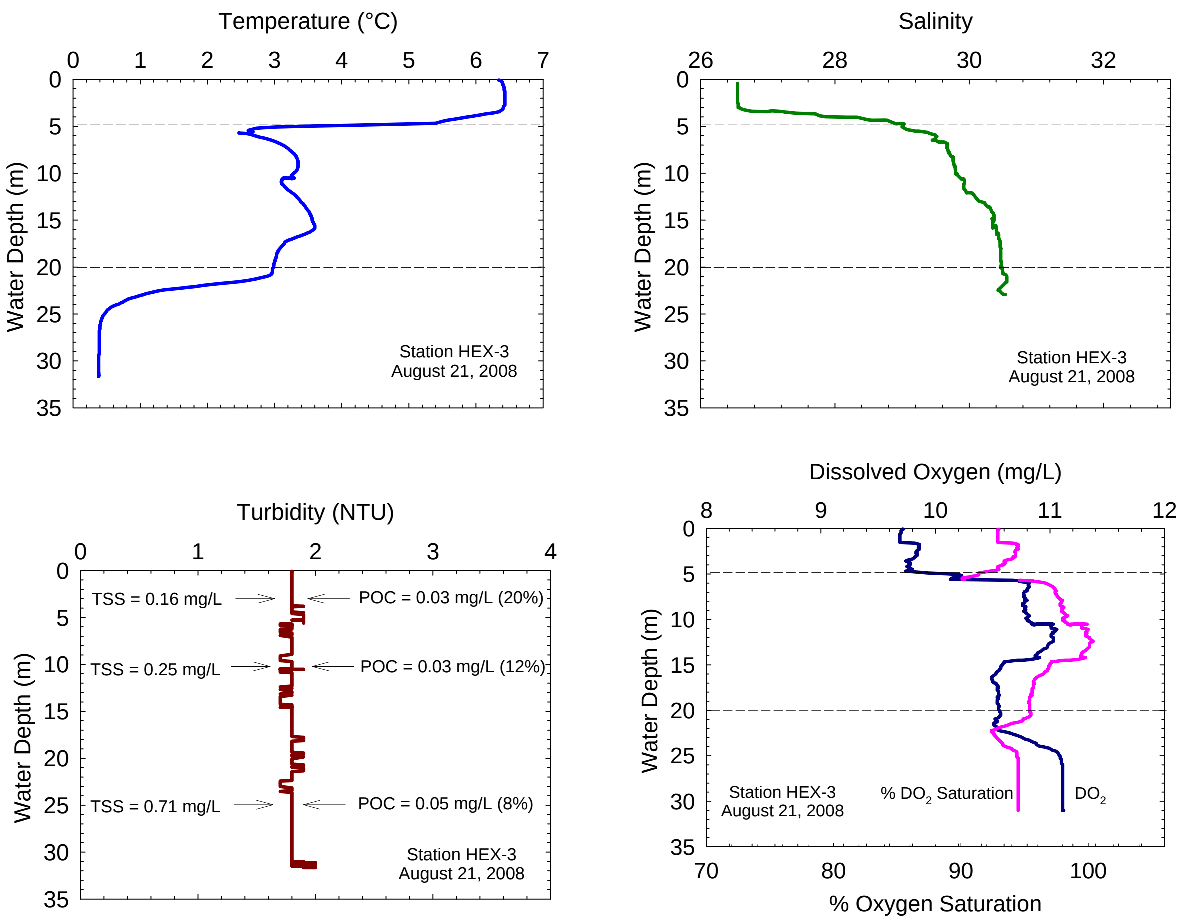


Figure 3.50. Vertical profiles for temperature, salinity, turbidity and dissolved oxygen for station HEX-3.

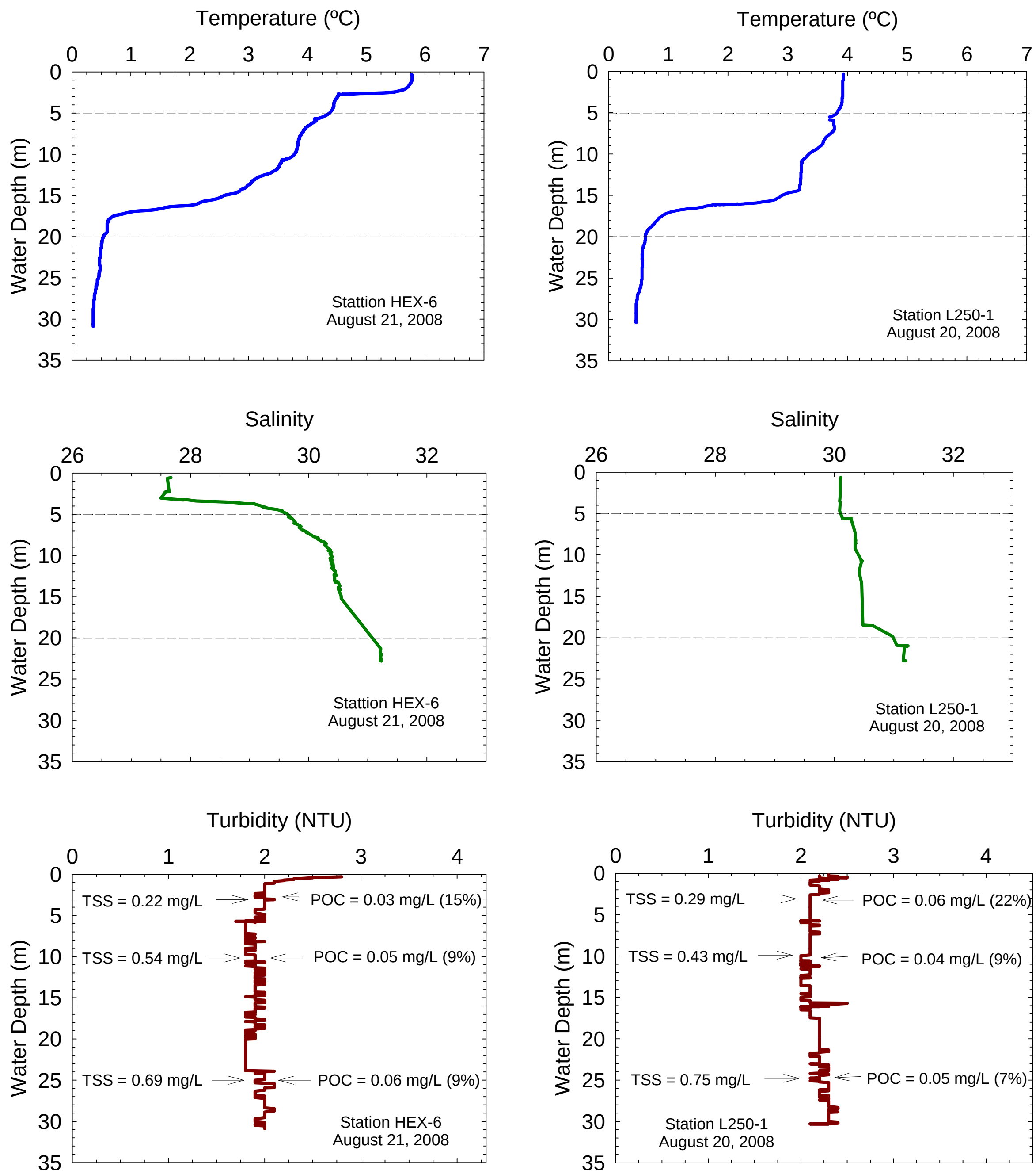


Figure 3.51. Vertical profiles for temperature, salinity and turbidity for station HEX-6 and L250-2.

Table 3.10. Summary data for total suspended solids (TSS) and particulate organic carbon (POC). The POC values are expressed in mg/L and as % of the TSS that was organic carbon.

Water Depth (m)	TSS (mg/L)	POC (mg/L)	POC (% of TSS)
Camden Bay 2008			
2-3 m (n = 8)	0.26 ± 0.13	0.066 ± 0.038	25.7 ± 6.4
10 m (n = 8)	0.61 ± 0.28	0.066 ± 0.024	11.5 ± 3.1
18-25 m (n = 8)	0.73 ± 0.31	0.081 ± 0.0.025	10.0 ± 3.5
Coastal Beaufort Sea[1] 2000	8.2 ± 4.8	0.23 ± 0.13	2.8 ± 1.2
2006	1.3 ± 0.7	0.051 ± 0.027	3.9 ± 1.7

[1]Trefry et. al. (2009)

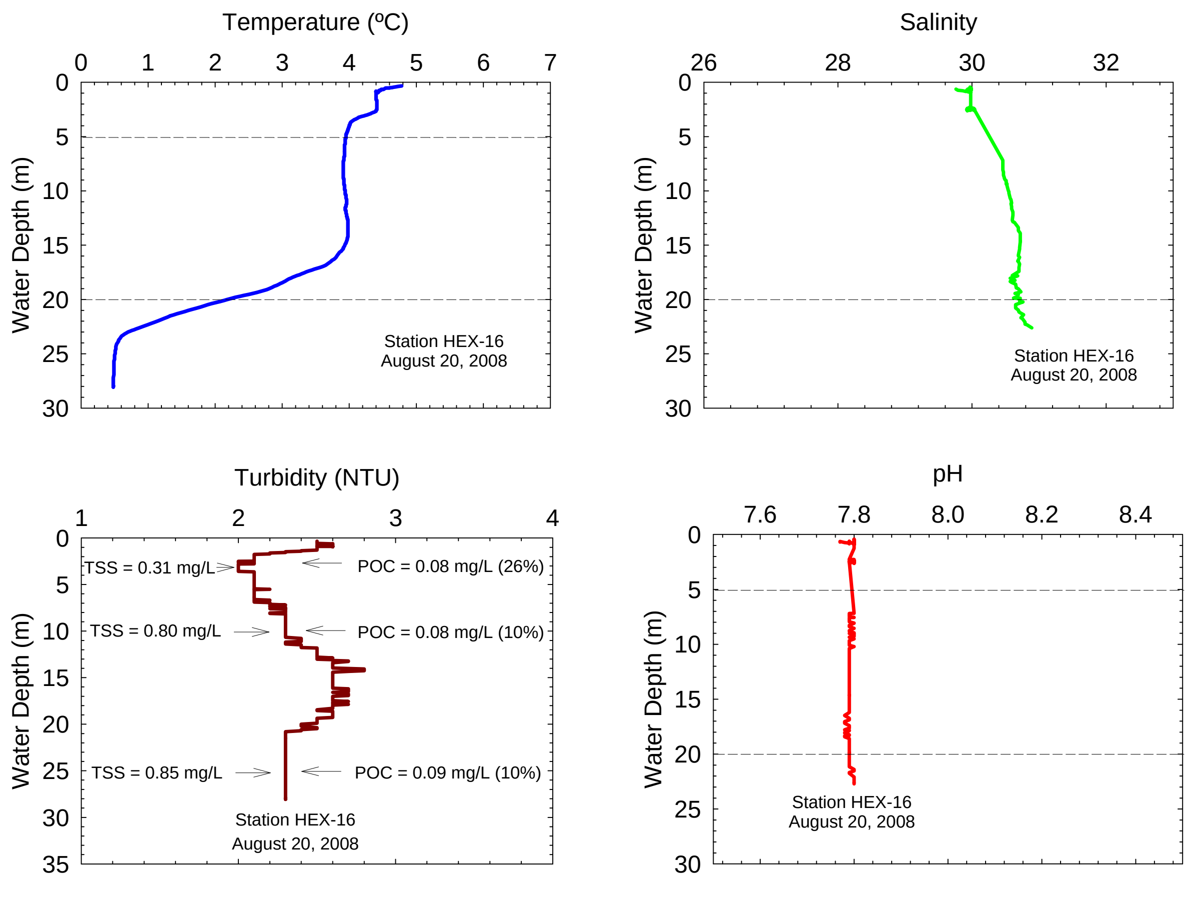


Figure 3.52. Vertical profiles for temperature, salinity, turbidity and pH for station HEX-16.

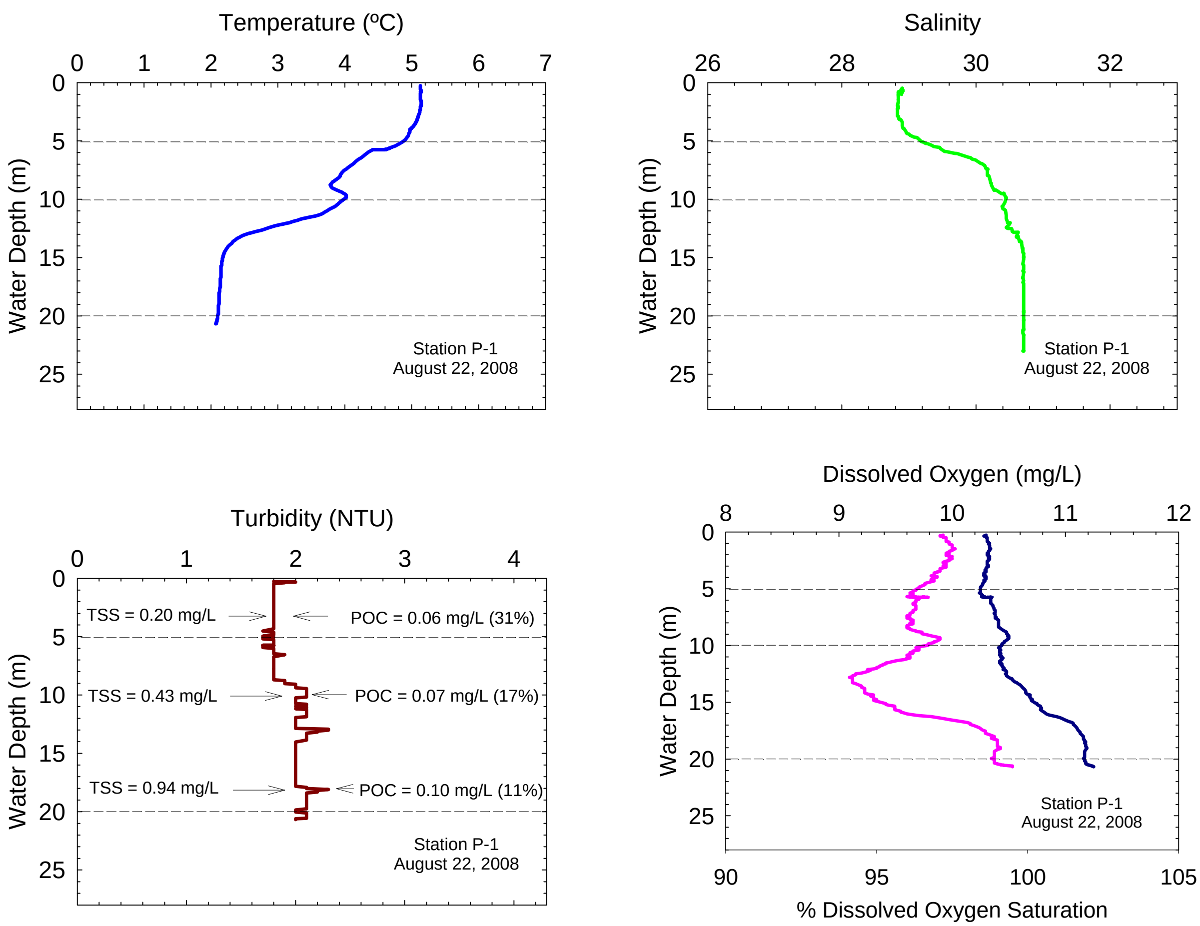


Figure 3.53. Vertical profiles for temperature, salinity, turbidity and pH for station P-1.

As wind speed and duration increases, TSS values of 2 to 8 mg/L (winds at 2.5-5 m/sec or 5-10 kts) and 5 to 15 mg/L (winds at 5-10 m/sec or 10-20 kts.) have been found in the nearshore locations (as in 2000 in Table 3.8).

Because the TSS values for the 2008 study in Camden Bay were low, the corresponding values for turbidity obtained during the vertical cast were low with a range of 1.8 to 3 nephelometric turbidity units (NTU, Figures 3.48-3.54 and Table 3.10). These low values are near the 1 NTU detection limit of the *in situ* turbidity sensor and thus resolution of differences among locations and depths was difficult. A plot of TSS versus *in situ* turbidity shows a weak correlation coefficient (r = 0.44) and considerably scatter in the data points (Figure 3.55a), most likely a factor of the turbidity values that are near the detection limit of the *in situ* detector.

Concentrations of POC for all 24 samples averaged 0.072 ± 0.028 mg/L with no significant difference among samples from water depths of 2 to 3 m, 10m and 18-25 m (Table 3.10). For all samples, the POC averaged about 16 ± 8% of the TSS. However, POC accounted for 26 ± 6% of the TSS in the samples from 2 to 3 m and 11 ± 3% of the TSS in the suspended matter from 10 m plus 18-25 m. If we assume that the organic matter contains about one third (33%) C, then the surface samples would be about 78% organic matter (3 x 26%) and the subsurface samples would be about 33% organic matter. Thus, the surface particles were organic rich with a higher fraction of the total mass of suspended matter being made up of organic matter.

The lower % POC values in subsurface waters are due to greater amounts of suspended clays in those samples. When concentrations of POC are plotted versus *in situ* turbidity, the correlation improves slightly (to r = 0.60) and the x-intercept remains at 1.1 NTU (Figure 3.55b). However, in both cases, the narrow range of turbidity values, all near the detection limit of 1 NTU, suggest that the turbidity values should be viewed as no more than a baseline at low concentrations of TSS. The fraction of the TSS that was POC ranged from 33.3% in surface water at station P-5 to 6.7% in the 25 m sample from station L250-1 (Figure 3.55c).

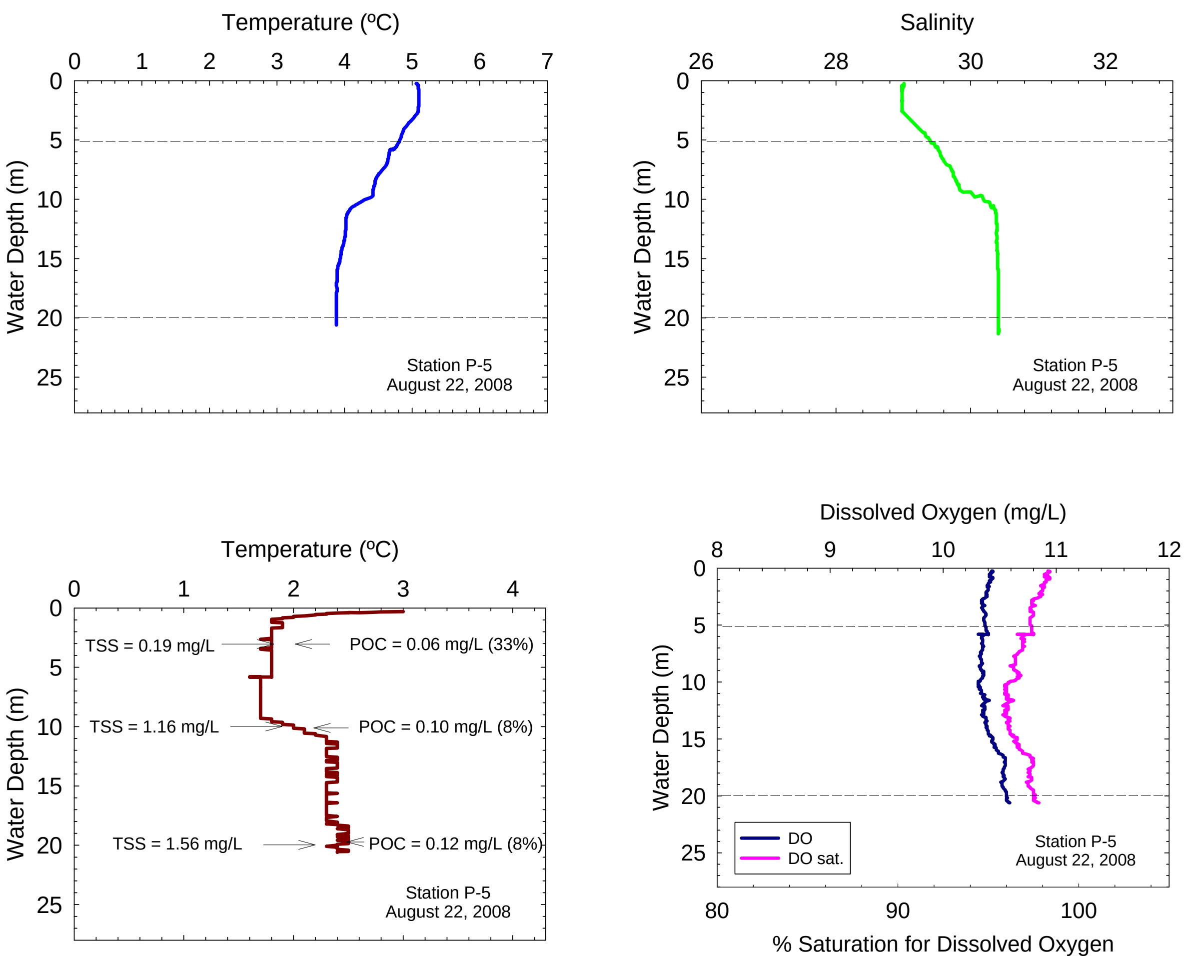


Figure 3.54. Vertical profiles for temperature, salinity, turbidity and pH for station P-5.

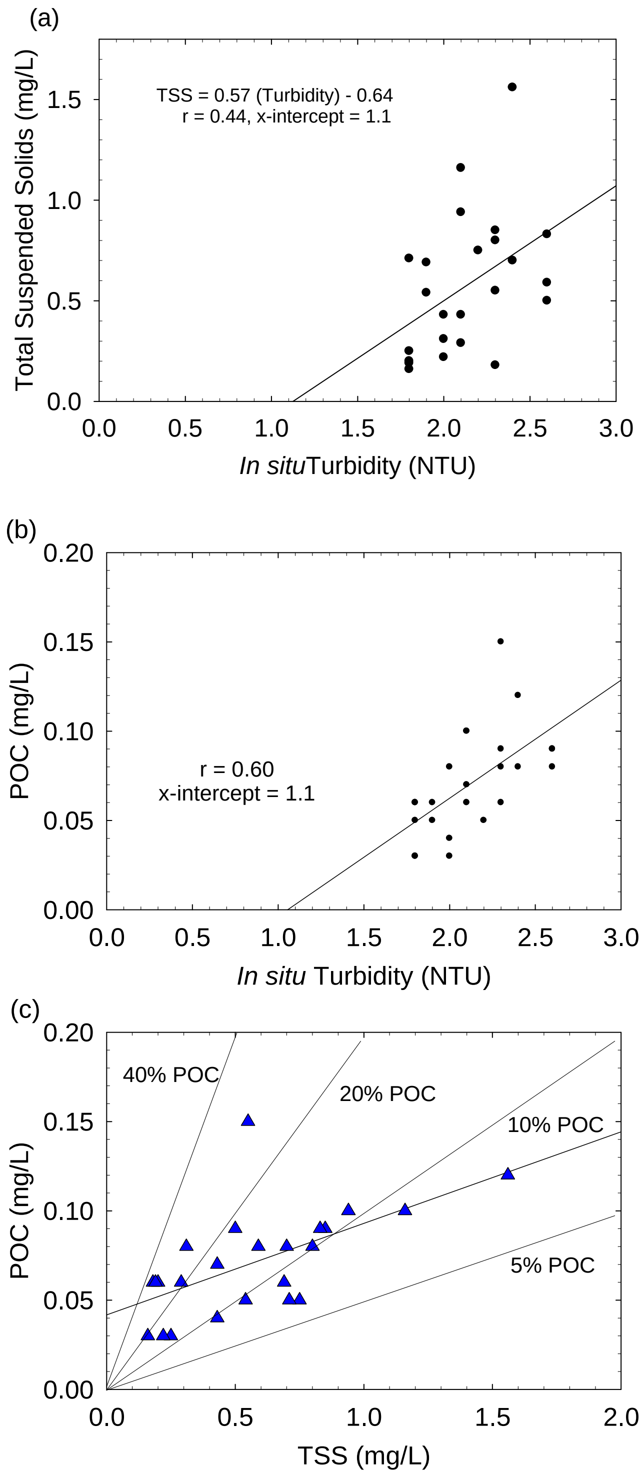


Figure 3.55. (a) Total suspended solids (TSS) versus *in situ* turbidity, (b) particulate organic carbon (POC) versus *in situ* turbidity and (c) POC versus TSS for 2008 study of Camden Bay.

4.0 SUMMARY AND CONCLUSIONS

A summary of the key findings from the chemical portion of the 2008 study of Camden Bay is given below:

- Concentrations of total Al, Fe, Cd, Hg, V and Zn were at background values in all surface and subsurface sediments collected in Camden Bay during 2008, including the 1985 Hammerhead (HH) drill site.

- Sediment samples from 42 of the 46 stations in Camden Bay contained background concentrations of Ba. Concentrations of Ba in four surface samples collected within ~100 m of the 1985 HH drill site, plus six samples from sediment cores from two of the four HH stations, were 1.4 to 200 times (average 39 times) above background values of ~600 µg/g and are most likely due to the presence of barite from discharges of drilling mud and cuttings.

- Total concentrations of the other metals studied (Ag, Cr, Cu, Pb and Se) were at background values at 45 of 46 stations, the exception being the station HH-5 drill site.

- All concentrations of Cd, Hg, Zn and Ag were below the minimum sediment quality criteria (ERL). One value of 49 µg/g for Pb from station HH-5 was above the ERL of 46.7 µg/g.

- Concentrations of total petroleum hydrocarbons (TPH) and total polycyclic aromatic hydrocarbons (TPAH) in surface sediments were at background values for Camden Bay at 45 of 46 locations, the exception being the drill station HH-5 where TPH and TPAH concentrations were about 6 and 4 times greater than found at the other stations.

- All 46 surface samples from the 2008 survey of Camden Bay contained concentrations of TPAH that were below the ERL.

- Good correlations among concentrations of different individual PAH and TPAH, excluding station HH-5, suggest that the sediments have a common natural source of PAH with variations in concentrations that are controlled partly by sediment grain size.

- Based on data for ^{137}Cs and excess ^{210}Pb for one short core (8-cm long), the sedimentation rate in Camden Bay is no greater than 0.12 cm/yr. Sediment mixing can bias the calculated sedimentation rate and tend to make it appear greater.

- Concentrations of total suspended solids (TSS) determined for discrete water samples averaged 0.26 ± 0.13 mg/L at 2 to 3m and 0.73 ± 0.31 mg/L at 10 to 25 m. These TSS values are consistent with values for clear offshore water in the coastal Beaufort Sea.

- Concentrations of particulate organic carbon (POC) averaged 26% and 11% of the TSS values in the 2 to 3 m and 10 to 25 m layers of the water column, respectively.

The main conclusions for the chemical portion of the study are as follows:

- Camden Bay has background values for trace metals as well as aliphatic and polycyclic aromatic hydrocarbons, through-out the bay, except for sediments collected within <100 m of a 1985 drilling site.

- Based on one example, movement of drilling mud and cuttings seems to be restricted to within ~100 m of the discharge site, at a water depth of ~32 m.

- Baseline data and supporting interpretative techniques are now in place to facilitate identification of anomalous concentrations of potential contaminants in sediments from Camden Bay well before they reach values that could have adverse environmental effects.

- Results from the companion study of sediment biology by Dunton et al. (2009) found no measurable differences in benthic community abundance or structure at the 10 HH stations, including HH-5, relative to the other stations in the area. This finding is consistent with the chemical data obtained during the 2008 survey.

5.0 ACKNOWLEDGEMENTS

We thank Captain Alfred Huff and the crew of the MV *Arctic Seal* for their tireless efforts on our behalf and for providing such strong support for our efforts while at sea. We also thank Kurt Borows and Royce Thomason of Shell for pre-cruise and at sea logistical support. Our technical interactions and support from Michael Macrander, Erling Westlien and Ian Voparil of Shell, and Jim Ray of Oceanic Environmental Solutions, were extremely valuable and we truly appreciate their support and enthusiasm for our work. Finally, we thank our scientific collaborators, Ken Dunton, Susan Schonberg and Nathan McTigue, for their friendship and collegiality that made our trip and subsequent scientific discussions both enjoyable and successful.

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FINAL

Characterization of Benthic Habitats in Camden Bay (Sivulliq Prospect and Hammerhead Drill Sites), Beaufort Sea Alaska

Summer 2008

Submitted to:

Shell Alaska
Anchorage, Alaska

15 July 2009

by

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TABLE OF CONTENTS

RESULTS & DISCUSSION

EXECUTIVE SUMMARY

We describe a pre-drilling chemical and biological sampling program in the vicinity of Shell Alaska's Sivulliq prospect near Camden Bay, Alaska. Our research program, a joint effort between Ken Dunton (The University of Texas Marine Science Institute; UTMSI) and John Trefry (Florida Institute of Technology; FIT), was designed to help us achieve a better understanding of the local mid-shelf ecosystem. Our specific objective was to determine the general characteristics and natural variability of the area, and to enable us to detect any changes that might have occurred in the past as well as to assess any changes that might occur in the future. This report addresses the biological characterization of the Sivulliq prospect with specific emphasis on the benthos, with related water column measurements at selected sites.

Sediment grab samples collected from the *RV Arctic Seal* and field processed between 17 July and 22 July 2008, were used to describe the character of the seabed with respect to the organisms that live within the sediments (the infauna). We did not conduct bottom trawls which would provide us with information on the mobile organisms living on the surface of the sediments (this activity is planned for summer 2009). We also measured the isotopic signatures of the organisms we collected to help us better understand the benthic food web. This information provides some insight into which animals are lower (or higher) on the food chain, and whether their organic carbon (food) sources are largely marine or terrestrial. Density, biomass, stable isotopic composition ($\delta^{13}C$ and $\delta^{15}N$), and species composition of the infaunal community were determined from 45 sites at depths ranging from 22 to 38 m.

We collected over 118 benthic invertebrate species in the study area, with areal biomass ranging from a 0 to 133 g m^{-2} and densities up to 1060 individuals m^{-2}. Polychaetes and bivalves composed over 90% of faunal abundance and biomass at most stations. The biomass and density of infaunal organisms were lower at shallower (22-26 m) stations along the Pipeline corridor, but biomass values at several sites are clearly among the highest recorded for the nearshore shelf of the central Alaskan Beaufort Sea. Multi-dimensional scaling (MDS) analyses (used to determine the percent similarity among stations) revealed that four of the five Pipeline stations possessed little resemblance to the remaining 41 stations, probably a consequence of frequent physical disturbance by deep draft ice and substrate differences.

Measurements of chlorophyll provide information on the abundance of phytoplankton in the water column and microalgae that live in the sediments on the bottom. These microalgae are very important food resources for organisms that live in marine environments. The ratio of carbon to nitrogen (C:N) in the sediments reflect a variety of biogeochemical processes, but ultimately provide information on the relative abundance of either carbon or nitrogen that is delivered to the sediments and then utilized by the organisms. At nearshore sites on the proposed undersea Pipeline corridor, subsamples of sediments from replicate grabs revealed strong correlations between sediment chlorophyll (>130 mg m^{-2}), higher C:N (>10.7), and elevated sediment $\delta^{13}C$ values (-20 to -22‰). These data reflect the production of carbon by benthic microalgae (as identified by their less negative $\delta^{13}C$ values) in these shallower waters where more light is available at depth for photosynthesis. Higher water column chlorophyll and ^{13}C enriched detritus (particulate organic matter; POM) at these same sites at depth suggest that sediment resuspension may enhance water column production through the injection of benthic microalgae into the water. This process exemplifies benthic-pelagic coupling which provides a strong mechanism of positive feedbacks between sediments and overlying waters.

Nutrient levels (inorganic nitrogen is usually the most limiting nutrient in sea water) help determine the extent of primary production. We found water column inorganic-N levels were nearly undetectable but noted high levels of sediment pore water ammonium (over 200 μM at some sites) at several stations. This indicates active biogeochemical processing of organic matter which potentially provides a major source of nutrients to overlying waters. Stable carbon and nitrogen isotopic ratios reveal a food web largely dependent on marine detritus (POM) and in situ sources of inorganic-N. The $\delta^{13}C$ and $\delta^{15}N$ values of POM were similar to both benthic and pelagic herbivorous invertebrates indicating that marine sources of production were most important (rather than organic matter derived from terrestrial sources). Based on $\delta^{15}N$ values of benthic filter feeders and consumers, the nearshore benthos in the Sivulliq prospect is characterized by three trophic levels. This is a minimum estimate since we made no collections of higher trophic level epibenthic organisms (fish, crabs, or larger mollusks). Our benthic biomass, density and organism isotopic data do not indicate that previous drilling activities at the Hammerhead (HH) 1 site (drilling activity took place in 1985) have had a measureable impact on the occurrence or trophic structure of the infaunal community at this site. One predatory species of nemertean possessed an isotopic signature at station HH-5 that reflected a diet common to that of a herbivore, but no other fauna collected at HH-5 displayed unusual isotopic signatures. We could not discern any measureable changes in benthic community structure at Hammerhead as a result of drilling activities that took place over 20 years ago. If the benthic community was impacted during the drilling event, it has progressed well towards recovery.

We did not find extensive areas of hard rock substrata ("boulder patches") although we noted scattered pebbles and cobbles at shallower depths (22-26 m) along the proposed Pipeline corridor. The large spatial variability in benthic infaunal biomass, abundance, and species diversity at the shallower inshore Pipeline stations is related to the heterogeneity of substrate types in this area and the intense physical disturbances (for example ice scour) that exemplify these inner-shelf benthic habitats. The additional data collected for this study has added an enormous amount of new information on the character of the Beaufort Sea shelf ecosystem that has greatly improved our knowledge of the region.

BACKGROUND

1.0 INTRODUCTION

Our knowledge of what currently lives in the Arctic Ocean is not as comprehensive as compared to other oceans, due to the logistical challenges imposed by its multi-year ice and inhospitable climate. Extreme changes in Alaska nearshore environmental conditions have been visible in recent years, particularly during open-water seasons 2007 and 2008. New data indicate that summer ice extent is now declining 11.7% per decade based on record low ice cover in 2007 (40% lower than the long-term average minimum) which was followed by the second lowest ice extent estimates in 2008 (National Snow and Ice Date Center; http://nsidc.org/index.html). These large losses in summer open-water ice cover are resulting in considerable coastal erosion (Dunton, pers. observation) that contribute enormous quantities of sediment into the coastal zone which can impact the marine biota on multiple levels, from populations to individuals. Species level information is, therefore, critical in delineating the effects of climate change versus those caused by anthropogenic activities. For monitoring and assessment of change, the availability of data collected over both temporal and spatial scales is absolutely necessary.

The coast and shelf of the Beaufort Sea extends from Point Barrow, Alaska to Banks Island in Canada, and incorporates three distinct shelf environments (inner, mid, and outer) and two large river systems, the Colville and the Mackenzie. In marked contrast to the Chukchi-Bering ecosystem on the west and the Queen Charlotte Islands on the east, the Beaufort Sea, and the eastern Alaskan Beaufort in particular, is decidedly estuarine in character. The combined flows of the Colville and the Mackenzie Rivers annually add nearly 350 km^3 of freshwater plus 130 x 10^6 tons sediment to a relatively broad shelf that ranges in width from 40 km in Alaska to 150 km in Canada (Macdonald et al., 2004). In addition, the Alaskan Beaufort Sea coast, from Barrow to Demarcation Bay, is skirted by an irregular and discontinuous chain of barrier islands that enclose numerous shallow (<8 m) lagoons that are fed by many small rivers and streams.

The Sivulliq prospect is located in the eastern portion of the nearshore shelf of the Alaskan Beaufort Sea (see Figs. 3.0.1–3.0.5). The Beaufort Sea is blanketed predominantly by silty sands and mud (Barnes and Reimnitz, 1974) composed of 21% fine silt, 16% silt, 20% very fine sand, and 28% fine sand (Chin et al., 1979). These fine grained sediments support an infaunal assemblage dominated by polychaete worms, small mollusks and crustaceans (Feder and Schamel, 1976; Carey and Ruff, 1977; Broad et al., 1978; Woodward-Clyde Consultants, 1979; Griffiths and Dillinger, 1981; Feder and Jewett, 1982; Carey et al., 1984). Large scale quantitative studies of Beaufort Sea coastal benthic biota did not begin until relatively recently, following the discovery of oil in Prudhoe Bay. Surveys under the Outer Continental Shelf Environmental Assessment Program (OCSEAP) began in the 1970s and continued into the early 1990s. The two major studies under this program were by led by A.C. Broad who surveyed the nearshore between 1975 and 1980 and A.G. Carey Jr. who sampled from the mid-shelf to the edge of the Arctic Basin (in 1971 and 1975-1978). These studies occupied several benthic sampling stations in the general vicinity of the Sivulliq prospect (Dunton et al., 2005).

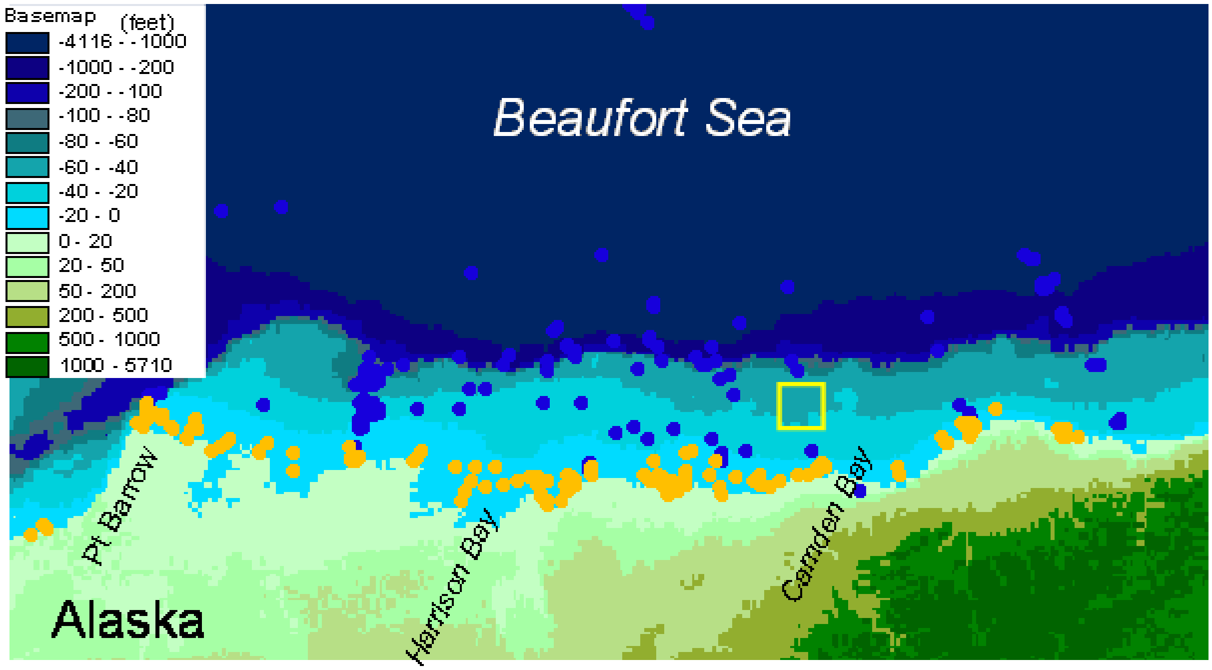

Figure 1.0.1. A bathymetric and topographic GIS map of the north coast of Alaska with historic benthic sampling stations indicated by dots. The yellow square denotes the general area of biological interest to Shell Oil. Blue dots are station locations occupied by Carey and orange dots are sites that Broad sampled. Both scientists worked in the 1970's and 1980 under the Outer Continental Shelf Program Environmental Assessment Program (OCSEAP).

The estimates provided by Dunton et al. (2005) for benthic biomass on the Alaskan Beaufort Shelf are based on historical data from stations that are not evenly distributed across or along the shelf, and consequently, our confidence in predicted values is quite variable. The Sivulliq study provides an excellent opportunity to add an enormous amount of information on the character of the Beaufort Sea shelf ecosystem that will greatly improve our quantitative knowledge of the region. Predicted biomass values for this region range from <25 to 50 g m^{-2}, nearly an order of magnitude less than the northeastern Chukchi shelf. In addition, we have little information on the composition of these benthic communities since earlier work only identified organisms to the level of family, not species. A detailed knowledge of benthic assemblages is also required for determination of spatial and temporal patterns in diversity as well as community structure.

Another enigma for this area is the source of carbon that supports the shelf biotic assemblages. We can distinguish terrestrial sources of organic material from marine sources based on their stable isotopic signatures. Terrestrial organic matter is characterized by $\delta^{13}C$ values of -27 to

-31‰ and $\delta^{15}N$ values of 0 to 1.5‰. In contrast, marine primary producers are identified by $\delta^{13}C$ values of -22 to -25‰ and $\delta^{15}N$ values of 5 to 7‰. We can use these endmember values in assessing the relative importance of these two sources of carbon to the marine consumers of the Sivulliq study area. Such knowledge provides us with an enhanced understanding of the system that can be used for impact assessment to minimize the effects of offshore development on populations through increased sensitivity to water quality (transparency) or coastal watersheds.

It is widely believed that phytoplankton production provides the ultimate source of food for both the pelagic and benthic components. However, isotopic data from sediments collected on the Beaufort Sea coast show a strong gradient of increasing terrestrial inputs of particulate organic carbon (POC) eastward along the coast and contributions from terrestrial POC along the nearshore portion of the eastern Beaufort (Naidu et al., 2000). On the Mackenzie shelf, isotopic evidence led Parsons et al. (1989) to conclude that terrigenous carbon was a significant component of the nearshore food web. The depleted $\delta^{13}C$ values in the organic carbon of arctic coastal sediments, particularly in regions around the Mackenzie and Colville Rivers, led Naidu et al. (2000) to conclude that at least 30-50% of the organic matter in nearshore and shelf sediments was of terrigenous origin. The sources of this allochthonous carbon include both river runoff and coastal erosion. Based on calculations made by Reimnitz et al. (1988) for the Alaskan Beaufort Sea and Are (1999) for the Laptev Sea, it appears that sediment influx derived from coastal erosion is greater than the riverine influx. However, the hydrological controls on biogeochemical feedbacks and linkages between arctic watersheds and their receiving basins on the northern Alaskan coast are not well understood.

The fate of this terrigenous carbon in arctic coastal food webs is largely unknown. Schell (1983) found evidence for the incorporation of ancient (8-12,000 yr BP; Schell and Ziemann, 1983) terrestrial peat carbon into freshwater aquatic food webs near the Colville River Delta based on depressed ^{14}C abundances in resident fish and ducks. However, ^{14}C activities in three marine invertebrate crustaceans were not depressed, leading Schell (1983) to conclude that utilization of terrestrial carbon in the arctic estuarine environment was very limited.

However, dissolved organic carbon (DOC) is by far the most abundant form of terrigenous carbon exported in arctic rivers (Gordeev et al., 1996; Lobbes et al., 2000) and, based on ^{14}C abundance data, this carbon pool is predominantly young (Benner et al., 2004). This study therefore provides an opportunity to examine the possible incorporation of terrestrial carbon into the food webs of the Beaufort Shelf from the inner shelf (just outside the barrier islands at 20 m) to the mid-shelf (about 40 m).

METHODS

2.0 OVERVIEW

2.0.1 Approach

The overall objective of the Sivulliq offshore baseline sampling program was to collect samples for water quality determinations, sediment chemistry, and benthic biological data for subsequent evaluation of possible future oil and gas development impacts. Unbiased, statistically rigorous statements about the status of chemistry and the biological communities in the proposed drill site area are also dependent on a spatially referenced dataset. This report is specifically focused on biological resources of the region surrounding the Sivulliq prospect and Hammerhead, an earlier prospect that was subject to exploratory drilling activities:

1. Biological and biogeochemical characterization of the benthos (isotopic composition of the sediments, chlorophyll *a*, pore water ammonium, sediment C:N ratios and benthic faunal density, biomass, species composition, diversity, and food web structure (based on stable isotopes of carbon and nitrogen).
2. Water column parameters (concentrations of chlorophyll *a* and nutrients, zooplankton and POM isotopic composition).

Our strategy involved benthic and water column sampling at 45 designated stations (Fig. 2.0.1). Two benthic grabs were collected at each station, one for biology (infaunal abundance and biomass) and one for chemistry (sediment parameters and selective collection of biota for determination of trophic structure). Vertical profiles of water column characteristics were assayed at seven selected stations

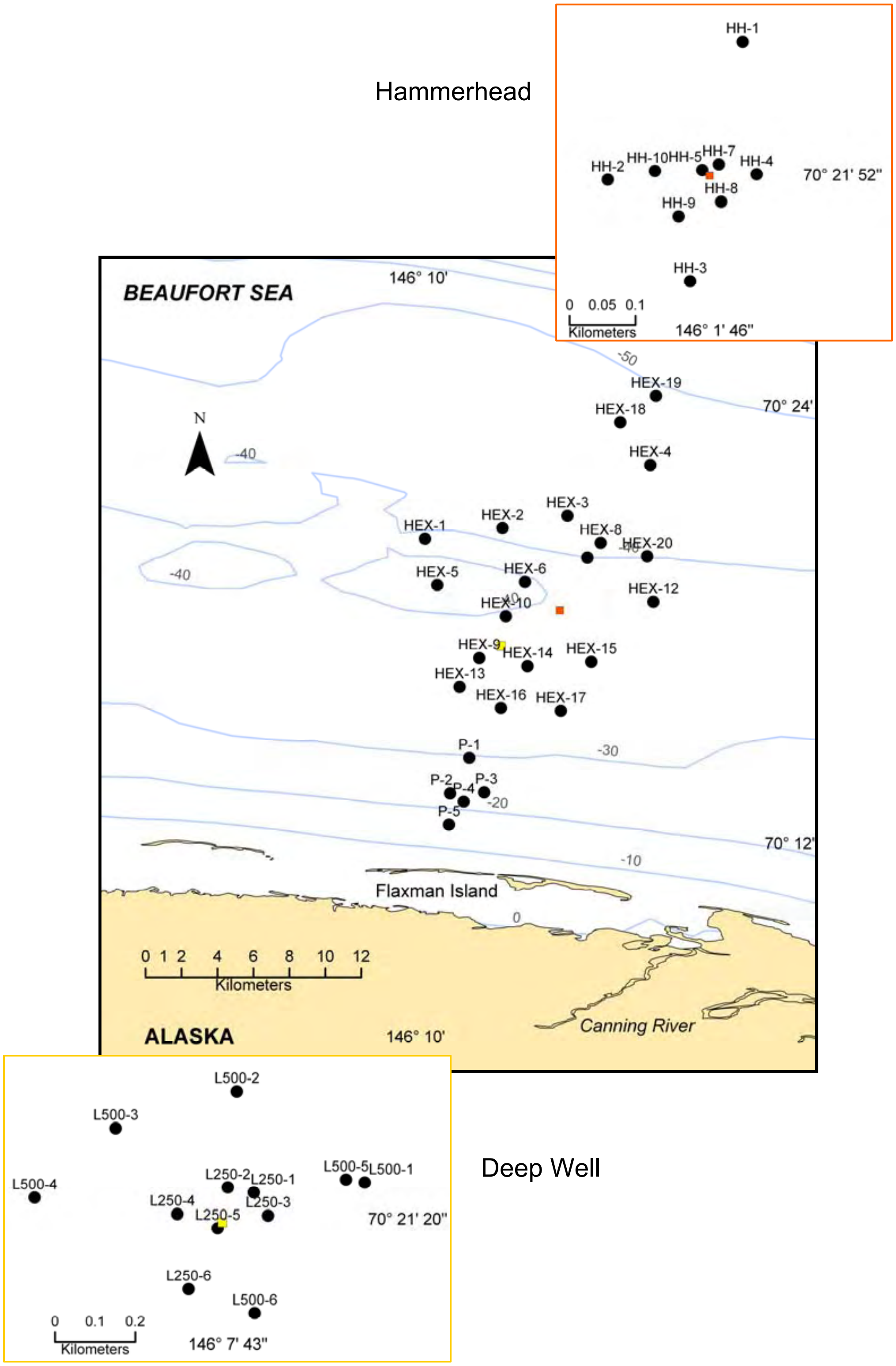

Figure 2.0.1. An area map showing Sivulliq biological sampling locations (black circles). Hammerhead site location is depicted with an orange square on center map with station detail in top right rectangle. Deep Well site location is denoted by a yellow square in center map with detail in bottom left rectangle. Depth contours are labeled in meters.

2.0.2 Site Selection

We collected samples at 19 sites (designated HEX) across the monitoring area to describe the spatial extent and patterns of biota biomass and density in the Sivulliq prospect on the nearshore shelf northwest of Camden Bay. The location for each site was chosen by laying a probability-based grid over the study site area and randomly choosing a location within each grid cell. This method allowed for sampling locations to be spaced quasi-evenly across the landscape while still maintaining assumptions required for a random sample (i.e., all locations have an equal chance of being sampled). To gain a better resolution of the variability around a specific site (Deep Well), we created a second probability grid over a smaller area (500 m). Six stations were located 250 m from Deep Well and another six stations were located at a distance of 500 m (designated L-250 and L-500 respectively). A third probability grid, similar to Deep Well, was created around a previous drill site (Hammerhead 1 drilled in 1985). Ten stations (designated HH) were sampled at this prospect but only nine benthic stations were sampled for biology. Finally, we sampled five stations that followed the course of the proposed Pipeline route from the Sivulliq prospect (designated P). Of the total number of sites sampled for benthic measurements (45), all but the five Pipeline stations were located in water depths greater than 30 m.

2.1 BENTHIC SEDIMENT MEASUREMENTS

2.1.1 Isotopic measurements – $\delta^{13}C$ and $\delta^{15}N$

Ecologists use stable isotopes to examine the origins of materials in the environment and to determine trophic relationships among organisms in a food web. Origins of organic matter are based on the premise that the potential sources are isotopically distinct from each other and do not change, or change predictably as those materials are transported. In the Beaufort Sea for example, terrestrial organic matter is characterized by $\delta^{13}C$ values of -27 to -31‰ and $\delta^{15}N$ values of 0 to 1.5‰. In contrast, marine primary producers are identified by $\delta^{13}C$ values of -22 to -25‰ and $\delta^{15}N$ values of 5 to 7‰. We can use these end member values in assessing the relative importance of these two sources of carbon to the marine consumers. For determination of trophic relationships, the technique is based on the known or estimated isotopic fractionation (or discrimination) of carbon (C) or nitrogen (N) as a function of trophic level. For both C and N, isotopic enrichment of the heavier isotope occurs with each successive trophic step in the food web. Consequently, organisms with higher $\delta^{13}C$ or $\delta^{15}N$ values occupy higher trophic levels or positions in the food web.

At each site, aliquots were removed from a 0.01 m^2 van Veen surface sediments and placed in pre-labeled Crio-vials, stored in frozen, dark conditions, and transported to UTMSI for analyses of natural abundance isotopes (C, N). Samples were sub-sampled for an acidification/non-acidification technique to remove carbonates, placed in aluminum trays, and dried at 60 °C. Acidified samples were soaked in 1 *N* HCl for several hours until bubbling stopped, rinsed with distilled water, and dried completely. All samples were analyzed on an automated system for coupled $\delta^{13}C$ and $\delta^{15}N$ measurements using a Finnegan MAT Delta Plus mass spectrometer attached to an elemental analyzer (CE Instruments, NC 2500). Samples were combusted at 1,020 °C and then injected into the mass spectrometer with continuous flow. Results are expressed in standard δ notation relative to carbonate PeeDeeBelemnite and atmospheric nitrogen where:

$\delta^{13}C$ or $\delta^{15}N$ (‰) = $[R_{sample}/R_{standard}) - 1] \times 1000$ and R = ($^{13}C/^{12}C$ or $^{15}N/^{14}N$), respectively. By definition, as δ values increase (or decrease), the relative abundances of the heavier isotopes, ^{13}C or ^{15}N, increase (or decrease). Secondary standards were used routinely for cross-calibration checks of tank reference gases, against which all samples were run. Our data were reproducible to within ± 0.2‰. Machine analytical error was ± 0.15‰.

2.1.2 Chlorophyll *a*

Measurements of chlorophyll provide information on the abundance of phytoplankton in the water column and microalgae that live in the sediments on the bottom. These microalgae are very important food resources for organisms that live in marine environments. Following Cooper et al. (2002), we extracted 2 cm deep aliquots from surface sediment samples collected from 0.01 m^2 van Veen grabs. The aliquot was placed in a pre-labeled 20-mL Falcon tube and promptly frozen in darkness. The frozen samples were transported back to UTMSI for extraction and analysis. Each sample was sub-sampled and chlorophyll *a* was extracted with 10 mL of 90% acetone for 12 hours at freezing temperature in darkness. The samples were centrifuged, and a

Shimadzu UV-2401 PC Spectrophotometer (Shimadzu, Tokyo, Japan) measured absorbance of the supernatant at wavelengths 750, 664, 647, and 630 nm. The combined sub-sample reading was then used to determine the amount of chlorophyll-*a* as expressed on an areal basis (mg m^{-2}).

2.1.3 Pore water ammonium (NH_4)

Ammonium is a critical nutrient for plants and its availability, along with nitrate, regulates benthic and water column primary productivity. Core samples were immediately collected from van Veen grabs on retrieval using a 60-mL syringe at each site. The cores were stored in dark, freezing conditions during transport to UTMSI for sediment pore water ammonium analysis. Pore water was extracted by centrifuging thawed sediments. The supernatant underwent colorimetric analysis as described by Parsons et al. (1984).

2.1.4 C:N ratios

The ratio of carbon to nitrogen (C:N) in the sediments reflect a variety of biogeochemical processes, but ultimately provide information on the relative abundance of either carbon or nitrogen that is delivered to the sediments and then utilized by the organisms. The top 2 cm of surface sediments were collected from undisturbed van Veen grab samples using a 10 cc syringe. Samples were placed in pre-labeled Crio-Vials and frozen in darkness for transport to UTMSI for elemental analysis. Carbon (C) and nitrogen (N) content of sediments were analyzed with an automatic elemental analyzer (model NC 2500, Fison Instruments, Rodano-Milan, Italy). Percent C and N were converted to molar (atomic) C:N ratios.

2.2 BENTHIC FAUNA MEASURMENTS

2.2.1 Station density, biomass, and species composition

A total of 45 stations were sampled using a van Veen grab to collect 0.1 m^{-2} sediment sections. All samples were carefully washed over 0.1 mm sieve. From the sorted retained fraction, invertebrates were sorted, identified, and counted where individuals could be distinguished. Species were weighed on a microbalance (Denver Instruments APX-60, Arvada, Colorado, USA) and preserved in 70% ethanol. All samples are stored at The University of Texas Marine Science Institute (UTMSI).

2.2.2 Isotope measurements - $\delta^{13}C$ and $\delta^{15}N$

A subset of representative specimens were identified, labeled, frozen, and shipped to UTMSI for natural abundance isotope analysis (C, N), a technique used to elucidate community food web structure. In the lab, samples were dried in aluminum dishes at 60 °C following removal of extraneous organic matter. When possible, soft tissues were removed from shelled organisms, but all invertebrate samples were subsequently soaked in 1 *N* HCl for several hours (or until bubbling stopped) to remove carbonates, rinsed in distilled water, and then dried. Only muscle or body wall tissue was analyzed from bivalves, gastropods, and fish. All other organisms were analyzed whole. Entire organisms or tissues were manually ground for isotopic analyses. Replicate analyses reflect the analysis of individual organisms, not composite samples. All samples were analyzed on an automated system for coupled $\delta^{13}C$ and $\delta^{15}N$ measurements using a Finnegan MAT Delta Plus mass spectrometer.

2.3 WATER COLUMN MEASUREMENTS

2.3.1 Chlorophyll *a*

Replicate water samples were collected at near-surface (5 m), intermediate (10 m), and near-bottom depths (25 m) using an electrically powered peristaltic water pump attached to a hose reel of Tygon tubing. The Tygon tubing was lowered by hand to depths selected from the YSI water column profile and seawater was pumped to the surface for collection. All samples were placed in pre-labeled plastic bottles and placed in a dark cooler to be filtered in the shipboard lab. In the dark, water from each replicate sample was filtered through Whatman GF/F filters (Whatman, Maidstone, England). After filtration, the filters and residue were placed in pre-labeled opaque vials and frozen. The frozen filters were transported to UTMSI for subsequent chlorophyll analysis. At UTMSI, filters were removed from the vials and placed in pre-labeled test tubes containing 5 ml of 90% acetone for overnight extraction (Parsons et al., 1984). Chlorophyll *a* concentration, in μg L^{-1}, was determined using a Shimadzu UV-2401 PC spectrophotometer by measuring absorbance at wavelengths 750, 664, 647, 630, and 600 nm. [Non-acidification techniques were used to account for the presence of chlorophyll *b* and phaeopigments (Welschmeyer, 1994).]

2.3.2 Zooplankton - $\delta^{13}C$ and $\delta^{15}N$

Zooplankton were collected in vertical tows using a 335 μm plankton net. Plankton were sorted by eye using a dissecting scope into phyla and filtered onto GF/F filters (Whatman, Maidstone, England). Zooplankton filters were frozen in darkness for transport to UTMSI for elemental analysis. At UTMSI, samples were dried at 60 °C. To remove carbonates from zooplankton, samples were soaked in 1 *N* HCl for several hours, or until bubbling stopped, rinsed with distilled water, and dried. All samples were analyzed on an automated system for coupled $\delta^{13}C$ and $\delta^{15}N$ measurements using a Finnegan MAT Delta Plus mass spectrometer. Percent C and N were converted to molar (atomic) C:N ratios in zooplankton.

2.3.3 POM profiles - $\delta^{13}C$ and $\delta^{15}N$

Particulate organic matter (POM) was collected by filtering replicate water samples from near-surface (5 m), intermediate (10 m), and near-bottom depths (25 m) onto Whatman GF/F filters (Whatman, Maidstone, England). POM filters were frozen in darkness for transport to UTMSI for elemental analysis. At the lab, samples were dried at 60 °C. To remove carbonates from zooplankton, samples were soaked in 1 *N* HCl for several hours, or until bubbling stopped, rinsed with distilled water, and dried. All samples were analyzed on an automated system for coupled $\delta^{13}C$ and $\delta^{15}N$ measurements using a Finnegan MAT Delta Plus mass spectrometer.

2.3.4 Nutrients (NH_4^+, SiO_4, PO_4^3, NO_2^- + NO_3^-)

Water samples were frozen on board the ship and transferred to UTMSI for nutrient analysis. Nutrient concentrations (μM) for NH_4^+, SiO_4, NO_2^- + NO_3^-,and PO_4^{3-} were determined by continuous flow injection analysis using colorimetric techniques on a Lachat QuikChem 8000 (Zellweger Analytics Inc., Milwaukee, Wisconsin, USA) with a minimum detection level of 0.03 μM.

2.4 GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

Geographical Information Systems (GIS; ESRI, 2008) was used to construct a geospatial database and analyze the benthic and water column community at the Shell Sivulliq prospect site. Sample data were assembled in a relational database and analyzed using Arc/Info 9.3. A Geostatistical Analyst extension to ArcMap was employed to interpolate benthic biomass and density, sediment chlorophyll and ammonium, and natural abundance isotopes with kriging techniques. Since these data cannot be sampled on a spatially continuous scale but at point locations, Geostatistical Analyst was used to interpolate the biological point data to model trends across a landscape.

We used geostatistical methods to create a prediction surface and provide an estimation of the statistical error associated with the prediction. A great advantage of these methods is that they provide an estimate of how well they are predicting the surface (error of prediction). Several methods of gaining familiarity with the data were used before interpolation took place. Histograms were used to examine the frequency distribution of the data. Normal Quantile-Quantile plots (QQ-plots) were used to determine the normality of the data. The Trend Analysis option in the extension allowed identification of nonrandom trends in the data such as outliers.

Radial Basis Functions (RBS) was used to interpolate the Sivulliq data. RBS is a deterministic interpolation technique built on the basic law of geography that points closer together are more similar than points that are far apart. RBS fits a smooth surface through every measured point and minimizes the surface curvature. This interpolation is a kriging function based in multivariate statistics.

2.5 COMMUNITY STRUCTURE ANALYSES (PRIMER)

We used PRIMER (Plymouth Routines In Multivariate Ecological Research) software to analyze benthic biota abundance and biomass data for similarity among stations using non-metric multi-dimensional scaling plots (MDS) and cluster analysis with a SIMPROF significance test based on Bray-Curtis similarities. Data were transformed using the square root function prior to MDS analysis. Additionally, a range of standard diversity measures were calculated using the DIVERSE function available in PRIMER. Community structure of the Sivulliq stations was analyzed using three methods: Pielou's index, Shannon-Wiener index, and Simpson's index. Pielou's evenness was determined to measure equitability; i.e. how evenly the individuals are distributed among the different species. Shannon-Wiener diversity index was used to explore species diversity, calculated using the natural log of the measurements. Simpson's index is a dominance index, in that its largest values correspond to assemblages whose total abundance is dominated by one, or a very few, of the species present. The reciprocal of the index was used in this report so a smaller index number indicates fewer species of the total possible were measured at a station.

2.6 QUALITY ASSURANCE

Our processing of benthic and pelagic biological samples requires adherence to the following two basic principles:

Accuracy: Benthic sorting, identification, counting, weighing, and entering data is a human-based, not machine based process, and consequently accuracy is a function of a person's experience and training. The taxonomist in charge of this project, Susan Schonberg, has over 25 years of experience with arctic biota. Such accuracy includes verification by taxonomic group specialists, including Nora Foster (mollusks) and Ken Coyle (crustaceans).

Control: We track samples with pre-printed forms from field to lab and from lab to database to insure a clear chain of custody process.

RESULTS & DISCUSSION

3.0 BENTHIC SEDIMENT BIOGEOCHEMICAL MEASUREMENTS

Spatial trends over the Sivulliq study area reveal some interesting patterns among some parameters, particularly sediment C:N ratios, chlorophyll, and $\delta^{13}C$ values (Figs. 3.0.1 – 3.0.5). The higher sediment C:N ratios (maximum C:N 13.1) at the Pipeline sites, which are located at comparably shallower depths and closest inshore, compared to all other sites (maximum C:N <11.5), is likely correlated to high sediment chlorophyll values (>130 mg m^{-2}) at the Pipeline sites. The elevated chlorophyll values are among the highest recorded in western arctic seas (Grebmeier et al., 2006) and reflect strong microphytobenthic carbon production. The presence of this microalgal assemblage is distinctly correlated with the highest $\delta^{13}C$ values in the area (-20 to -22‰), compared to more depleted values (< -22‰) measured throughout the rest of the study area. Isotopically enriched ^{13}C values are associated with marine primary producers, while more depleted values are attributed to terrestrial sources of carbon (i.e. transport from Colville and Mackenzie Rivers; see Dunton et al., 2006). Higher sediment chlorophyll values in the northern reaches of the study area are not correlated with C:N or $\delta^{13}C$ values, and probably represent ephemeral features.

There are no obvious spatial trends in sediment ammonium values, which were generally less than 140 µM except at a few sites where values exceeded 200 µM. The pore water concentrations reported here for ammonium are higher than expected for these sediments and indicate that sufficient organic matter is present in the sediments to support aerobic decomposition processes (ammonification). We found sediment $\delta^{15}N$ values to range between 2 and 4.5‰, with values generally increasing seaward. The rather tight distribution of $\delta^{15}N$ values (2.5‰ range) reflects a system that is relatively homogeneous with respect to ultimate nitrogen sources.

Within the Hammerhead and Deep Well sites, no obvious trends in the distribution of the biogeochemical parameters were apparent. Values for sediment chlorophyll, reflective of benthic microalgal abundance, showed substantial spatial heterogeneity that could not be correlated with any specific biotic or abiotic parameter. C:N ratios varied in a more predictable narrow range (from 9-11), very similar to that recoded by Grebmeier and Cooper (2009) along the inner shelf area of the Chukchi Sea (8.5-11). Values for TOC (Table 3.01) are also within the range reported by Grebmeier and Cooper (2009). Sediment C:N values greater than Redfield ratios (6.6) as depicted here suggest the delivery of other organic material (possibly terrestrial carbon), or more pronounced N limitation compared to other shelf environments.

Table 3.0.1 Surface sediment total organic nitrogen (TON) and total organic carbon (TOC), C:N ratios, and $\delta^{15}N$ and $\delta^{13}C$

SEDIMENTS						$\delta^{15}N$	$\delta^{13}C$
		Sample	TON	TOC	C:N	At-air	PDB
Site	Location	Name	(%)	(%)		(‰)	(‰)
Hex	1	285	0.05	0.58	10.44	2.99	-25.29
Hex	2	404	0.07	0.79	9.28	3.70	-25.42
Hex	3	286	0.09	1.00	9.23	3.70	-25.20
Hex	4	405	0.05	0.57	9.73	3.65	-25.46
Hex	5	287	0.08	0.84	9.01	2.83	-25.36
Hex	6	406	0.10	1.16	10.02	4.25	-24.96
Hex	7	288	0.09	0.98	9.70	2.36	-25.31
Hex	8	407	0.06	0.71	9.48	2.84	-25.56
Hex	9	289	0.08	0.98	10.20	2.86	-25.50
Hex	10	408	0.09	0.92	9.04	3.09	-25.69
Hex	12	409	0.06	0.70	9.59	3.16	-25.36
Hex	13	290	0.09	0.91	8.76	2.74	-25.09
Hex	14	410	0.07	0.73	8.70	2.95	-25.46
Hex	15	291	0.14	1.43	8.54	3.95	-25.34
Hex	16	411	0.09	1.00	9.79	3.37	-25.71
Hex	17	292	0.09	0.96	9.52	3.90	-25.40
Hex	18	412	0.14	1.54	9.26	4.25	-25.55
Hex	19	293	0.05	0.56	9.84	3.79	-24.98
Hex	20	413	0.08	1.04	10.89	3.77	-25.64
HH	1	275	0.07	0.74	9.25	3.61	-24.99
HH	2	276	0.03	0.45	11.38	3.71	-25.53

SEDIMENTS						$\delta^{15}N$	$\delta^{13}C$
		Sample	TON	TOC	C:N	At-air	PDB
Site	Location	Name	(%)	(%)		(‰)	(‰)
HH	3	277	0.07	0.81	9.71	3.34	-25.72
HH	4	278	0.05	0.64	10.43	3.80	-25.71
HH	5	279	0.03	0.30	10.29	3.45	-25.84
HH	6	280	0.07	0.80	9.40	2.94	-25.98
HH	7	281	0.17	1.77	9.20	3.53	-26.13
HH	8	282	0.08	1.07	11.21	3.21	-26.19
HH	9	283	0.08	0.92	10.01	2.67	-25.45
HH	10	284	0.08	0.98	10.12	2.81	-25.33
L2	1	414	0.08	0.79	8.98	2.81	-25.92
L2	2	415	0.08	0.86	8.78	3.19	-25.91
L2	3	416	0.12	1.37	9.71	4.06	-25.70
L2	4	417	0.08	0.83	8.46	3.02	-25.35
L2	5	418	0.09	0.96	9.50	2.45	-25.42
L2	6	419	0.10	1.00	9.00	3.12	-25.63
L5	1	398	0.07	0.85	10.74	3.15	-25.90
L5	2	399	0.04	0.54	11.45	3.00	-25.78
L5	3	400	0.07	0.85	11.14	3.23	-25.84
L5	4	401	0.07	0.86	10.15	4.10	-25.97
L5	5	402	0.08	0.90	10.05	3.99	-25.81
L5	6	403	0.08	0.85	9.42	3.75	-25.38
P	1	294	0.11	1.33	10.67	3.36	-26.07
P	2	295	0.08	0.98	10.85	3.40	-25.77
P	3	296	0.05	0.71	12.63	2.75	-25.95
P	4	297	0.08	1.13	11.61	2.25	-22.36
P	5	298	0.09	1.42	13.11	2.64	-20.19

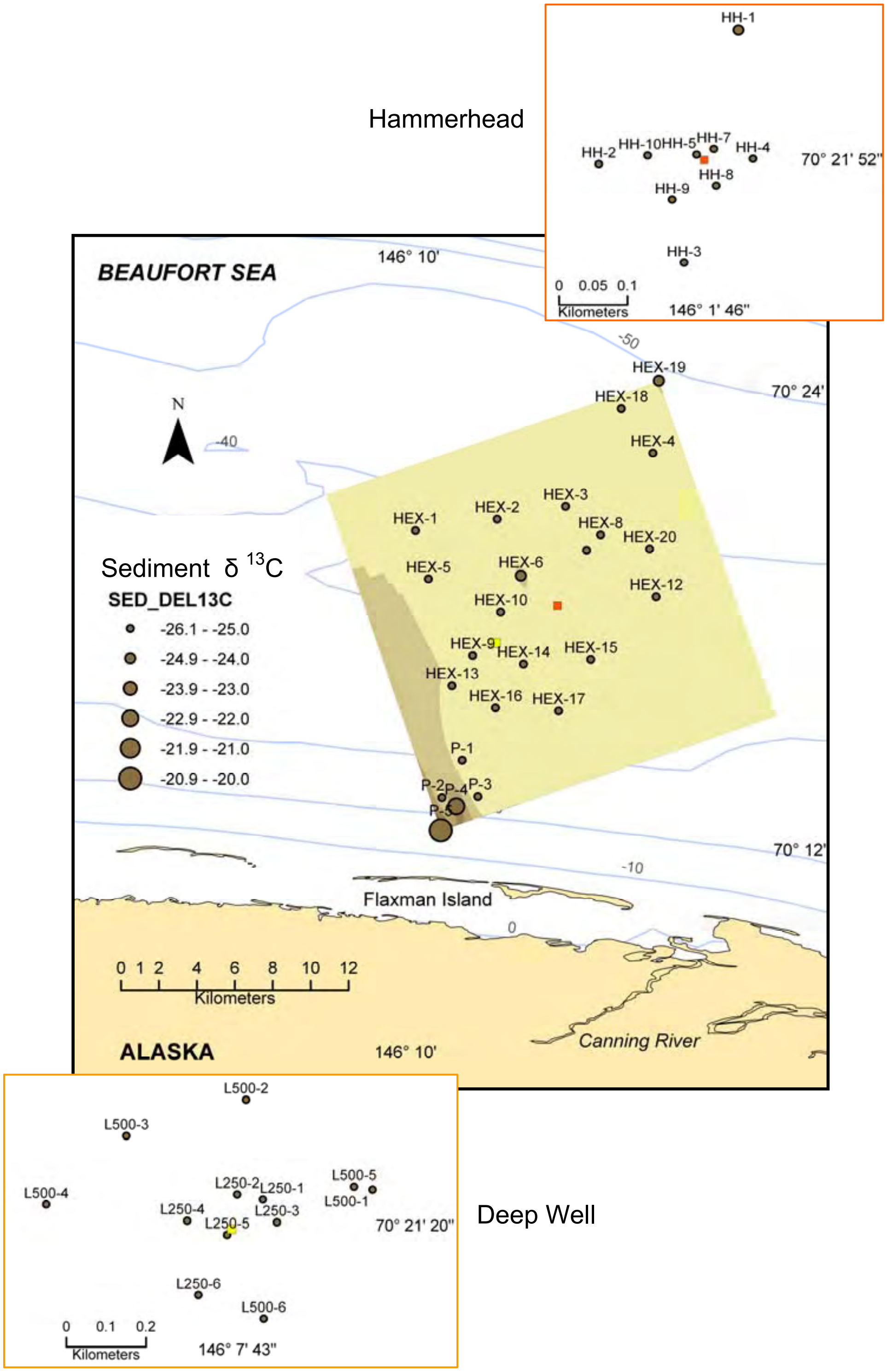

Figure 3.0.1 Distribution of sediment $\delta^{13}C$ values in the Sivulliq prospect area. Note that sediments become most enriched in ^{13}C at the most nearshore sites. Red and yellow squares denote the location of the Hammerhead and Deep Well sites, respectively, on the large projection. Depth contours are labeled in meters.

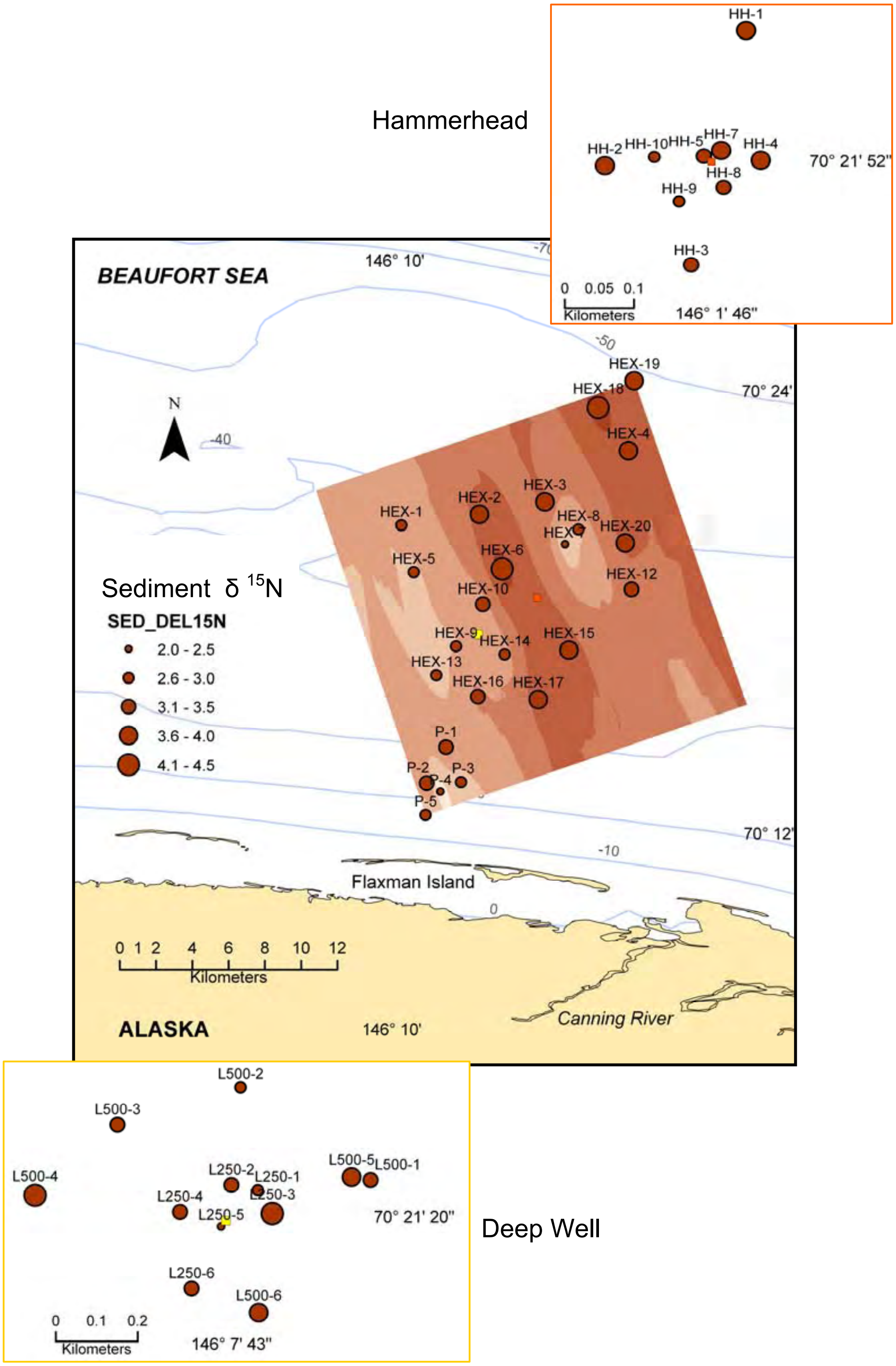

Figure 3.0.2 Distribution of sediment $\delta^{15}N$ values in the Sivulliq prospect area. Values become generally higher offshore but have a relatively small range (2.5‰), revealing a common inorganic-N source. Depth contours are labeled in meters.

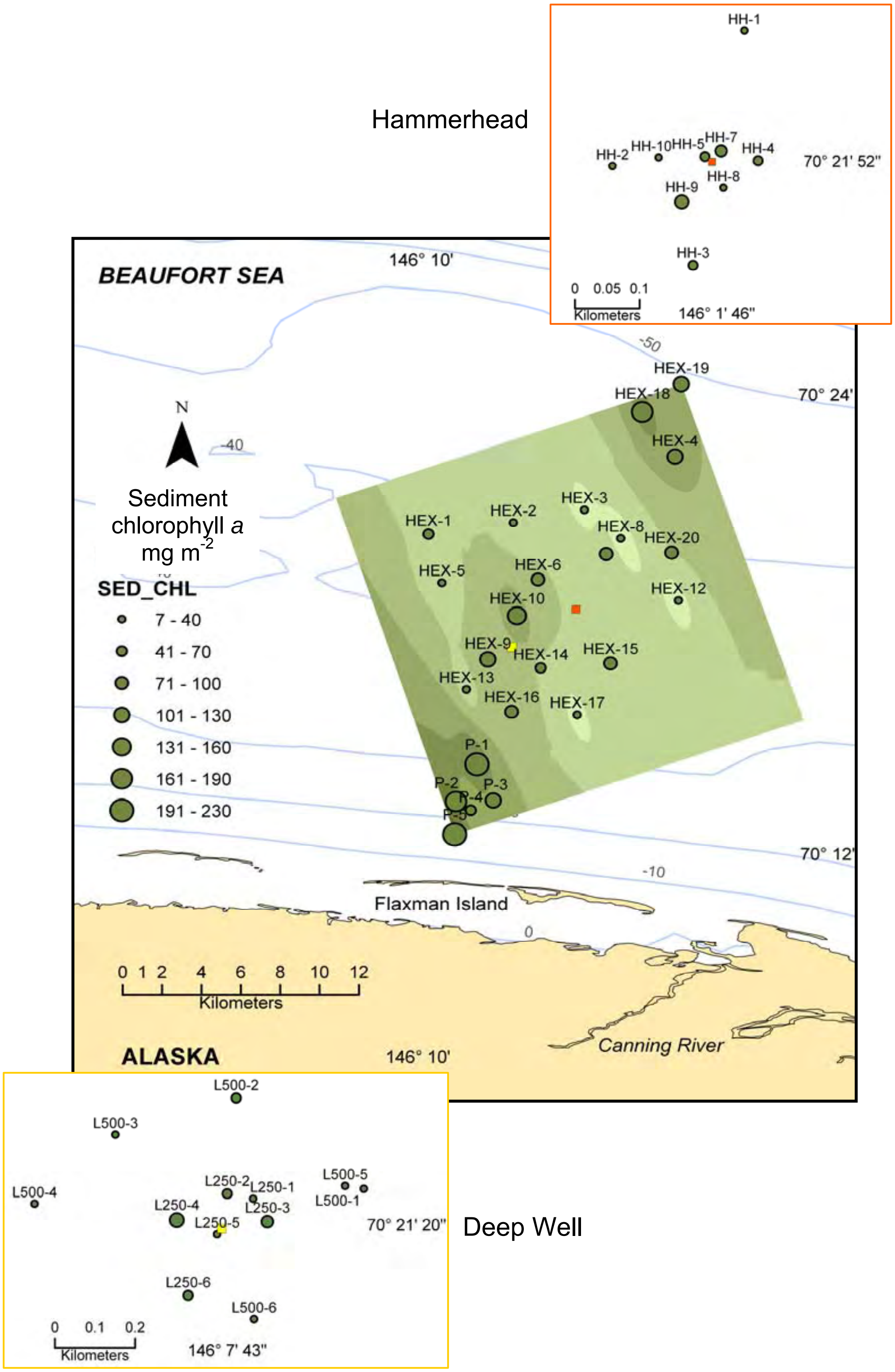

Figure 3.0.3 Variations in sediment chlorophyll *a* across the study. Values are highest nearest the coast and furthest offshore. Depth contours are labeled in meters.

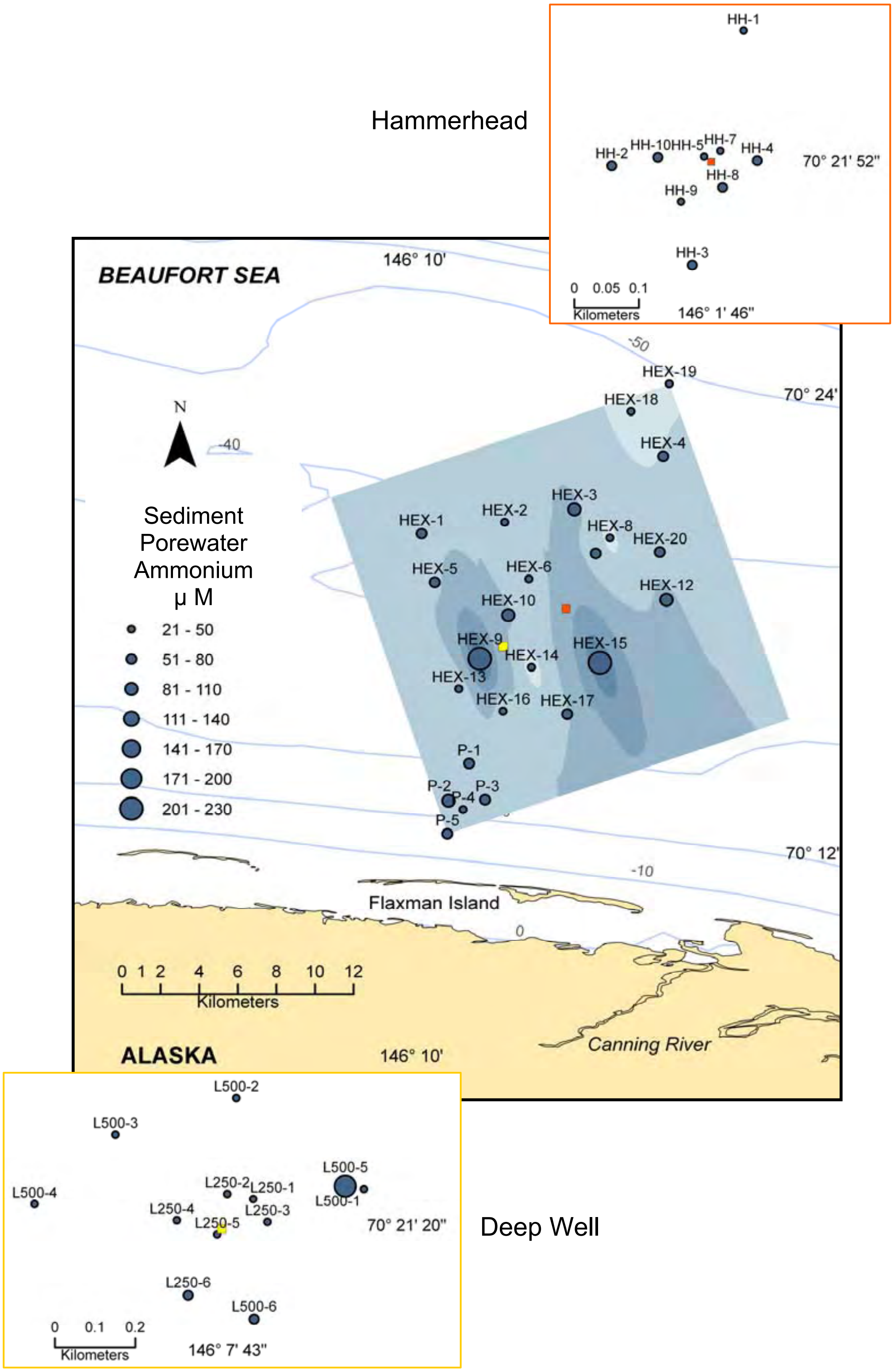

Figure 3.0.4 Sediment porewater ammonium values range over an order of magnitude across the study area, revealing areas of high organic matter decomposition processes. Depth contours are labeled in meters.

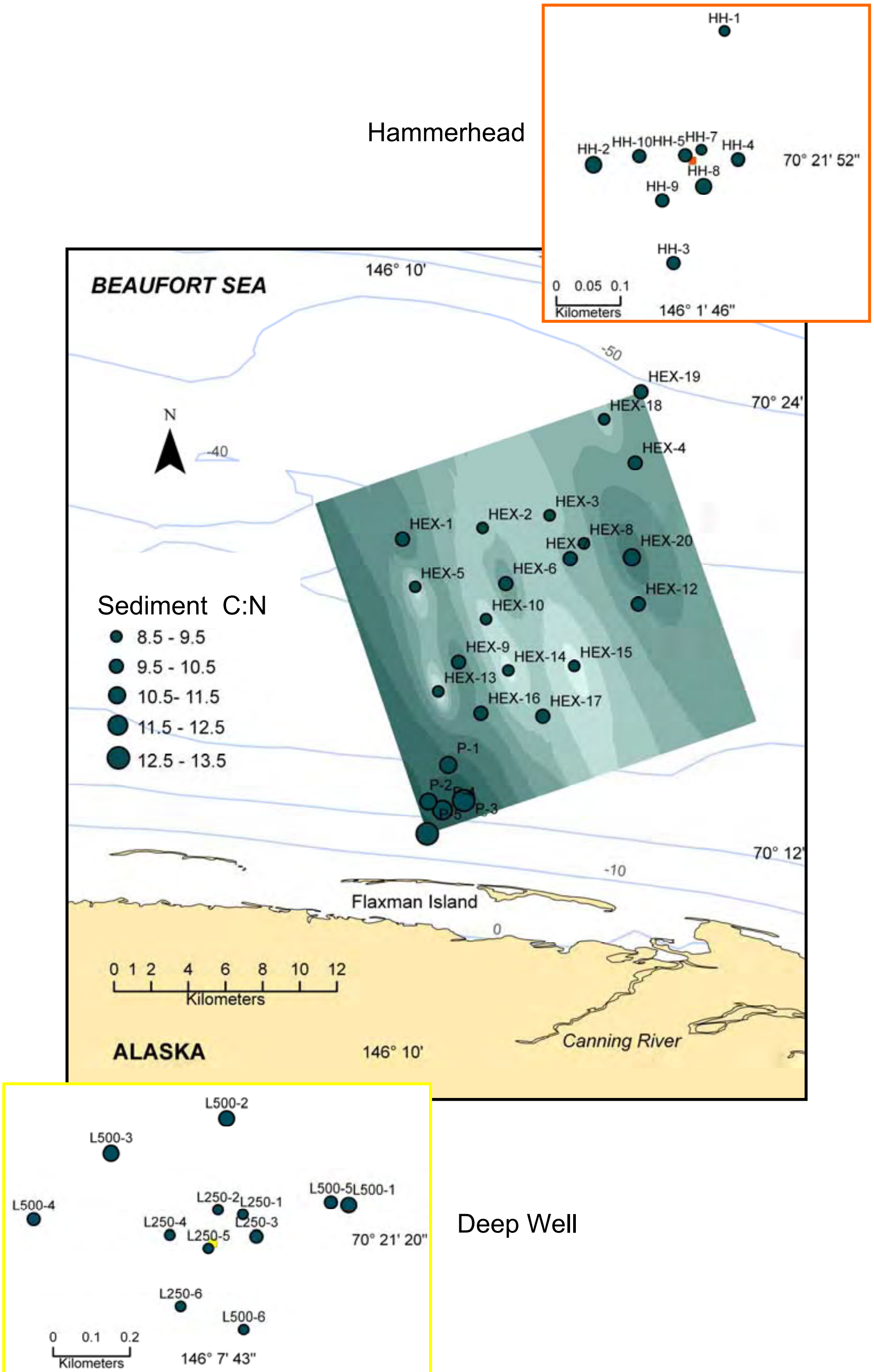

Figure 3.0.5 Distribution of sediment C:N values across the Sivulliq study area. C:N ratios are highest nearest the coast and correspond to elevated levels of sediment chlorophyll and increased $\delta^{13}C$ values (see Figs. 3.0.1 and 3.0.3). Depth contours are labeled in meters.

3.1 BENTHIC FAUNA

A total of 45 sites were sampled for benthic quantitative measurements in the Sivulliq study area. Benthic infauna were dominated by three groups; polychaetes, mollusks (bivalves and gastropods) and crustaceans (amphipods and cumaceans; Table 3.1.1). A total of 118 species were identified (Table 3.1.2). Benthic biota belonged to 12 major phyla: Porifera, Cnidaria (Anthozoa, Hydrozoa), Mollusca (Gastropoda, Bivalvia), Annelida (Polychaeta), Arthropoda (Amphipoda, Isopoda, Cumacea, Mysidea), Bryozoa, Echinodermata (Asteroidea, Holothurian), Tunicata (Ascideacea), Nemertea, Foraminifera, Priapula, Sipuncula, Osteichthyes.

3.1.1 Station abundance, biomass and species composition

No discernible broad scale geographic patterns in benthic infaunal abundance and biomass were observed within the Sivulliq prospect area (Fig. 3.1.1 and Fig. 3.1.2). Areal biomass ranged from 0 to 133 g m^{-2} with densities from 0 up to 1060 individuals m^{-2} (a zero value was obtained at Station Hex-16). Although low biomass values were expected for the nearshore shelf, many sites were characterized by values that exceeded 75 g m^{-2}, which are clearly among the highest recorded for the nearshore shelf of the central Alaskan Beaufort Sea (Dunton et al., 2005). In general, lowest values of infaunal density and biomass occurred in shallower nearshore coastal waters along the proposed Pipeline corridor. The higher benthic productivity associated with these shallower sites (22-25 m) is likely offset by severe and frequent disturbance by deep-draft ice in the Stamuki Zone which scours the seabed.

Table 3.1.1 Number of species in each major group from all Sivulliq sites.

Groups	No. Species	Groups	No. Species
Polychaete	41	Anthozoan	1
Bivalve	20	Ascidean	1
Amphipod	20	Caprellid	1
Gastropod	11	Foraminifera	1
Cumacea	7	Hydrozoan	1
Actinaria	3	Mysid	1
Bryozoan	3	Osteichthyes	1
Holothurian	2	Porifera	1
Isopod	2	Priapulid	1
Nemertean	2	Sipunculid	1

Table 3.1.2 Benthic species list from all Sivulliq sites sorted by group.

	Group	Taxon
1	Amphipod	*Aceroides latipes*
2	Amphipod	*Ampelisca birulai*
3	Amphipod	*Ampelisca macrocephala*
4	Amphipod	*Ampelisca sp.*
5	Amphipod	*Anonyx nugax*
6	Amphipod	*Anonyx sp.*
7	Amphipod	*Arrhis luthkei*
8	Amphipod	*Byblis gaimardi*
9	Amphipod	*Corophiidae*
10	Amphipod	*Gammarus wilkitzkii*
11	Amphipod	*Haploops laevis*
12	Amphipod	*Haploops tubicola*
13	Amphipod	*Isaeidae*
14	Amphipod	*Ischyrocerus sp.*
15	Amphipod	*Lilljeborgia fissicornis*
16	Amphipod	*Lysianassidae*
17	Amphipod	*Lysippe labiata*
18	Amphipod	*Onisimus sp.*
19	Amphipod	*Podoceridae*
20	Amphipod	*Protomedeia fasciata*
21	Amphipod	*Protomedeia sp.*
22	Ascidian	*Pelonaia corrugata*
23	Bivalve	*Arctinula greenlandica*
24	Bivalve	*Astarte borealis*
25	Bivalve	*Astarte montagui*
26	Bivalve	*Crenella descussata*
27	Bivalve	*Cuspidaria glacialis*
28	Bivalve	*Ennucula tenuis*
29	Bivalve	*Hiatella arctica*
30	Bivalve	*Liocyma fluctuosa*
31	Bivalve	*Macoma calcarea*
32	Bivalve	*Musculus glacialis*

	Group	Taxon
33	Bivalve	*Mya arenosa*
34	Bivalve	*Nuculana pernula*
35	Bivalve	*Pandora glacialis*
36	Bivalve	*Periploma aleutica*
37	Bivalve	*Portlandia arctica*
38	Bivalve	*Portlandia lenticula*
39	Bivalve	*Serripes groenlandicus*
40	Bivalve	*Thracia myopsis*
41	Bivalve	*Thracia septentrionalis*
42	Bivalve	*Thyasira flexuosa*
43	Bivalve	*Yoldiella frigida*
44	Bryozoa	*Alcyonidium gelatinosum*
45	Bryozoa	Unidentified encrusting
46	Bryozoa	*Carbasea carbasea*
47	Bryozoa	*Eucratea loricata*
48	Caprellid	Unidentified
49	Cnidaria	*Gersemia rubiformis*
50	Cnidaria	Unidentified (3 actinaria species)
51	Cumacea	*Diastylis edwardsi*
52	Cumacea	*Diastylis goodsiri*
53	Cumacea	*Diastylis rathkei*
54	Cumacea	*Diastylis spinulosa*
55	Cumacea	*Eudorella emarginata*
56	Cumacea	*Leptostylis villosa*
57	Cumacea	*Leucon nasica*
58	Foraminifera	Unidentified
59	Gastropod	*Admete viridula*
60	Gastropod	*Buccinum ciliatum*
61	Gastropod	*Cryptonatica clausa*
62	Gastropod	*Curtitoma novajasemliensis*
63	Gastropod	*Cylichna alba*
64	Gastropod	*Neptunea heros*
65	Gastropod	*Oenopota elegans*
66	Gastropod	*Oenopota sp.*
67	Gastropod	*Retusa obtusa*
68	Gastropod	*Solariella obscura*
69	Gastropod	*Tachyrhynchus erosus*
70	Gastropod	*Unidentified*
71	Holothurian	*Cucumaria sp.*
72	Holothurian	*Holothurian*
73	Hydroid	*Lafoeina maxima*
74	Isopod	*Saduria sabini*
75	Isopod	*Synidotea marmorata*
76	Mysid	*Mysis sp.*
77	Nemertean	*Nemertean*
78	Osteichthyes	*Liparis sp.*
79	Polychaete	*Aglaophamus malmgreni*
80	Polychaete	*Ampharete arctica*

	Group	Taxon
81	Polychaete	*Artacama proboscidea*
82	Polychaete	*Brada inhabilis*
83	Polychaete	*Chaetozone setosa*
84	Polychaete	*Chone cincta*
85	Polychaete	*Cirratulus cirratus*
86	Polychaete	*Diplocirrus longisetosus*
87	Polychaete	*Eteone longa*
88	Polychaete	*Euchone analis*
89	Polychaete	*Euchone sp.*
90	Polychaete	*Eunoe senta*
91	Polychaete	*Gattyana cirrosa*
92	Polychaete	*Heteromastus filiformis*
93	Polychaete	*Laonice cirrata*
94	Polychaete	*Lumbrineris fragilis*
95	Polychaete	*Maldane sarsi*
96	Polychaete	*Melaenis loveni*
97	Polychaete	*Nephtys ciliata*
98	Polychaete	*Nereis zonata*
99	Polychaete	*Nicolea zostericola*
100	Polychaete	*Nicomache lumbricalis*
101	Polychaete	*Notomastus latericeus*
102	Polychaete	*Owenia fusiformis*
103	Polychaete	*Pectinaria hyperborea*
104	Polychaete	*Pectinaria japonica*
105	Polychaete	*Pholoe minuta*
106	Polychaete	*Phyllodoce groenlandica*
107	Polychaete	*Pista sp.*
108	Polychaete	*Praxillella praetermissa*
109	Polychaete	*Sabellides borealis*
110	Polychaete	*Scalibregma inflatum*
111	Polychaete	*Scoloplos armiger*
112	Polychaete	*Spinther sp.*
113	Polychaete	*Sternaspis scutata*
114	Polychaete	*Terebellides stroemi*
115	Polychaete	*Tharyx sp.*
116	Polychaete	*Thelepus cincinnatus*
117	Polychaete	*Trochochaeta multisetosum*
118	Porifera	*Phakellia cribrosa*

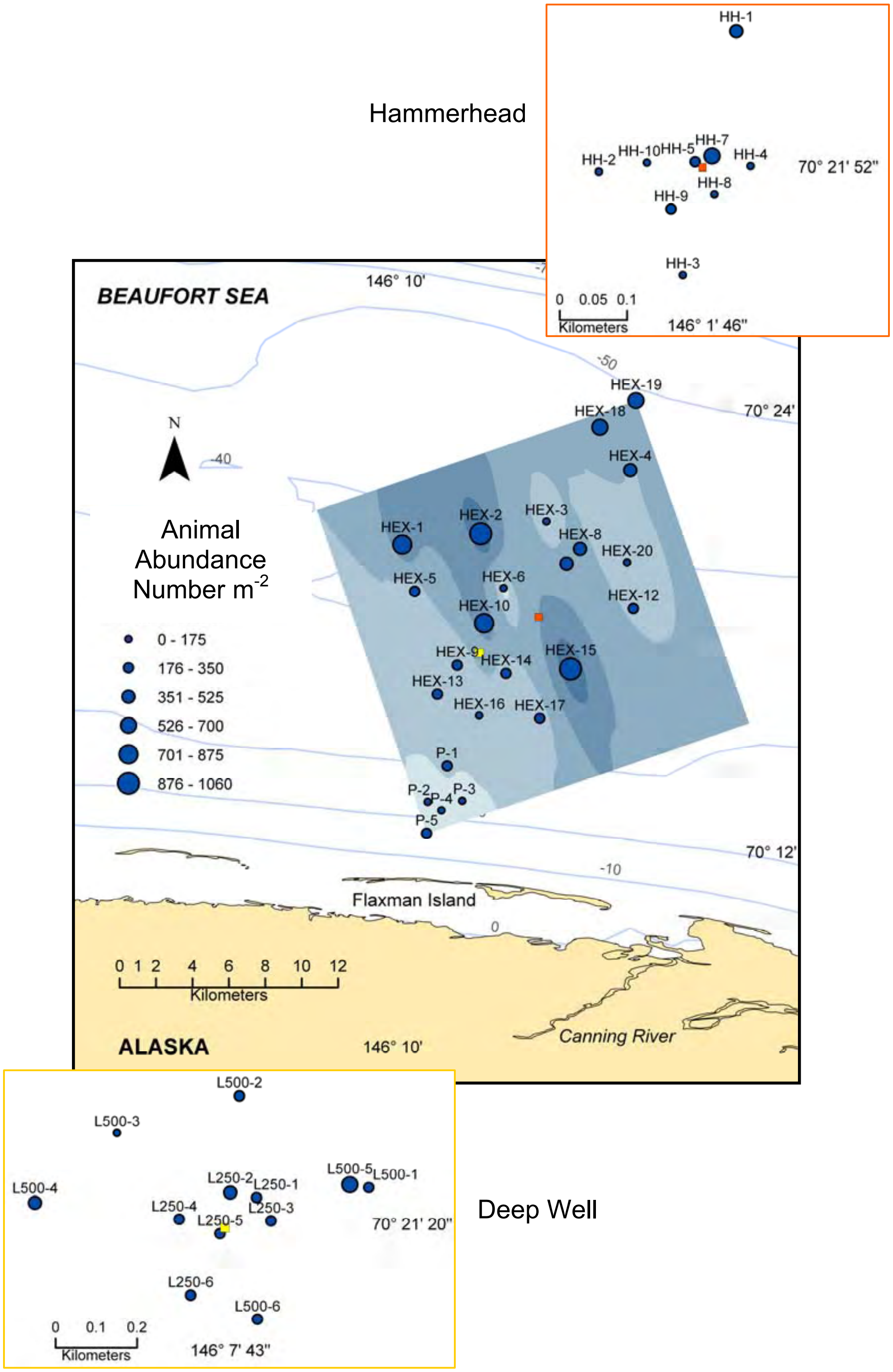

Figure 3.1.1 Spatial variation in benthic infaunal density over the Sivulliq study area. Depth contours are labeled in meters.

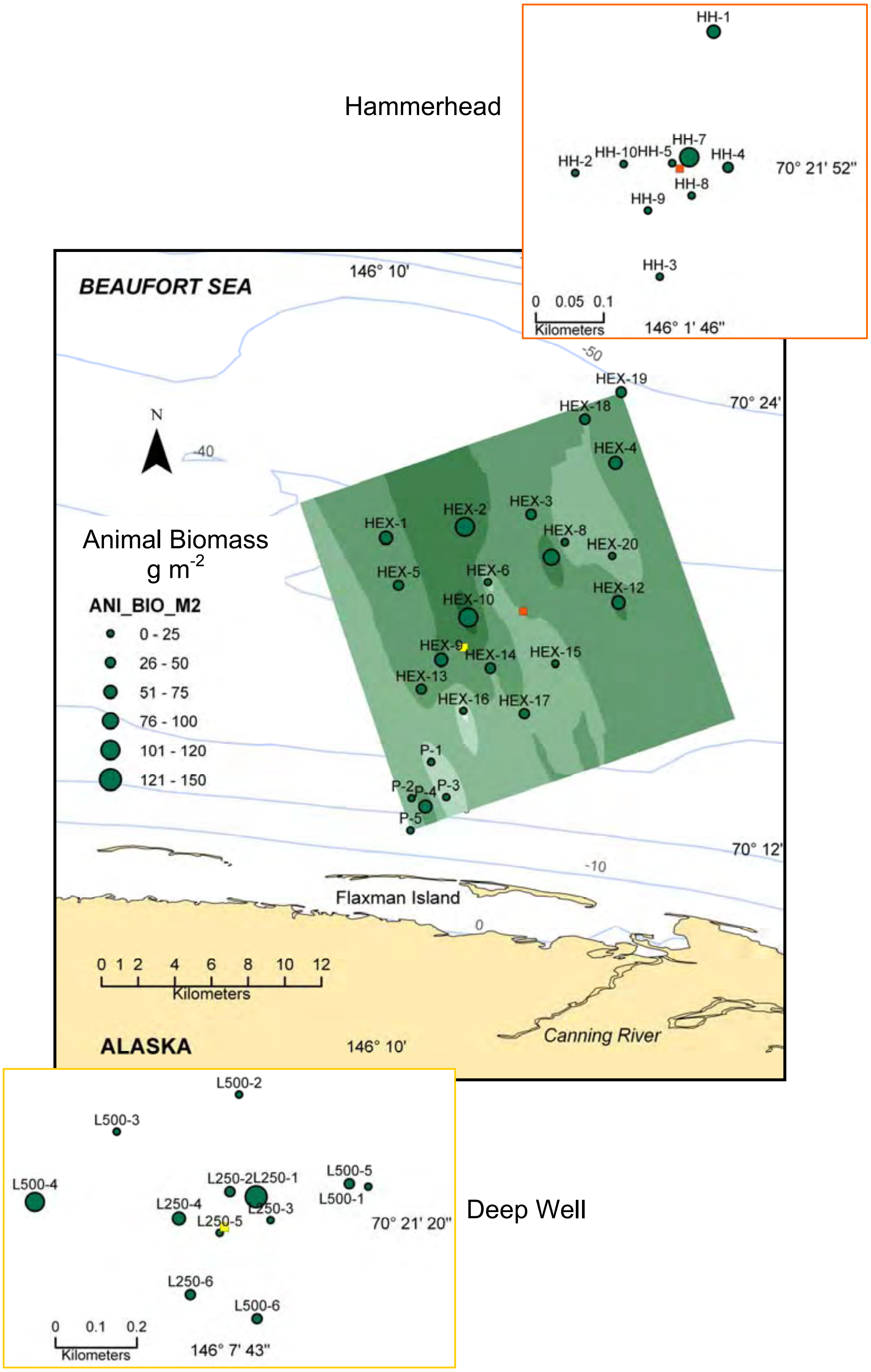

Figure 3.1.2 Spatial variation in benthic infaunal biomass over the Sivulliq study area. Depth contours are labeled in meters.

Station invertebrate abundance mean values ranged from 0 m^{-2} at Station Hex-16 to 1060 m^{-2} at Hex-15 (Fig. 3.1.3). Overall abundance was dominated by polychaetes, bivalves and amphipods. Highest abundance counts (>1000 m^{-2}) were driven by numerous tiny juvenile *Pectinaria hyperborea* polychaetes. The maldanid polychaetes, *Praxillella praetermissa* and *Maldane sarsi* were found in most samples, often in comparatively large numbers.

Site invertebrate biomass values ranged from 0 m^{-2} at Station Hex-16 to 129.1 m^{-2} at Station L250-1 (Fig. 3.1.4). Sites with highest biomass values contained relatively large bivalves, nemerteans, and/or maldanid polychaete worms. The bivalves *Thracia septentrionalis, Astarte montagui and Portlandia lenticula* were widespread throughout the area and contributed to stations with higher biomass recorded in the study area.

Species groups that were collected infrequently and in small numbers were lumped into a miscellaneous group (Misc) for Figures 3.1.1 and 3.1.2. Included in this miscellaneous collection were the following groups: Ascideacea, bryozoa, caprellid, anthozoa, echinodermata, osteichthyes, asteroidea, foraminifera, holothurian, hydrozoa, isopoda, mysidea, porifera, priapulida and sipunculida.

Benthic density and biomass measurements yielded no discernable spatial trends in either parameter at Hammerhead or Deep Well (L250 and L500) sites. The recovery of drilling muds and copious bivalve shell material in grabs taken at HH-5 and HH-8 were of considerable interest. It is not known if the burial of benthic infaunal and epifaunal organisms during drilling activities results in long-term effects to benthic secondary production. No studies have addressed this question since it has not been logistically possible to re-visit drill sites to conduct benthic biological studies. Moreover, the chances of obtaining grab samples at a confirmed drill site location are extremely difficult. Our preliminary data indicate that if the benthic community was impacted during drilling, it has progressed well towards recovery in the two decades following the activity.

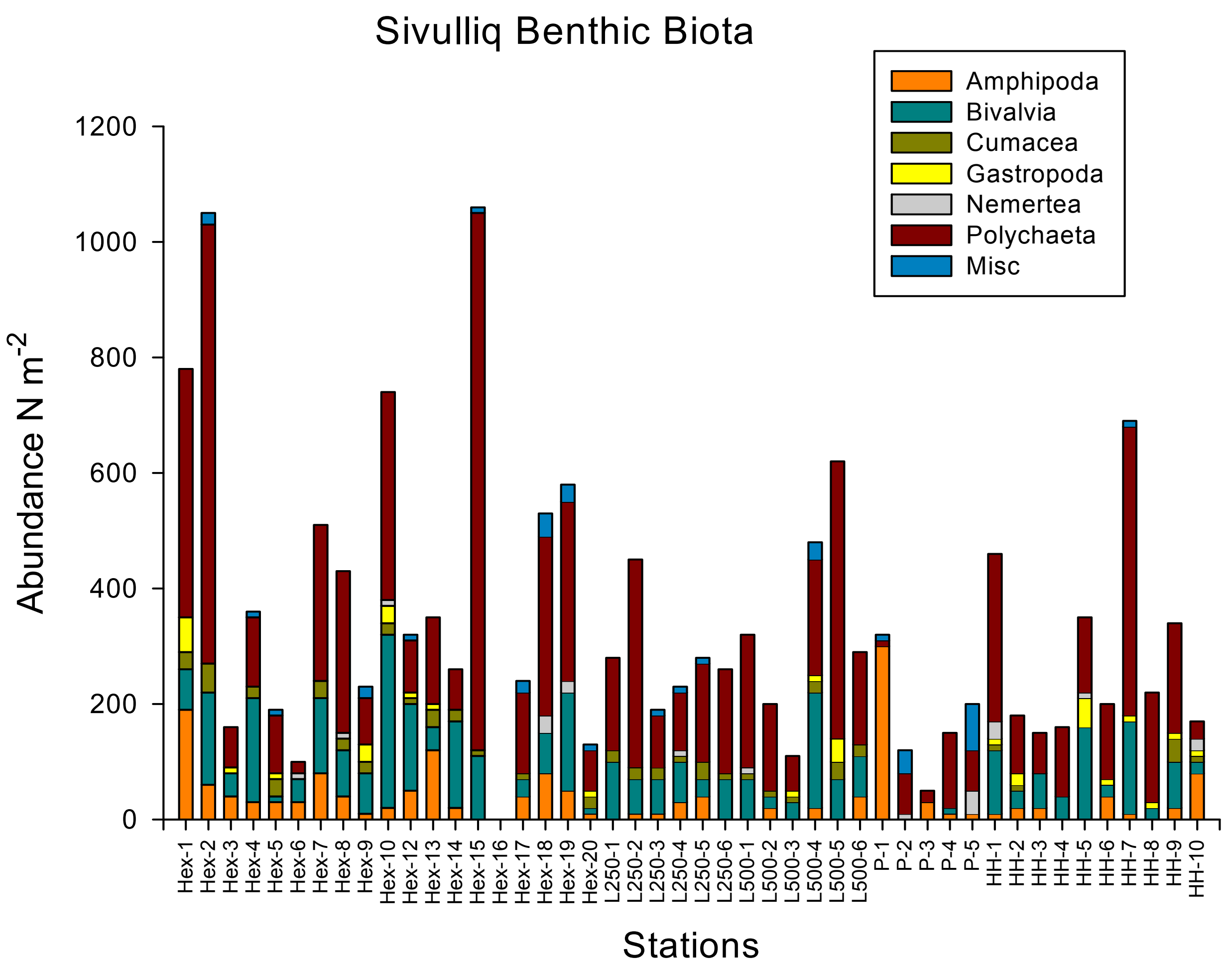

Figure 3.1.3 Variation in benthic infaunal abundance by group at each station in the Sivulliq study area. Misc (Miscellaneous) included infrequently sampled organisms (see text).

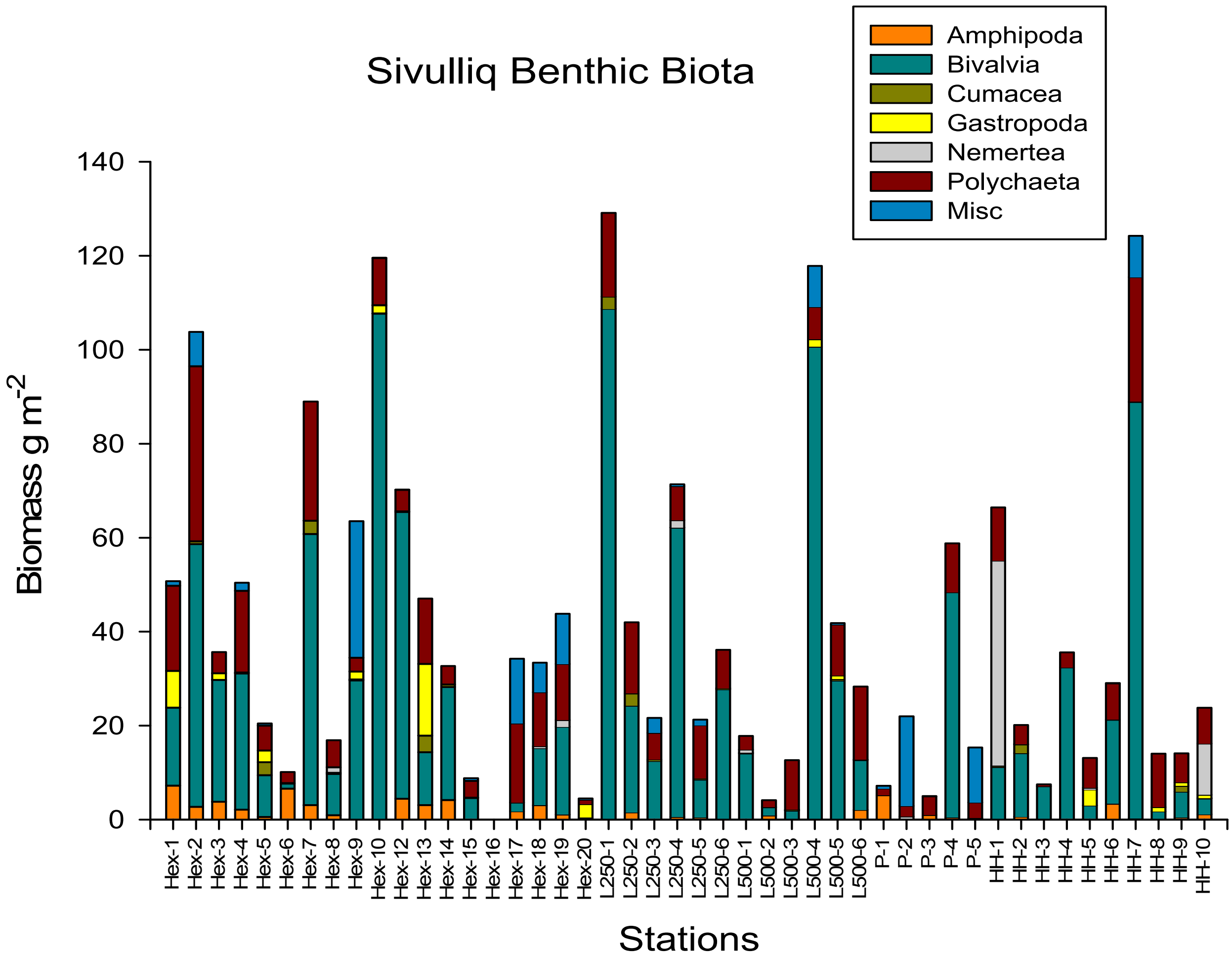

Figure 3.1.4 Variation in benthic infaunal biomass by group at each station in the Sivulliq study area. Misc (Miscellaneous) included infrequently sampled organisms (see text).

3.1.2 Benthic community structure

We used PRIMER software to examine benthic biota abundance and biomass data using multivariate and univariate routines. Benthic biota data were tested for species group similarity among Sivulliq stations using non-metric multidimensional scaling plots (MDS; Fig. 3.1.2 and Fig.3.1.3). Organisms were divided into the following 19 functional groups for analyses: amphipoda, actinaria, ascidiacea, bivalvia, bryozoa, alcyonaria, echinodermata, osteichthyes, foraminifera, gastropoda, holothuria, hydrozoa, isopoda, mysidacea, nemertea, polychaeta, porifera, priapulida and sipunculida. Data were transformed using the square root function prior to MDS analysis to reduce dominant contribution from extremely abundant or high biomass species to the Bray-Curtis similarities. MDS arrays data in multi-dimensional space such that points which are spatially closer together have greater similarity. With the exception of four Pipeline stations (P-1, P-2, P-3 and P-5), the Sivulliq stations clustered together in plots of both abundance (Fig. 3.1.5) and biomass (Fig.3.1.6). Pipeline stations (excluding P-4) were located in relatively shallow depths (22.0 to 26.0 m) contained less species, odd combinations of organisms, and no bivalves (see Fig. 3.1.3 and Fig. 3.1.4). Consequently, MDS analysis revealed that less than 25% of the 19 functional groups of these four stations were common to the remaining stations on the basis of abundance. P-1 contained a high abundance of amphipods and P-2 had none. P-2 and particularly P-5 were dominated by large numbers of miscellaneous species. But in contrast to other Pipeline stations, P-4 displayed similar abundance and biomass compositions to non-Pipeline stations. For biomass, MDS plots revealed that Hex-20 and Hex-17 stations were separated from other clusters and Hex-6 was binned with P-3 and P-1 at 50% similarity. Additional analysis revealed that Hex-20 had low biomass with a large proportionally large number of gastropods. Hex-17 contained a large number of miscellaneous species, and Hex-6 was dominated by gastropods and amphipods (same as P-1). Stations P-2 and P-5 remained distinct from all remaining stations, which is likely related to the large proportion of miscellaneous species at these sites.

Miscellaneous species at station P-5 included actinaria, holothurians, hydrozoans, bryozoans, and porifera which are organisms found on hard substrates. We noted the increased frequency of pebbles and cobbles at the Pipeline stations; these rocks were retained in grab samples, and explain the unique assemblage of organisms listed for stations P-5 and P-2. Pipeline stations in general contained few organisms and/or had low diversity. These sites are located in shallower waters, where the seafloor is more prone to gouging and physical disruption by deep draft ice. Reimnitz et al. (1977) noted that pronounced linear pressure and shear between the undeformed fast ice (which extends to the 20 m isobath) and the westward drifting polar pack ice resulted in grounded ice ridges and rubble fields that extended up to 13 m high (the Stamuki Zone). At depths just seaward of 20 m, which correspond to the depths of the Pipeline stations (22-26 m), Reimnitz et al. (1977) noted that grounded pressure–ridge keels in the Stamuki Zone exerted tremendous stresses on the seabed. It is likely that benthic organisms in this region of the shelf are subject to frequent and devastating disturbances by grounded ice in both time and space, resulting in a mosaic of benthic assemblages in different stages of ecological succession.

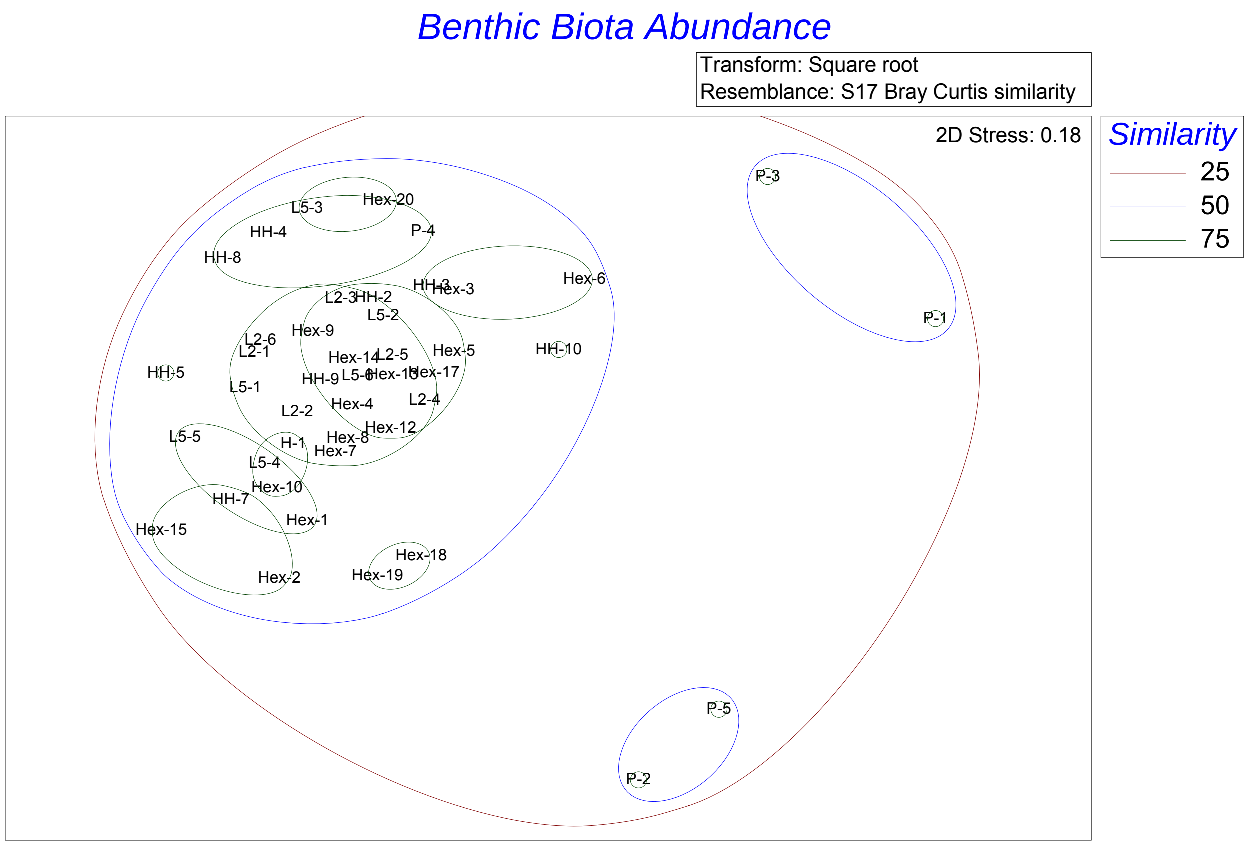

Figure 3.1.5 Similarity of benthic infaunal invertebrate communities based on MDS analyses of station abundance over the Sivulliq study area. L2 = L250 and L5 = L500. P = Pipeline, HH = Hammerhead. All MDS analyses use Bray-Curtis similarities on square root transformed data.

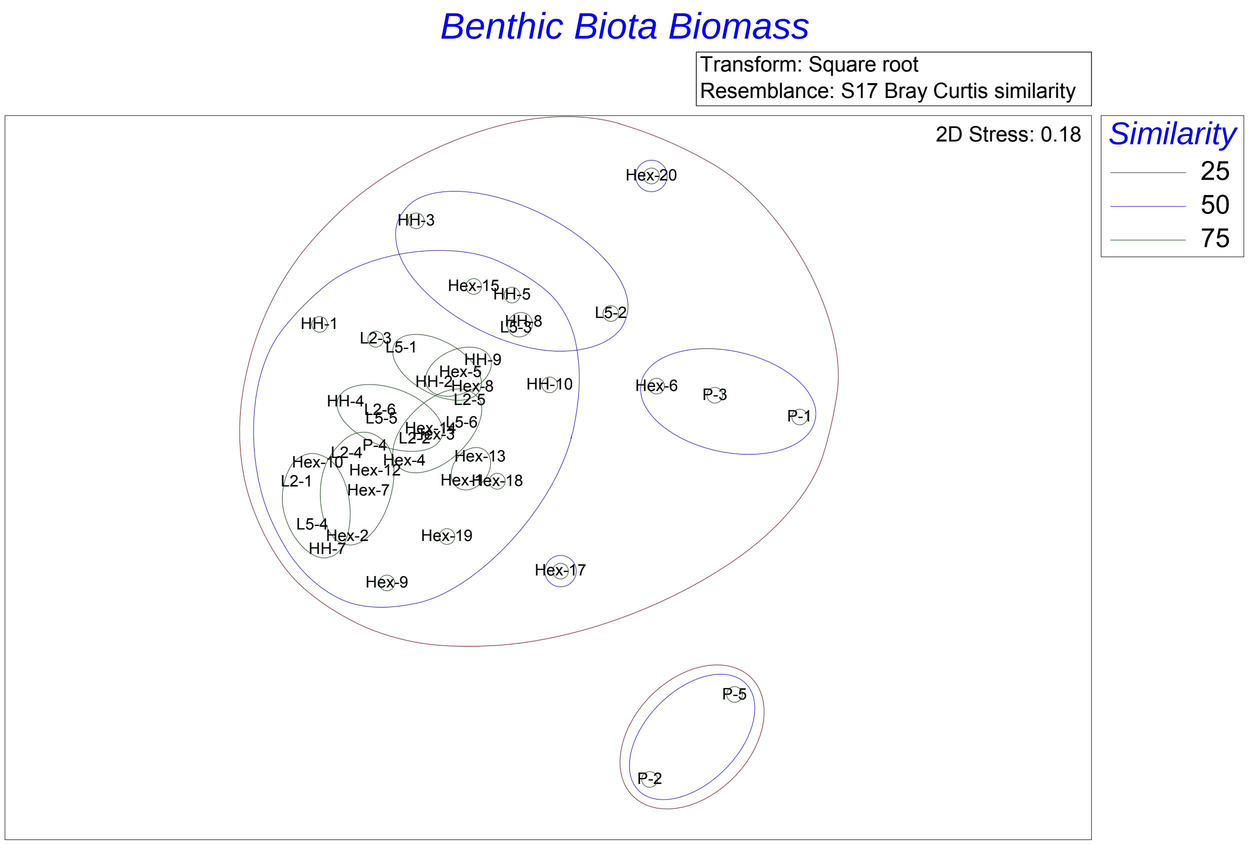

Figure 3.1.6 Similarity of benthic infaunal invertebrate communities based on MDS analyses of benthic biota station biomass over the Sivulliq study area. L2 = L250 and L5 = L500. P = Pipeline, HH = Hammerhead. All MDS analyses use Bray-Curtis similarities on square root transformed data.

Overall, mean abundance, Pielou, Shannon-Wiener, and Simpson index values were all lower at Pipeline stations compared to these average indices at all other stations (Table 3.1.4). Next lowest were Hammerhead and L stations. Hex stations had the highest mean values in all categories. Pielou's evenness index abundance mean for all sites was 0.70 with a range from 0.25 at station P-1 to 0.97 at station P-3 (Fig. 3.1.4). The Shannon-Wiener diversity index abundance mean value for all sites was 1.06 and ranged from a low of 0.28 at station P-1 to a high of 1.69 at station P-5 (Fig. 3.1.4). Simpson's diversity index abundance mean for all sites was 0.55 with a range from 0.12 at station P-1 to 0.78 at station P-5.

Mean biomass, Pielou, Shannon-Wiener and Simpson index values varied by group (Table 3.1.6). The lowest group mean weight was measured at the Pipeline stations, but the lowest

Pielou, Shannon-Wiener and Simpson values were measured at the L250 and L500 stations. Hex stations had the highest values in all categories. Pielou's mean biomass value was 0.58 for all sites and varied from a low of 0.19 at station Hex-10, to a high of 0.90 at station Hex-13 (Table 3.1.6). Shannon-Wiener's mean biomass value was 0.91 for all sites and varied from a low of 0.27 at station HH-3, to a high of 1.72 at station P-5 (Table 3.1.6). Simpson's mean biomass value was 0.52 for all sites and varied from a low of 0.14 at station HH-3, to a high of 0.87 at station L500-2.

Table 3.1.3 Indices of benthic community structure based on results of analyses from abundance data at all Sivulliq sites.

Station	Date	Water Depth (m)	Group Count	Abundance no. m^{-2}	Pielou	Shannon -Wiener	Simpson
HEX-1	8/20/2008	34.7	5	780	0.75	1.21	0.62
HEX-2	8/21/2008	35.4	6	1050	0.51	0.92	0.45
HEX-3	8/19/2008	34.4	4	160	0.89	1.23	0.68
HEX-4	8/19/2008	37.2	5	360	0.73	1.18	0.63
HEX-5	8/20/2008	32.9	6	190	0.77	1.39	0.67
HEX-6	8/18/2008	33.2	4	100	0.92	1.28	0.71
HEX-7	8/19/2008	32.9	4	510	0.82	1.14	0.63
HEX-8	8/19/2008	32.9	5	430	0.65	1.04	0.53
HEX-9	8/20/2008	30.8	6	230	0.87	1.56	0.76
HEX-10	8/18/2008	32.6	6	740	0.61	1.10	0.60
HEX-12	8/19/2008	31.1	6	320	0.74	1.33	0.68
HEX-13	8/20/2008	29.9	5	350	0.80	1.29	0.68
HEX-14	8/21/2008	31.4	4	260	0.77	1.07	0.59
HEX-15	8/21/2008	32.0	4	1060	0.32	0.44	0.22
HEX-17	8/21/2008	29.7	6	240	0.71	1.27	0.61
HEX-18	8/19/2008	38.1	5	530	0.76	1.22	0.61
HEX-19	8/19/2008	38.1	7	580	0.63	1.23	0.62
HEX-20	8/19/2008	32.3	6	130	0.79	1.41	0.67
L250-1	8/18/2008	31.7	3	280	0.80	0.88	0.54
L250-2	8/18/2008	31.7	4	450	0.48	0.67	0.34
L250-3	8/18/2008	31.4	5	190	0.79	1.27	0.66
L250-4	8/18/2008	32.0	6	230	0.78	1.40	0.70
L250-5	8/18/2008	31.1	5	280	0.73	1.18	0.59
L250-6	8/18/2008	31.4	3	260	0.67	0.73	0.45
L500-1	8/18/2008	30.8	4	320	0.57	0.79	0.44
L500-2	8/18/2008	31.7	4	200	0.60	0.83	0.42
L500-3	8/18/2008	31.4	4	110	0.81	1.12	0.62
L500-4	8/18/2008	31.7	8	480	0.63	1.32	0.65
L500-5	8/18/2008	31.7	4	620	0.55	0.77	0.38
L500-6	8/18/2008	31.4	4	290	0.81	1.13	0.62
P-1	8/22/2008	26.0	3	320	0.25	0.28	0.12
P-2	8/22/2008	23.5	4	120	0.78	1.08	0.59
P-3	8/22/2008	23.7	2	50	0.97	0.67	0.49
P-4	8/22/2008	23.5	3	150	0.44	0.49	0.24
P-5	8/22/2008	22.0	7	200	0.87	1.69	0.78
HH-1	8/17/2008	32.3	6	460	0.59	1.06	0.54
HH-2	8/17/2008	32.3	5	180	0.79	1.27	0.64
HH-3	8/17/2008	32.6	3	150	0.90	0.99	0.61

Station	Date	Water Depth (m)	Group Count	Abundance no. m^{-2}	Pielou	Shannon -Wiener	Simpson
HH-4	8/17/2008	31.7	2	160	0.81	0.56	0.38
HH-5	8/17/2008	31.7	4	350	0.80	1.11	0.63
HH-7	8/17/2008	32.6	5	690	0.47	0.76	0.42
HH-8	8/17/2008	32.9	3	220	0.44	0.49	0.24
HH-9	8/17/2008	32.6	5	340	0.74	1.19	0.62
HH-10	8/17/2008	31.7	6	170	0.84	1.50	0.72

Table 3.1.4 Summary of benthic community structure indices of abundance data at all Sivulliq sites.

	Water Depth (m)	Group Count	Abundance (no. m^{-2})	Pielou	Shannon -Wiener	Simpson
All Samples						
Minimum	22.0	2.0	50	0.25	0.28	0.12
Maximum	38.1	8.0	1060	0.97	1.69	0.78
Mean	31.5	4.7	348	0.70	1.06	0.55
HEX						
Mean	33.3	5.2	445.6	0.72	1.18	0.61
HH (Hammerhead)						
Mean	32.3	4.3	302.2	0.71	0.99	0.53
L (Deep Well)						
Mean	31.5	4.5	309.2	0.69	1.01	0.53
P (Pipeline)						
Mean	23.7	3.8	168.0	0.66	0.84	0.44

Table 3.1.5 Indices of benthic community structure based on analyses from biomass data at all Sivulliq sites.

Station	Date	Water Depth (m)	Group Count	Weight (g m^{-2})	Pielou	Shannon -Wiener	Simpson
HEX-1	8/20/2008	34.7	6	50.73	0.77	1.38	0.74
HEX-2	8/21/2008	35.4	6	103.78	0.58	1.04	0.58
HEX-3	8/19/2008	34.4	4	35.65	0.62	0.86	0.46
HEX-4	8/19/2008	37.2	5	50.41	0.59	0.96	0.56
HEX-5	8/20/2008	32.9	6	20.48	0.80	1.43	0.75
HEX-6	8/18/2008	33.2	4	10.11	0.64	0.89	0.56
HEX-7	8/19/2008	32.9	4	88.96	0.62	0.87	0.50
HEX-8	8/19/2008	32.9	5	16.90	0.69	1.12	0.64
HEX-9	8/20/2008	30.8	7	63.49	0.51	1.00	0.58
HEX-10	8/18/2008	32.6	7	119.52	0.19	0.38	0.18
HEX-12	8/19/2008	31.1	6	70.20	0.27	0.49	0.24
HEX-13	8/20/2008	29.9	5	47.04	0.90	1.44	0.76
HEX-14	8/21/2008	31.4	4	32.71	0.59	0.81	0.44
HEX-15	8/21/2008	32.0	5	8.82	0.58	0.94	0.63
HEX-17	8/21/2008	29.7	6	34.24	0.72	1.30	0.69
HEX-18	8/19/2008	38.1	5	33.38	0.82	1.32	0.73
HEX-19	8/19/2008	38.1	7	43.83	0.72	1.40	0.72
HEX-20	8/19/2008	32.3	6	4.51	0.64	1.15	0.72
L250-1	8/18/2008	31.7	3	129.10	0.45	0.50	0.27
L250-2	8/18/2008	31.7	4	41.99	0.72	0.99	0.59
L250-3	8/18/2008	31.4	6	21.66	0.61	1.09	0.61
L250-4	8/18/2008	32.0	6	71.37	0.29	0.52	0.25
L250-5	8/18/2008	31.1	5	21.26	0.63	1.01	0.60
L250-6	8/18/2008	31.4	3	36.12	0.52	0.57	0.37
L500-1	8/18/2008	30.8	4	17.82	0.46	0.64	0.37
L500-2	8/18/2008	31.7	4	4.14	0.83	1.15	0.87
L500-3	8/18/2008	31.4	4	12.63	0.38	0.53	0.31
L500-4	8/18/2008	31.7	8	117.82	0.27	0.56	0.26
L500-5	8/18/2008	31.7	5	41.81	0.46	0.74	0.44
L500-6	8/18/2008	31.4	4	28.32	0.66	0.91	0.57
P-1	8/22/2008	26.0	3	7.20	0.69	0.76	0.51
P-2	8/22/2008	23.5	5	22.00	0.66	1.06	0.57
P-3	8/22/2008	23.7	3	4.99	0.49	0.54	0.41
P-4	8/22/2008	23.5	3	58.81	0.47	0.51	0.31
P-5	8/22/2008	22.0	8	15.37	0.82	1.72	0.84
HH-1	8/17/2008	32.3	6	66.43	0.51	0.91	0.52
HH-2	8/17/2008	32.3	5	20.16	0.59	0.95	0.53
HH-3	8/17/2008	32.6	3	7.49	0.25	0.27	0.14

Station	Date	Water Depth (m)	Group Count	Weight (g m^{-2})	Pielou	Shannon -Wiener	Simpson
HH-4	8/17/2008	31.7	2	35.61	0.44	0.30	0.17
HH-5	8/17/2008	31.7	4	13.12	0.82	1.14	0.70
HH-7	8/17/2008	32.6	6	124.22	0.43	0.78	0.44
HH-8	8/17/2008	32.9	3	14.05	0.55	0.60	0.35
HH-9	8/17/2008	32.6	5	14.10	0.76	1.22	0.70
HH-10	8/17/2008	31.7	6	23.79	0.71	1.27	0.69

Table 3.1.6 Summary of benthic community structure indices based on biomass data at all Sivulliq sites.

	Water Depth (m)	Group Count	Weight (g m^{-2})	Pielou	Shannon -Wiener	Simpson
All Samples						
Minimum	22.0	2.0	4.1	0.19	0.27	0.14
Maximum	38.1	8.0	129.1	0.90	1.72	0.87
Mean	31.5	4.9	41.1	0.58	0.91	0.52
HEX						
Mean	33.3	5.4	46.4	0.63	1.04	0.58
HH (Hammerhead)						
Mean	32.3	4.4	35.4	0.56	0.83	0.47
L (Deep Well)						
Mean	31.5	4.7	45.3	0.52	0.77	0.46
P (Pipeline)						
Mean	23.7	4.4	21.7	0.63	0.92	0.53

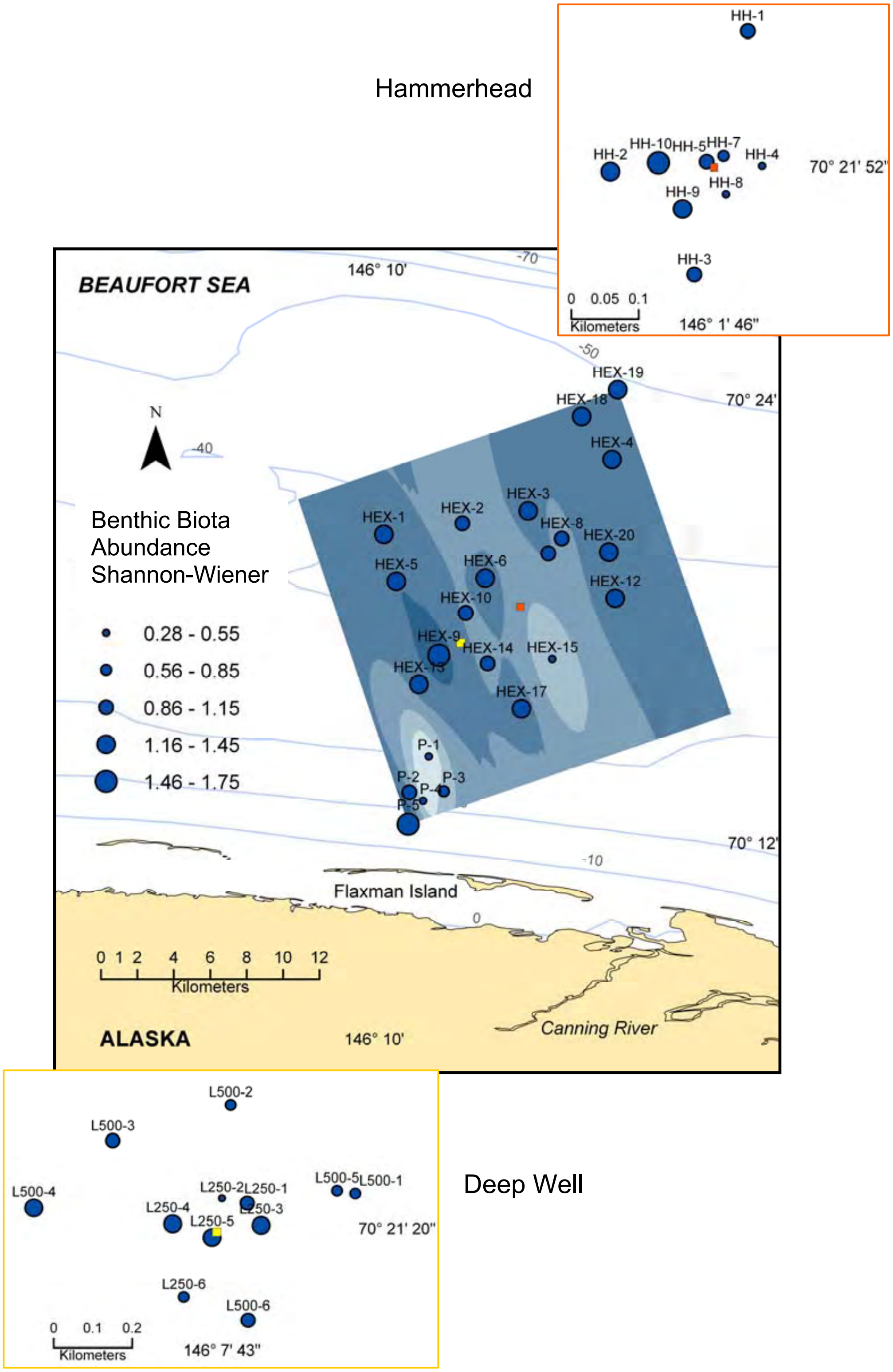

Figure 3.1.7 Spatial distribution of Shannon-Wiener data calculated from benthic biota abundance data. Depth contours are labeled in meters.

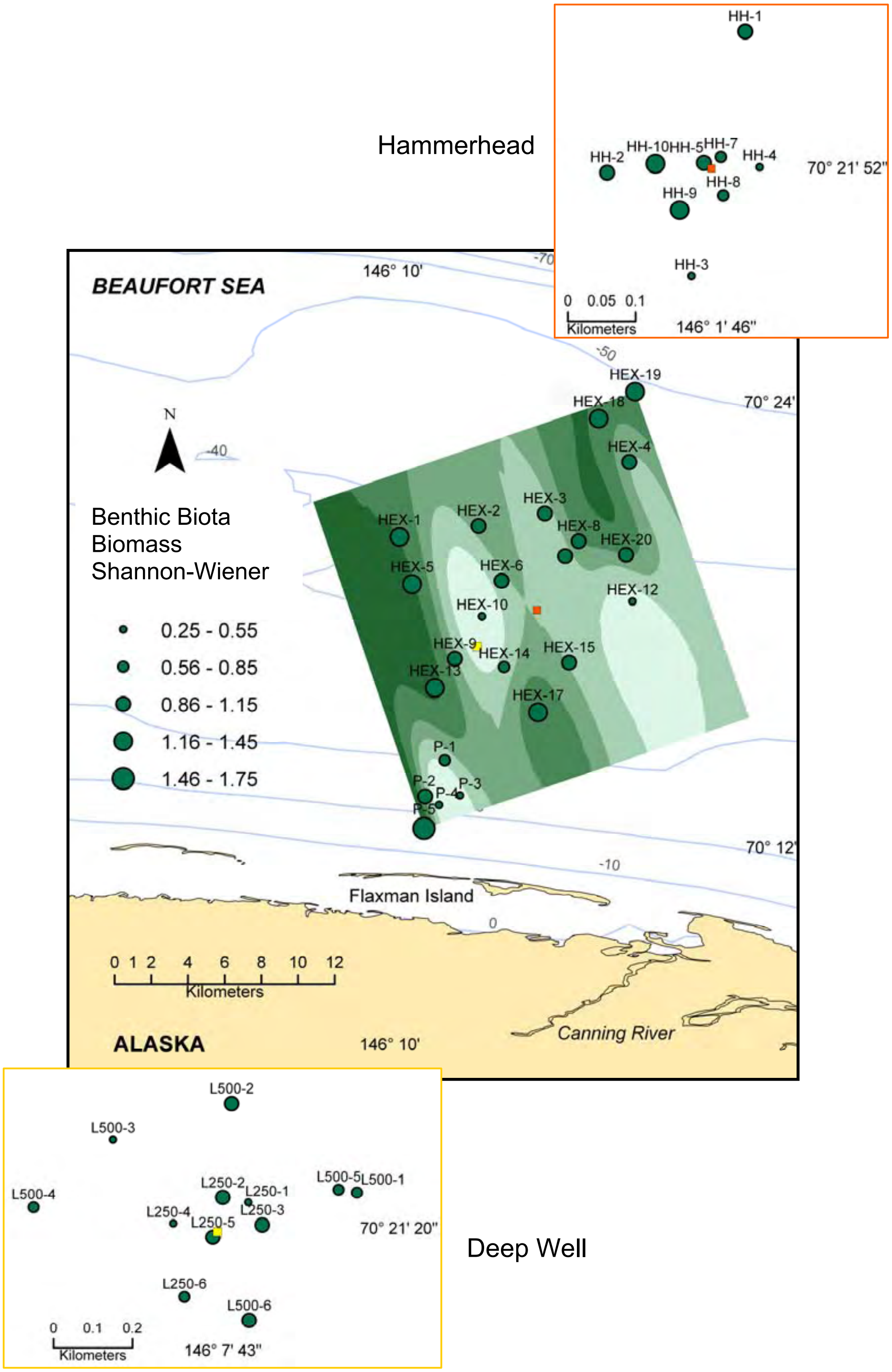

Figure 3.1.8 Spatial distribution of Shannon-Wiener data calculated from benthic biota biomass data. Depth contours are labeled in meters.

3.1.3 Isotopic measurements – $\delta^{13}C$ and $\delta^{15}N$

Measurements of ^{13}C and ^{15}N provide valuable markers in defining the isotopic signatures of organic matter available to consumers and in defining trophic structure. Dual measurements of ^{13}C and ^{15}N have previously been used to as a primary tool for determining the contributions of terrestrial and marine organic carbon and nitrogen in Beaufort Sea estuarine food webs (Schell, 1983; Schell et al., 1984a). In this study, we measured the C and N isotopic values of several hundred organisms from 45 sites to obtain a preliminary understanding of the trophic structure in the Sivulliq prospect area.

The variation in $\delta^{13}C$ values of the major taxonomic groups of biota range from -21.5 to -26.5‰ (Fig. 3.1.9). Primary consumers, notably amphipods were most depleted in ^{13}C, reflecting their dependency on particulate organic matter (POM). Secondary consumers are generally more ^{13}C enriched due to selective respiration of ^{12}C with increasing trophic level. Organisms that were most ^{13}C enriched included deposit feeding priapulids, benthic predators (e.g. nemerteans), and hydrozoans, which prey on zooplankton. The range of organism feeding habits are reflected in the variability in isotopic composition (length of error bars). Nereid polychaete worms for example, are extremely omnivorous, reflecting their diets as both predators and herbivores. Other species, such as ampharetid polychaetes, are more specialized, feeding exclusively on particles in the water column. In general the range in $\delta^{13}C$ values appear to reflect the importance of marine POM (average $\delta^{13}C$ = 25.5‰) as an ultimate food source, although the contribution by benthic microalgae (average $\delta^{13}C$ > 23.0‰; Fig. 3.0.1) at the shallower Pipeline sites, may be important.

Benthic food web structure, as reflected by $\delta^{15}N$ values ranging from 6.5 to 13.5‰ (Fig. 3.1.10), span three trophic levels in the Sivulliq prospect study area based on an average POM value of 5.5‰ (Fig. 3.11). This estimate is based on ^{15}N trophic level enrichments of 3‰ compared to only about 1‰ for ^{13}C (Dunton et al., 2006). Consistent with carbon isotopic data, $\delta^{15}N$ analyses showed that higher trophic level organisms included actinarians, priapulids, and nemerteans ($\delta^{15}N$ values from 12 to13‰). Lower trophic level biota included crustaceans (amphipods,

Table 3.1.1. Comparative values of $\delta^{13}C$ and $\delta^{15}N$ isotopic values between (HH-5) with five other Hammerhead sites that contained the same species. Values are means ± SE (*n*).

	$\delta^{13}C$			$\delta^{15}N$	
GROUP	HH- 5	Other HH sites		HH-5	Other HH sites
Amphipod	-25.7 (1)	-26.0 ± 0.6 (5)		8.4 (1)	8.8 ± 0.6 (5)
Bivalve*	-23.3 (1)	-23.7 ± 0.2(13)		7.1 (1)	8.0 ± 2.2 (13)
Nemertean	-24.4 (1)	-20.1 ± 0.6 (2)		8.0 (1)	14.6 ± 0.4 (2)
Polychaete*	-22.4 (1)	-23.3 ± 0.2 (7)		11.7 (1)	11.6 ± 0.6 (7)

*Bivalve is *Nuculana*; Polychaete *is Nephtys.*

caprellids) and filter feeding bivalves (tellinids and *Yoldia*). The distribution of organism $\delta^{15}N$ values greater than 6‰ indicate that POM derived from marine sources (defined by $\delta^{15}N$ values from 5 to 7‰) are more likely the major source of organic nitrogen to marine food webs of the shelf than terrestrial sources (characterized by $\delta^{15}N$ values between 0 and 1.5‰; see Dunton et al., 2006).

We also used stable isotopic values to examine potential changes at Hammerhead related to drilling activities. We surmised that any serious long-term impacts to the benthic community at HH-5 would result in a change in organism dependence on ultimate carbon sources or a compromised food web structure as dictated by $\delta^{13}C$ and $\delta^{15}N$ isotopic values. A comparison of isotopic values of biota at HH-5 with the same species at five adjacent Hammerhead sites showed that of the four classes of invertebrates examined, three were not significantly different in either $\delta^{13}C$ or $\delta^{15}N$ signatures. However, the nemertean collected at HH-5 was significantly depleted in ^{13}C and ^{15}N compared to individuals collected at other Hammerhead sites, which indicates that this individual was feeding on different prey and occupied a lower trophic level than the same individuals at other sites. Collection of additional organisms would be required to document conclusively that nemerteans or other higher tropic level organisms have shifted their diets in response to changes in preferred prey density.

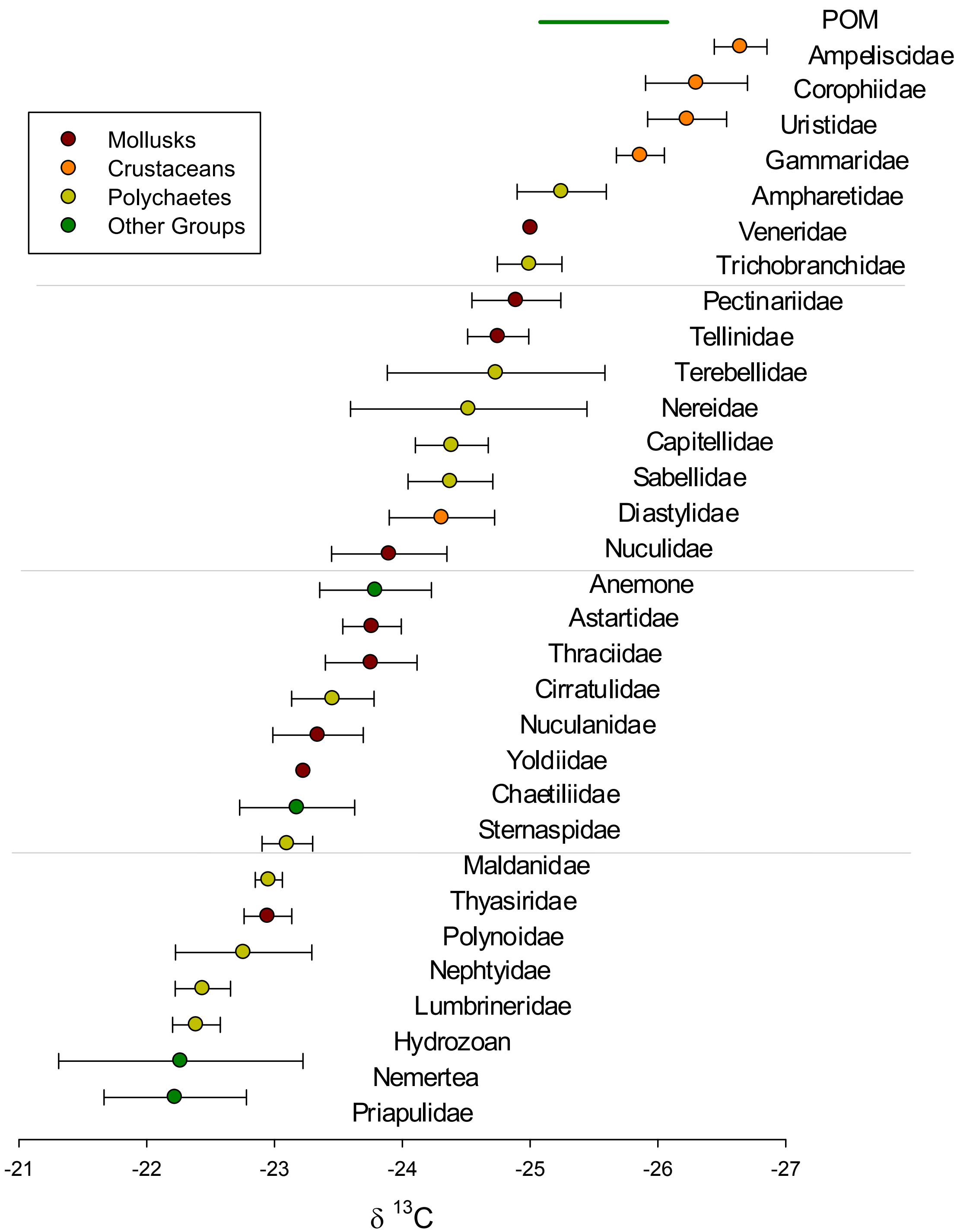

Figure 3.1.9 Stable carbon isotopic values of representative benthic biota in relation to POM based on collections in the Sivulliq study area. Values are mean ± SE.

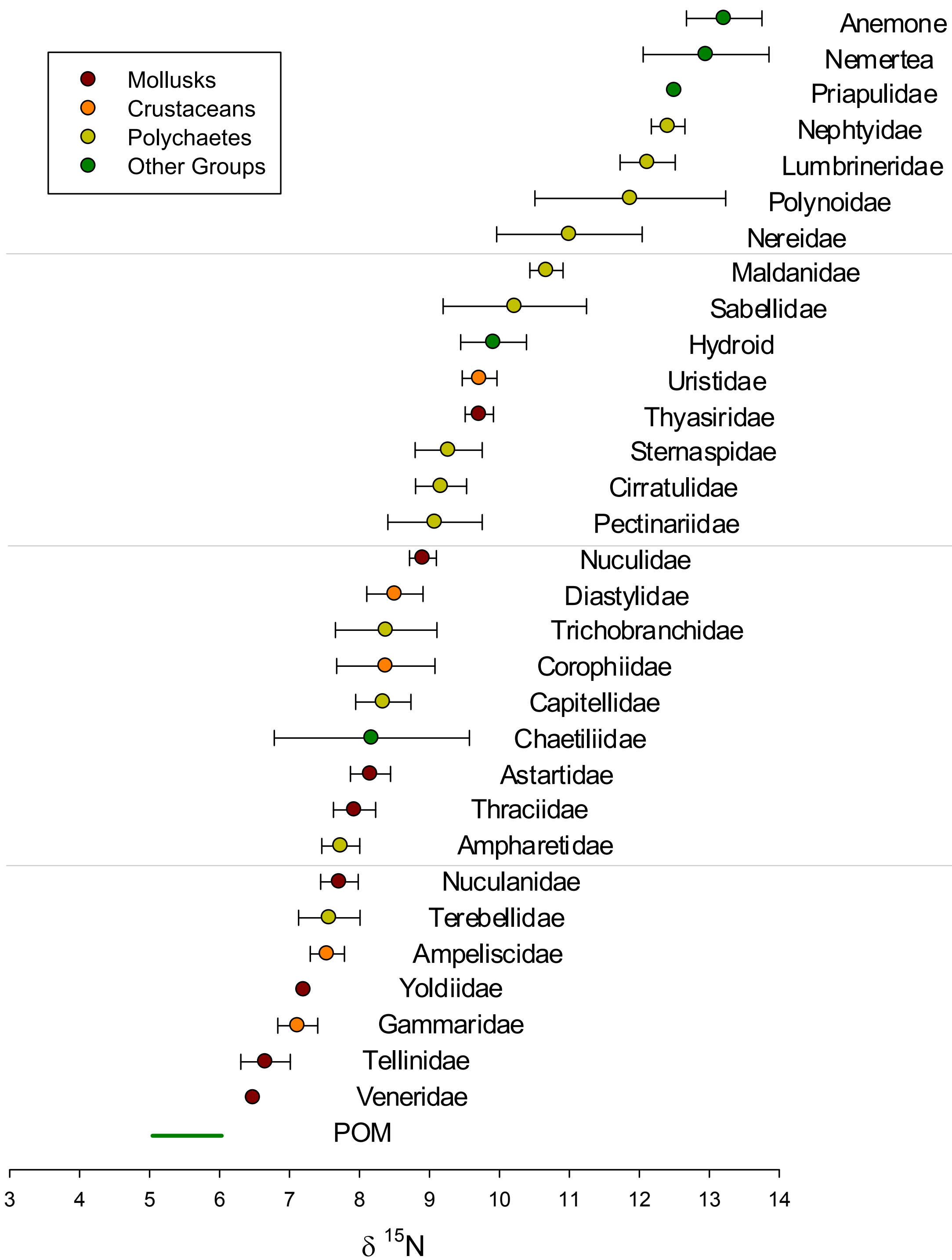

Figure 3.1.10 Stable nitrogen isotopic values of representative benthic biota in relation to POM in the Sivulliq study area. Values are mean ± SE.

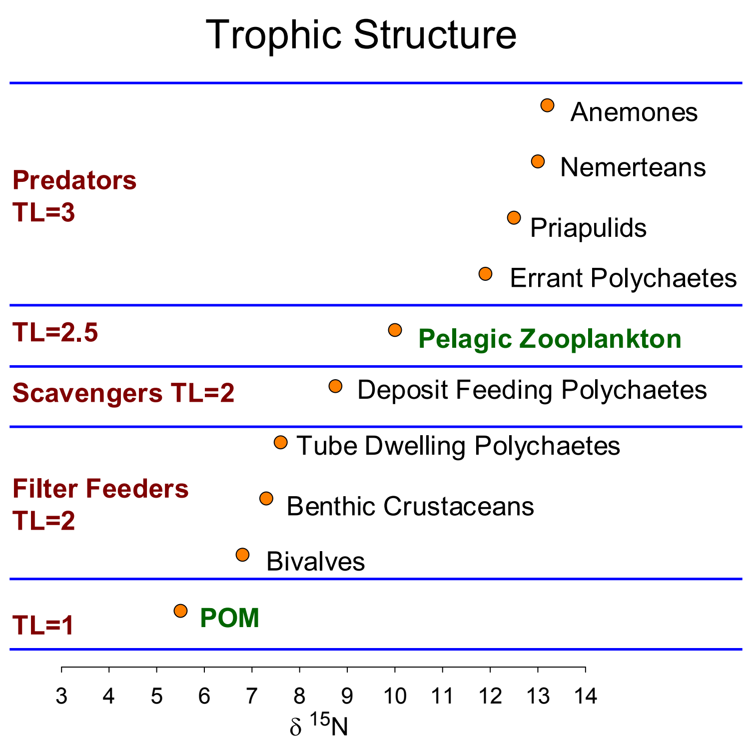

Figure 3.1.11 Stable nitrogen isotopic values of functional benthic trophic groups in relation to POM and zooplankton in the Sivulliq study area. Trophic level (TL) is indicated in red.

3.2 WATER COLUMN MEASUREMENTS

3.2.1 Chlorophyll *a*

Water column chlorophyll *a* was uniformly very low throughout the study area during the period of sampling (Fig. 3.2.1). Values ranged from undetectable to 0.5 µg L^{-1}. Vertical profiles showed that offshore waters were relatively well mixed with respect to chlorophyll, but values were generally greater at depth. This was especially apparent at inshore sites (P-1, P-5), where values approached 0.5 µg L^{-1} compared to 0.1 µg L^{-1} near the surface. The higher values near the bottom may be related to the resuspension of benthic microalgae based on the higher sediment chlorophyll values recorded at these inshore sites.

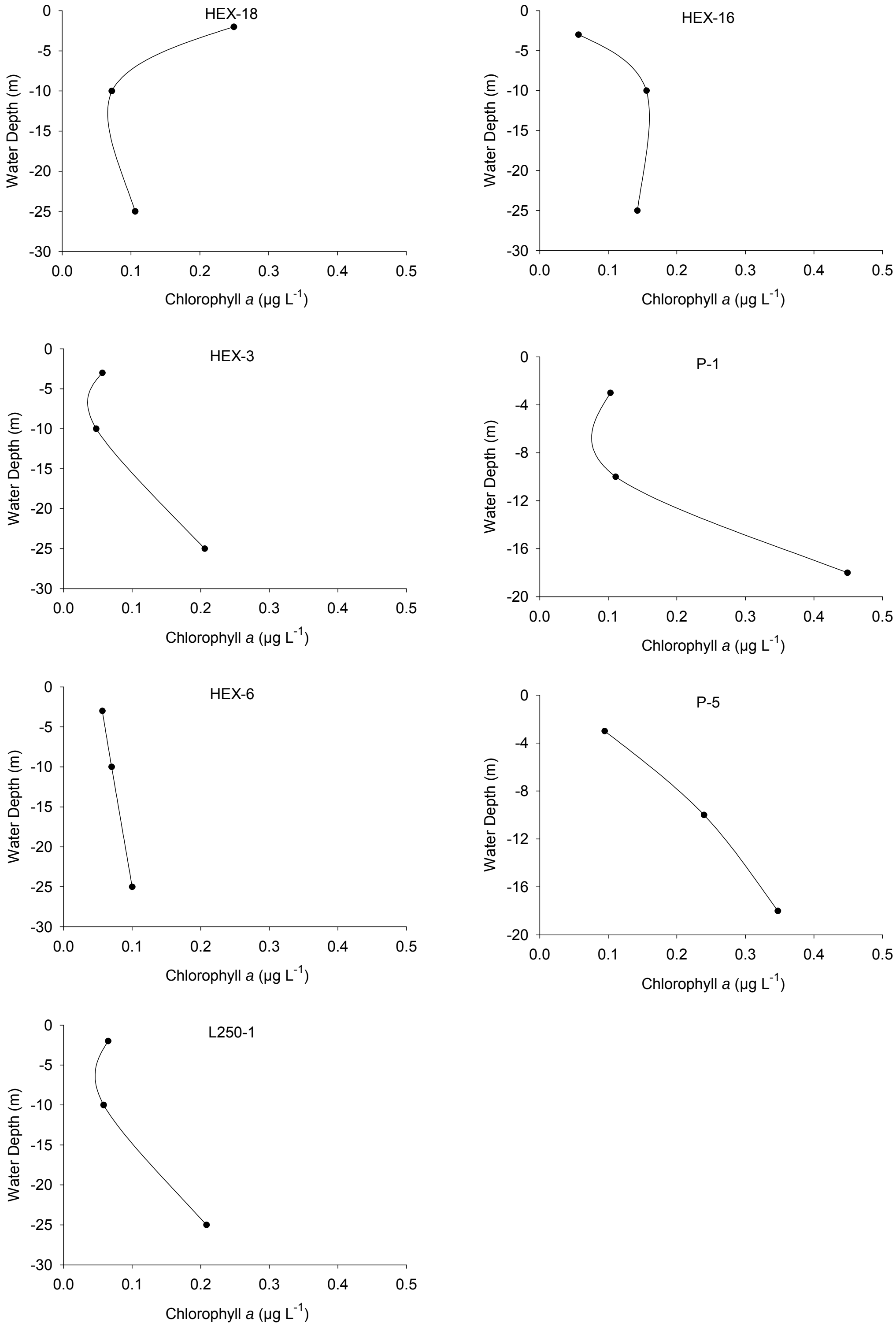

Figure 3.2.1 Vertical profiles of chlorophyll *a* at seven Sivulliq sites**.** Note the increase in chlorophyll levels with depth at the shallower Pipeline stations.

3.2.2 Zooplankton - $\delta^{13}C$ and $\delta^{15}N$

Stable carbon isotopic values of both calanoid copepods (Fig 3.2.3) and gelatinous zooplankton (Fig. 3.2.4) yielded similar ranges in $\delta^{13}C$ values, from -23.3 to -26.7‰. Because of the opportunistic nature of this sampling effort, there is insufficient data to depict any real geographic trends in zooplankton ^{13}C or ^{15}N signatures across the study area. Similarly, stable nitrogen isotopic values of both calanoid copepods (Fig 3.2.5) and gelatinous zooplankton (Fig. 3.2.6) yielded similar ranges in $\delta^{15}N$ values, from 8.7 to -12.9‰ A notably high $\delta^{15}N$ value (13.6‰) was recorded for the carnivorous amphipod (*Thermisto)*, reflecting its higher trophic level relative to the herbivorous copepods on which it feeds.

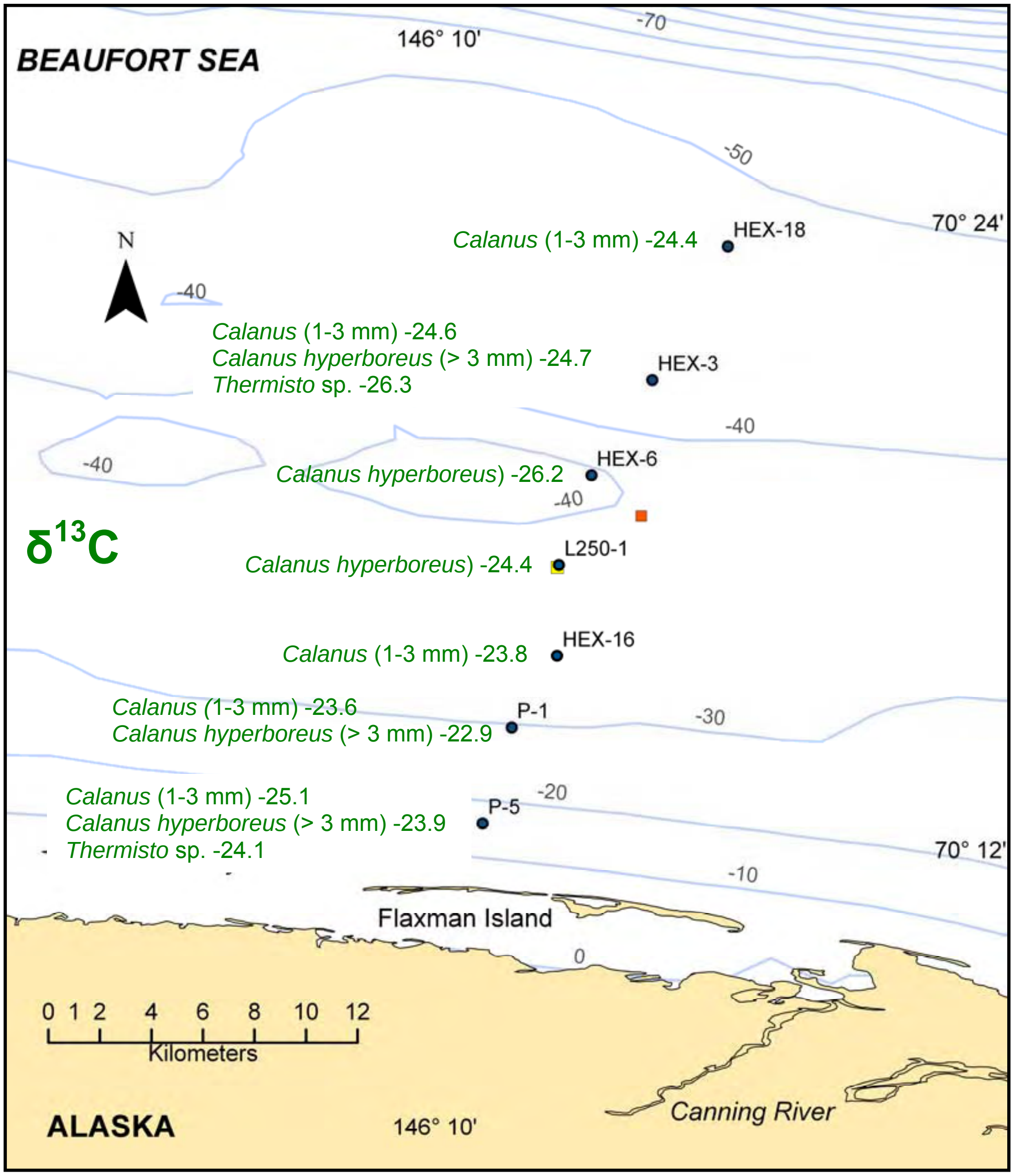

Figure 3.2.3 Stable carbon isotopic values of herbivorous calanoid copepods and a carnivorous amphipod (*Thermisto)* across the study area based on collections from vertical plankton tows. Isotopic values become increasing more negative with distance offshore, similar to sediment δ^{13}C values (see Fig. 3.0.1) that reflect an increasing more ^{13}C depleted carbon source. Depth contours are labeled in meters.

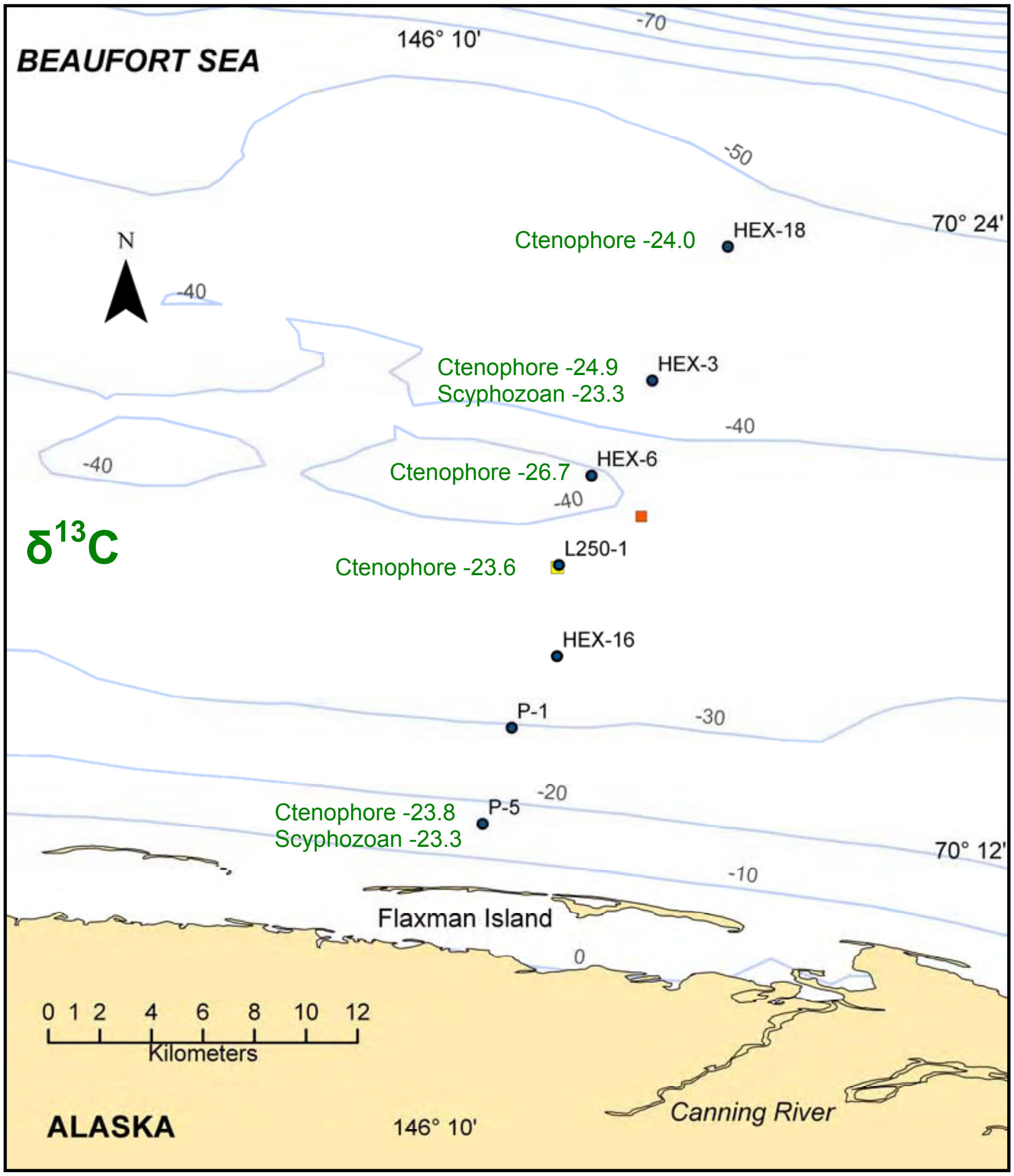

Figure 3.2.4 Stable carbon isotopic values of gelatinous zooplankton across the study area based on collections from vertical plankton tows. The gradient is similar to that reported in Fig. 3.2.3. Depth contours are labeled in meters.

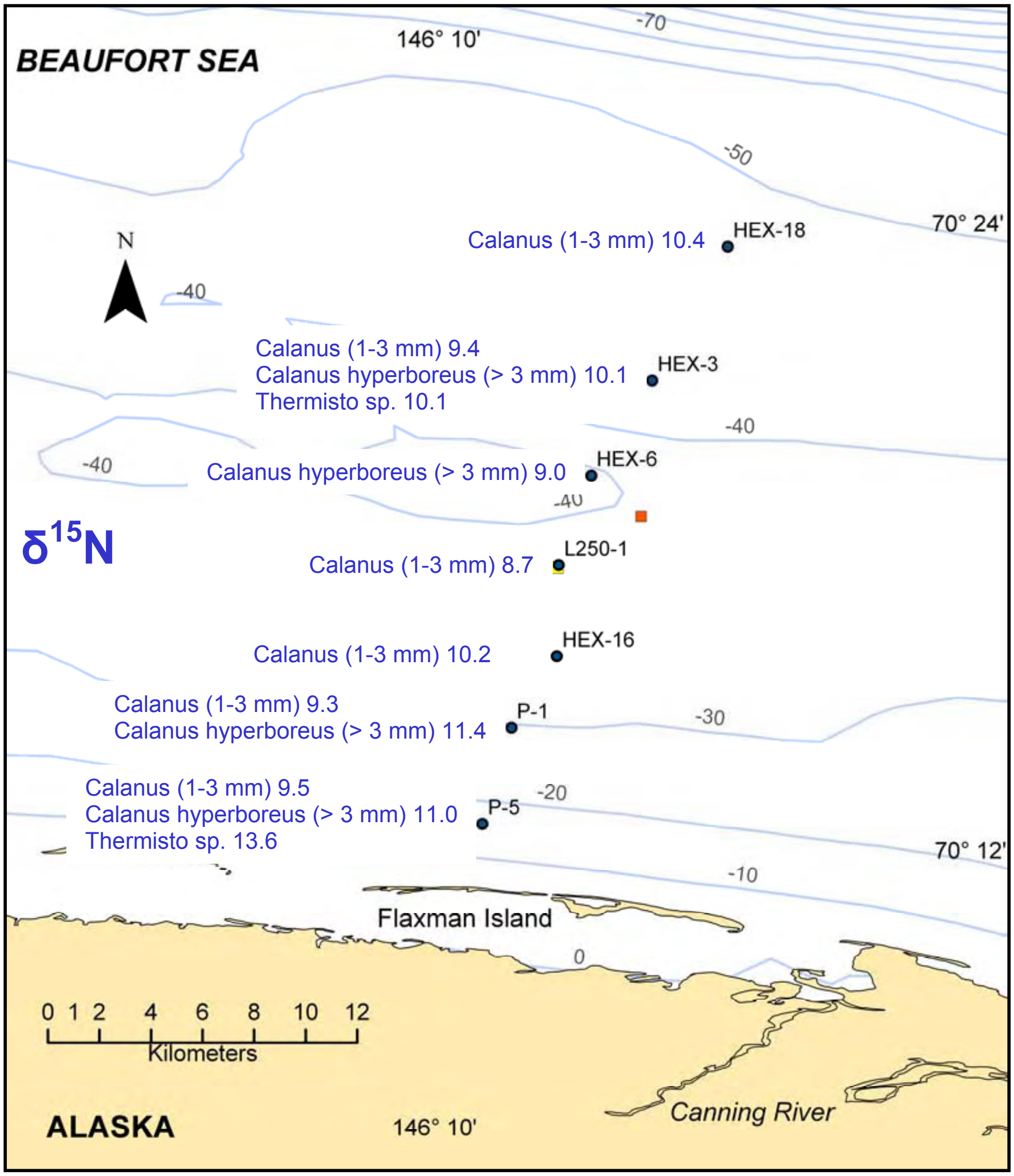

Figure 3.2.5 Stable nitrogen isotopic values of herbivorous calanoid copepods and a carnivorous amphipod (*Thermisto)* across the study area based on collections from vertical plankton tows. These isotopic ratios reflect their roles as primary consumers (see Fig. 3.1.11). Depth contours are labeled in meters.

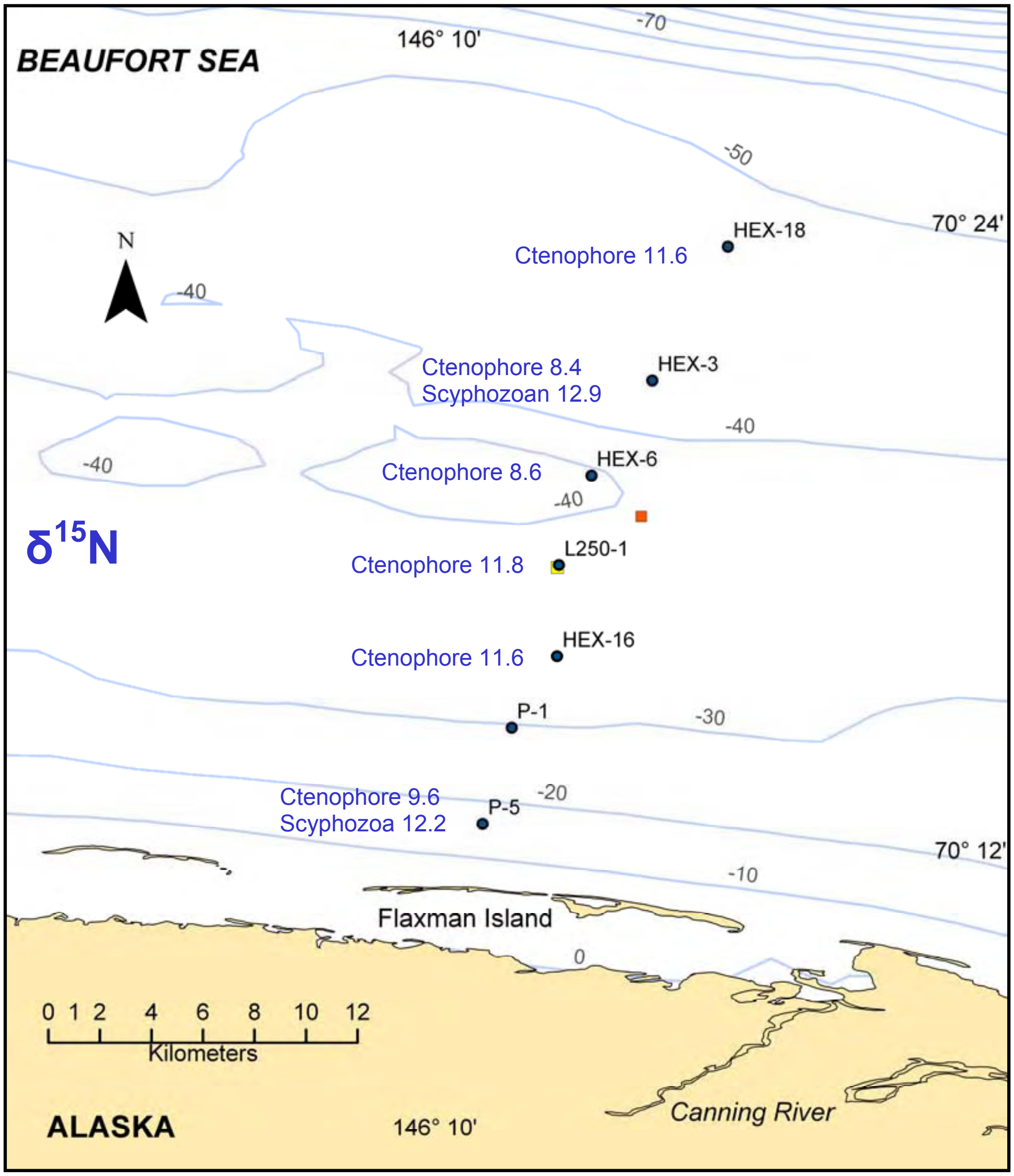

Figure 3.2.6 Stable nitrogen isotopic values of gelatinous zooplankton across the study area based on collections from vertical plankton tows. The values are generally similar is to that reported in Fig. 3.2.5. Depth contours are labeled in meters.

3.2.3 POM vertical profiles - $\delta^{13}C$ and $\delta^{15}N$

Stable carbon isotopic composition of POM (Fig. 3.2.7) ranged from -22 to -26‰ and strongly reflected the highly depleted ^{13}C signatures of zooplankton reported earlier (Fig. 3.2.3 and 3.2.4). Vertical profiles showed that offshore waters were relatively well mixed with respect to chlorophyll, but $\delta^{13}C$ values were generally greater at depth. This was especially apparent at inshore sites (P-1, P-5), where $\delta^{13}C$ values increased dramatically from the surface (-27‰) to the bottom (-22‰). The higher values near the bottom may be related to the resuspension of benthic microalgae and sediments that are ^{13}C enriched as noted earlier (Fig. 3.0.1), especially at the inshore sites where sediment chlorophyll levels were highest in the entire study area. In contrast, $\delta^{15}N$ values were variable as a function of depth, ranging from 2.5 to 6.5‰, but within the range of one trophic level (3‰) of herbivorous zooplankton and benthic filter feeders.

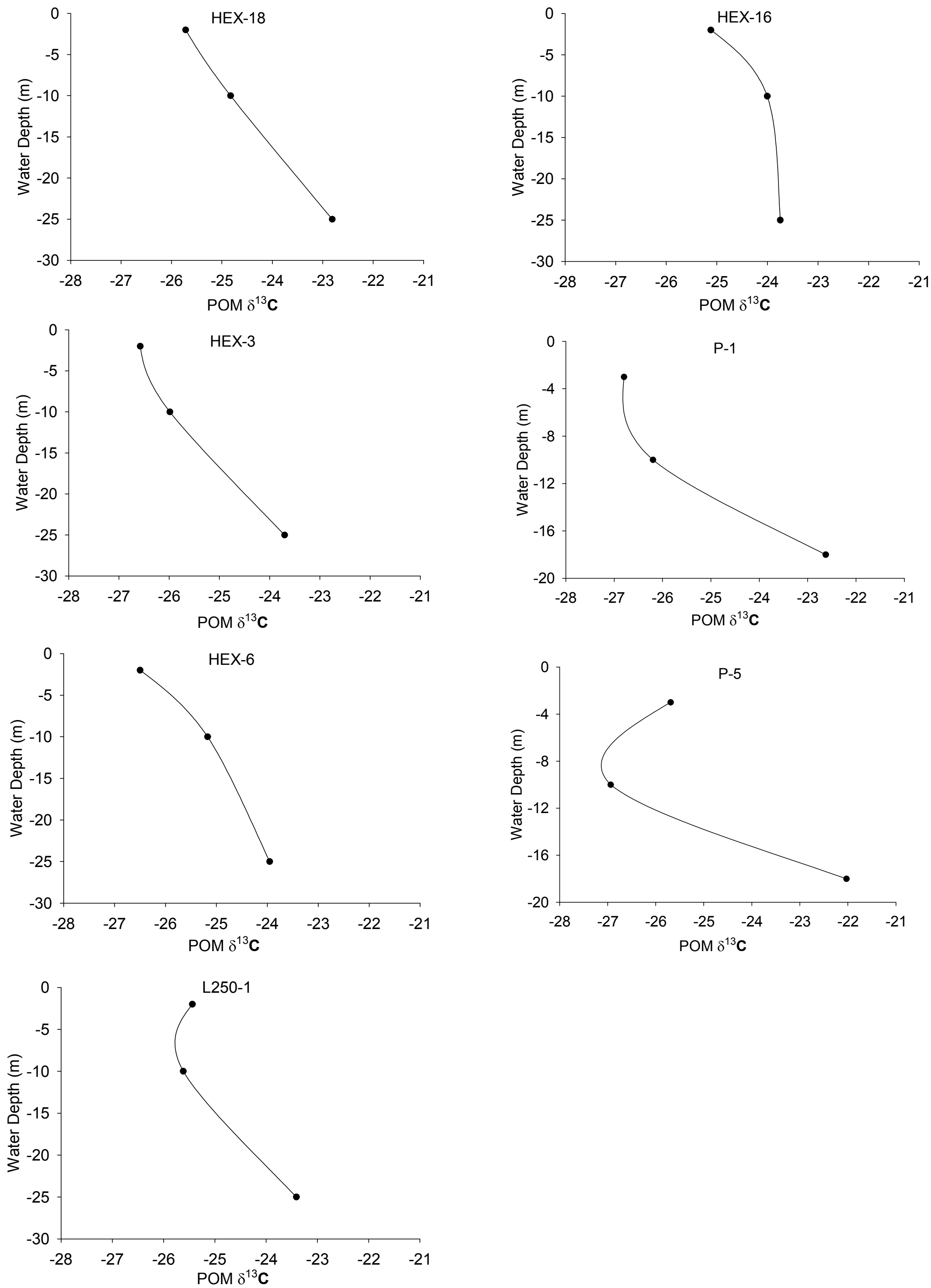

Figure 3.2.7 Vertical profiles of the stable carbon isotopic composition of POM at seven Sivulliq sites. The increase in $\delta^{13}C$ values with depth correlates with higher chlorophyll levels, particularly at Pipeline stations P-1 and P-5 (see Fig. 3.2.1).

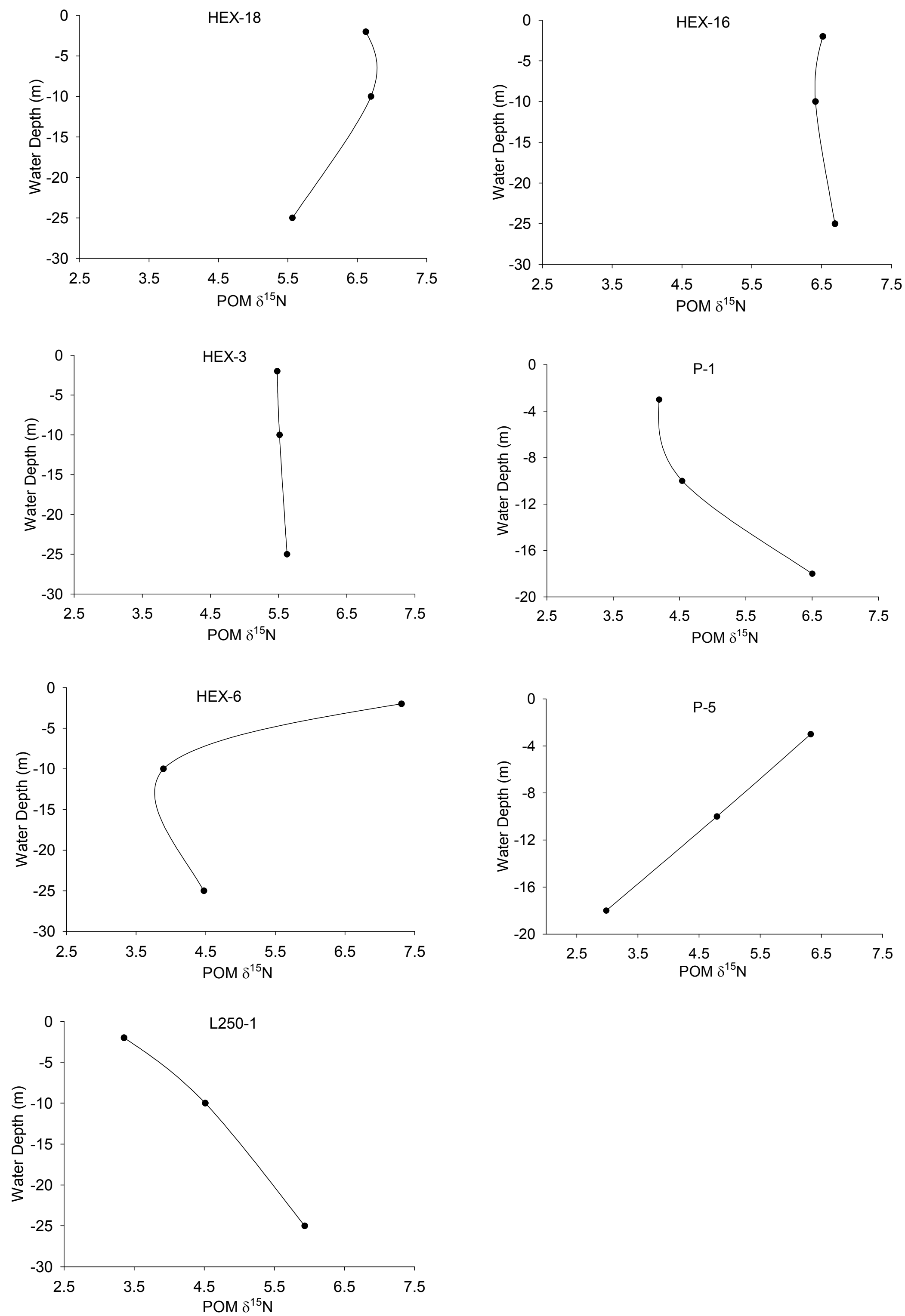

Figure 3.2.8 Vertical profiles of the stable nitrogen isotopic composition of POM at seven Sivulliq sites.

3.2.4 Nutrients (NH_4^+, SiO_4, PO_4^3, NO_2^- + NO_3^-)

Concentrations of inorganic nutrients, especially the undetectable or extremely low levels for nitrate + nitrite and ammonium, strongly reflect the oligotrophic character of the Beaufort Sea in late summer (Table 3.2.4). Such N-limitation clearly explains the low chlorophyll concentrations observed throughout the study area (Fig. 3.2.1) and reveals the importance of nutrient regeneration in the sediments as reflected in pore water ammonium concentrations (Fig. 3.0.4).

Table 3.2.4 Concentrations (µM) of the major autotrophic inorganic nutrients collected at three sampling depths at eight stations in the study area.

Station	Sample Depth (m)	NH_4^+	SiO_4	PO_4^{3-}	NO_2^- + NO_3^-
HEX-18	2	<0.05	5.14	0.23	0.05
HEX-18	10	0.19	5.44	0.32	<0.05
HEX-18	25	0.24	3.14	0.30	0.05
HEX-3	2	<0.05	5.52	0.21	0.05
HEX-3	10	0.18	6.88	0.33	<0.05
HEX-3	25	<0.05	3.96	0.25	0.06
HEX-6	2	1.46	5.75	0.20	0.06
HEX-6	10	<0.05	2.84	0.29	<0.05
HEX-6	25	0.64	5.17	0.38	0.06
HEX-16	2	0.74	2.81	0.29	0.05
HEX-16	10	<0.05	3.85	0.27	<0.05
HEX-16	25	1.11	3.54	0.20	0.09
L250-1	2	0.34	3.16	0.27	0.05
L250-1	10	0.67	2.44	0.30	0.06
L250-1	25	<0.05	3.81	0.24	<0.05
HEX-19	2	0.42	5.81	0.25	0.05
HEX-19	10	0.07	3.07	0.32	0.05
HEX-19	25	<0.05	3.09	0.29	0.05

Station	Sample Depth (m)	NH_4^+	SiO_4	PO_4^{3-}	$NO_2^- + NO_3^-$
P-1	3	<0.05	4.16	0.27	<0.05
P-1	10	0.09	3.50	0.28	<0.05
P-1	12	0.62	3.40	0.31	<0.05
P-5	3	<0.05	3.63	0.24	0.05
P-5	10	0.30	3.73	0.29	0.07
P-5	12	1.53	2.73	0.30	0.06

SUMMARY

Our biological studies in the Sivulliq study area have clearly added a considerable amount of new information to our existing knowledge of the mid-shelf region of the Alaskan Beaufort Sea. Until now, very little information on the benthic food web structure has been available for this region. Isotopic data show that carbon derived from marine sources, not terrestrial, are most important to benthic consumers. We found that the benthos is fairly well coupled to overlying water column production based on (1) stable carbon and nitrogen isotopic ratios that denote three trophic levels and (2) much higher indices of biomass than predicted from historical studies. In contrast to the mid-shelf region, Pipeline stations on the inner shelf revealed that benthic microalgae may provide an additional carbon source to benthic consumers. Finally, comparison of community structure among the 45 stations revealed that the large spatial variability in benthic infaunal biomass, abundance, and species diversity at four of the five Pipeline stations likely reflect (1) the occurrence of a variable substrate, including scattered pebbles and cobbles, on the seabed, and (2) the predominance of extreme disruptive processes of ice scour at the shallower depths characteristic of this more inshore region, where massive ice ridges form as fast ice collides with floating pack ice.

ACKNOWLEDGEMENTS

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APPENDIX

Figure A1. A sample of undisturbed seafloor sediments collected using a van Veen grab. The sample was sieved and sorted for infauna (see below).

Figure A2. Organisms sieved from sediments collected using a van Veen grab. This sample primarily contained different types of polychaete worms.