APPENDICES

Appendix A

Analysis of Industry Crude and Product Oil Spills on the Alaska North Slope and Estimates of Potential Spills for the Liberty Development Project

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Appendix A. Analysis of Industry Crude and Product Oil Spills on the Alaska North Slope and Estimates of Potential Spills for the Liberty Development Project

Summary

This appendix explains the data, methods, and results of an analysis of historical crude oil and refined product[1] ("product") spills for Alaska North Slope (ANS) facilities, including wells, facilities and other pipelines up to (but not including) Pump Station 1 (PS-1), which marks the beginning of the Trans Alaska Pipeline System (TAPS). The purpose of this analysis is to estimate the potential direct and indirect environmental impacts of the Liberty Development Project from potential crude oil and product spills. The projection method is based on statistical models used by the Minerals Management Service (MMS) for ANS and other oilfields. The data used for this analysis include historical ANS crude and product spills for the period 1985 – 2006; a time period believed most appropriate for this purpose.[2] The basic assumption is that the likelihood of future crude and product spills associated with the Liberty Development Project can be accurately estimated from prior ANS experience, i.e., that spill rates (per billion barrels produced) for this project will be similar to those at other ANS facilities. This basic assumption may overstate potential spills from the Liberty Development Project because this project makes efficient use of existing facilities and features few incremental facilities. The Liberty Development Project design and scope have evolved from an offshore stand-alone development in the outer continental shelf (OCS) (production/ drilling island and subsea pipeline) – as described in the 2002 Liberty Development and Production Plan Final Environmental Impact Statement – to make maximum use of the existing infrastructure involving an expansion of the Endicott Satellite Drilling Island (SDI). As a result, development of Liberty from Endicott significantly reduces potential environmental impacts, project footprint and does not require construction of new processing and transportation facilities.

Liberty will be developed with very few wells; up to six wells will be drilled from the expanded SDI using a purpose built drilling rig to reach the offshore Liberty reservoir located on the OCS. The drilling rig will be powered by natural gas so no handling and

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[1] Two types of spills are considered in this analysis (1) spills of crude oil and (2) spills of refined products (e.g., aviation fuel, gasoline, diesel fuel, turbine fuel, motor oil, hydraulic oil, transformer oil, transmission oil, and engine lube oil, etc.). Produced water spills are not considered in this analysis. In cases where a "mixed spill" occurs the respective volumes of crude oil and product are calculated by multiplying the total spill volume by the respective percentages of crude or product. For simplicity, these are referred to as crude and product spills in the remainder of this appendix.

[2] It is believed that use of this spill reporting period is more accurate. First, the accuracy of oil spill data may have increased after 1985 and 1999 due to increased public awareness after certain large spills such as the Exxon Valdez, changes in the underlying reporting requirements in state and federal law, and a change from a paper format to an electronic format for records retention. Second, the reporting threshold for spills has substantially decreased since the early days of North Slope operations. This is supported by the finding that the average reported volumetric spill rate (see main text for definitions) from 1985 onwards was approximately 3 times greater than for the period 1977 – 1984. To avoid the possibility of under-estimating the number of spills the period from 1985 onwards was selected in this analysis.

storage of large quantities of diesel fuel is required for the project. Production from the Liberty wells will be tied into the existing Endicott flow line system with production sent from the SDI via the existing 28-inch CRA (Corrosion Resistant Alloy) three phase flow line to the Endicott Main Production Island (MPI) for processing. The Endicott plant internals are constructed of duplex stainless steel for production. After processing at the MPI facilities, Liberty oil will be transported through the existing 16-inch Endicott Sales oil pipeline (which is a DOT regulated pipeline) to Pump Station No. 1 of TAPS. This pipeline is internally inspected on a cycle of not less than once every five years (the last inspection was 2005) using a magnetic flux pig. The Liberty Project will be utilizing the Endicott facilities through a Facility Sharing Agreement (FSA) with the Duck Island Unit Owners which is currently being negotiated. No buried subsea pipelines (included in the alternatives considered in the original FEIS) are required.

As noted above, Liberty will maximize use of existing infrastructure; the analysis presented here conservatively assumes that the direct and indirect impacts of the Liberty Development Project can be estimated based on a statistical analysis of the historical crude and refined product oil spills that occurred on the North Slope.

Crude oil spills included in this analysis are subdivided into large spills (those greater than or equal [≥] to 200 barrels [bbls]) and small spills.[3] For large crude oil spills:

- The expected[4] number of large crude oil spills for the operating life of the Liberty Development Project is 0.09 based on the estimated production of 105 million bbls and the ANS experience that nine large crude oil spills occurred during the production of nearly 11 billion bbls of crude oil produced over the period from 1985 to 2006. We have high (95%) confidence that the expected number of future large crude oil spills associated with the Liberty Development Project ranges will be between 0.039 and 0.163.[5]

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[3] MMS traditionally uses 1,000 bbls as the threshold for a large OCS oil spill. However, only one ANS spill > 1,000 bbls has occurred over the period from 1977 to the present. The original EIS for Liberty used 500 bbls as a threshold and more recent studies (Eschenbach and Harper, 2006) have considered thresholds as small as 50 bbls. The choice of 200 bbls provides an adequate sample of large spills for statistical purposes and lowers the likelihood that the estimates will be biased if the volume distribution of small spills differs from that for large spills.

[4] This is a statistical term of art and denotes the sum of the probabilities of 0, 1, 2, 3…spills times the number of spills, summed over all possible numbers of spills. Another word that might be chosen is the *estimated* number of spills. In this instance the expected or estimated number of large spills is 0.09—an impossibility because the number of large spills must be an integer (0, 1, 2, 3, etc). What this estimate tells us is that it is very likely that zero large spills will occur, a point amplified in the following paragraph.

[5] Technically this is known as a *confidence interval*. In statistics, a confidence interval (CI) for a population parameter (the large crude oil spill rate in this example) is an interval with an associated probability (95% in this instance) that is generated from a random sample of an underlying population such that if the sampling was repeated numerous times and the confidence interval recalculated from each sample according to the same method, a percentage (95%) of the confidence intervals would contain the true value of the population parameter in question. The use of confidence intervals was one of the specific recommendations of the NSBSAC. For additional information on confidence intervals, see http://www.cas.lancs.ac.uk/glossary_v1.1/confint.html.

- The estimated probability (in percentage terms) that no large crude oil spill will occur from the Liberty Development Project is approximately 92%[6] if the future is like the past and the assumed model is correct.[7] We have high (95%) confidence that the actual probability that no large crude oil spill will occur during the operation of Liberty lies between 85% and 96%. That is, large crude oil spills associated with the Liberty Development Project are unlikely.

- The estimated probabilities (expressed in percentage terms) that there will be 1, 2, or 3 large spills are approximately 7.8%, 0.3%, and < 0.01%, respectively.

- The odds against one or more large spills occurring are approximately 11:1. The odds against two or more large spills occurring are nearly 285:1.

- If a single large crude oil spill were to occur, then a reasonable estimate of the probable spill volume (using actual data directly as well as fitting statistical models) is 1,000 bbls. Allowing for the possibility of multiple large spills, the estimated spill volume is only slightly larger than 1,000 bbls. However, because large spills are infrequent, the weighted-average large spill volume is estimated to be 85 bbls[8].

- Because there is a distribution of large spill volumes, it is possible that the cumulative large spill volume—given the unlikely event that one occurs—would be greater than 1,000 bbls. Monte Carlo simulations, explained in the text, indicate that the 95% confidence interval on the volume of large spills (given that one occurs) is from 225 to 4,786 bbls.

It is important to note that, because the throughput of the Liberty Development Project is only a small fraction of the total ANS crude oil throughput, it is more likely that any future large crude oil spill will come from one of the other producing fields than from Liberty.

The Liberty Final EIS (USDOI, MMS, 2002) concluded on the basis of engineering judgment that the original designs would produce a "minimal chance of a significant oil spill reaching the water." This conclusion was based on the results gathered from several spill analyses done for Liberty that applied trend analysis and looked at causal factors. All showed a low likelihood of a spill, on the order of a 1 – 6% chance or less over the estimated 15 – 20 year life of the field.

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[6] Note that this statement applies only to large crude oil spills. Many small spills (addressed later in this appendix) are likely to occur. Note also that probabilities can be expressed in two equivalent ways, as fractions between zero and one and as percentages. Thus, for example, a probability of 0.5 is exactly equivalent to a probability expressed in percentage terms of 50%--as likely as not in this case. For many readers it is more intuitive to think of probabilities as percentages. To avoid confusion, we insert the percentage symbol (%) to denote a probability expressed in percentage terms.

[7] This model is conceptually plausible and has been validated by historical experience in the Gulf of Mexico and ANS areas.

[8] As noted, if a large spill occurs, the volume estimate is approximately 1,000 bbls. But because the probability of a large spill occurring is so low, the weighted average volume of a large spill is much lower.

Small spills of either crude oil or refined product are more numerous than large spills. However, the average size of a small spill is very much smaller than the average size of a large spill, with the result that the aggregate volume of small spills is only about 28% of the total volume spilled (for crude). This analysis also develops estimates of the volume of small spills associated with Liberty. For small crude oil spills:

- The estimated total volume (throughout the operating lifetime of the Liberty Project) based on the observed ratio of the volume of small spills to ANS production is approximately 34 bbls. The Liberty Project Description (BPXA, 2006) does not specify the economic life of the project. Assuming a 20-year project lifetime, the average small crude-oil volume spilled per year would be approximately 1.75 bbl/year.

- The 95% confidence interval on the total volume of small crude oil spills ranges from 6 to 100 bbls.

Refined product spills, though numerous, are very small on average. Using the same method as that employed to project small crude oil spills, the following estimates are derived for the expected and 95% confidence limits on the volume of refined product spills yields the following estimates:

- The estimated total volume (throughout the operating lifetime of the Liberty Development Project) based on the observed ratio of the volume of small spills to ANS production is approximately 42 bbls, equivalent to approximately 2 bbl/year over a 20-year project lifetime.

- The 95% confidence interval on the total volume of small crude oil spills ranges from 10 to 125 bbls.

Introduction

This appendix provides an analysis of historical crude oil and refined product ("product") spills occurring on the Alaska North Slope (ANS) and develops projections of future spills associated with the operation of the Liberty Development Project using models originally developed by the Minerals Management Service (MMS) of the US Department of the Interior. Other sections of this Environmental Impact Analysis address a trajectory scenario and fate and effects of crude oil and product spills. As noted above, we believe that the estimates provided in this analysis are conservative in the sense that these are (if anything) likely to overstate spills originating from the Liberty Development Project because this facility will take maximum advantage of existing infrastructure.

Crude oil spills are among the most visible of the environmental impacts associated with industry exploration and production (E&P) activities and, as such, merit careful attention in any study of the environmental consequences of proposed ANS oil development.

This analysis begins with a characterization and analysis of historical crude and product spills. Crude oil is produced via deep wells, the oil/water/gas mixture is transported via flow lines to the production facilities, the three-phase mixture is processed (to remove water, solids, and gas), and then transported off the North Slope to refineries located in Alaska and elsewhere. Refined oil products, including aviation fuel, gasoline, diesel fuel, turbine fuel, motor oil, hydraulic oil, transformer oil, transmission oil, and engine lube oil, are used during E&P operations (MMS, 2002; BLM, 1998). Spills associated with operation of ANS facilities include both crude oil and product spills.

A brief description of Typical ANS Oil and Gas facilities

It is useful to provide a brief description of the ANS oilfields in order to understand possible sources of crude oil and product spills. This description is abstracted from discussions found in several *environmental impact statements* [EISs] (e.g., NPR-A, BLM, 1998). Oil is produced from wells (typically located on gravel *production pads*) and flows from wellhead manifolds to production facilities (PF) [termed flowstations, gathering centers, or central processing facilities depending upon the particular field and nomenclature of the operators]. Offshore wells are located on islands. Produced oil is transported as a multiphase slurry (or three phase oil containing oil, gas, and water) by *facility oil pipelines* and the *flowlines* from the wellhead manifold to the PFs. A PF is the operational center of production activities in an oilfield. The PF typically includes production equipment, offices, maintenance facilities, storage tanks for fuel and water, power generators, and a communications facility. The oil production equipment includes three-phase separators (oil, gas, and water are produced in varying proportions from each well), gas conditioning equipment (to remove natural gas liquids from produced gas), pipeline manifold and pressure-regulation systems, and well monitoring and control systems. Oil from production wells is filtered (to remove sand and other solids) and processed (removing water and gas). After processing, crude oil (termed *sales oil*) is routed either via non-common carrier oil transit pipelines if the lines are still inside the oil and gas field or are routed through a sales meter and transportation on one or more common carrier *crude oil transmission pipelines*, (also termed *sales-oil pipelines*) for delivery to a larger-diameter mainline at *Pump Station 1* (PS-1) of the *Trans Alaska Pipeline System* (TAPS) for shipment to Fairbanks or Valdez and ultimate loading onto tankers. System pipelines are many and vary in what they are designed to carry (three-phase fluids, produced water, fresh water, salt water, gas, crude oil, diesel or other products such as methanol) and vary in diameter, depending upon function and necessary capacity, and are normally laid out in straight-line segments and installed above ground on *vertical support members* (VSMs). Above ground pipelines are less disruptive to the environment and easier to monitor, repair, and (when necessary) reconfigure than are buried pipelines. Only one offshore field (Northstar) is connected into the system via a buried *(subsea)* pipeline.

Thus, the production-processing-distribution system on the North Slope consists of wells, facility oil piping, flowlines, PFs, transmission pipelines, and various associated equipment (e.g., pumps, valves of various kinds, and separators). Tanks are used to store water, refined products, and certain other fluids.

In principle, crude oil or product spills can occur at any of the types of facilities described above. Crude oil spills result when the integrity of the production-processing-transport system is breached. Product spills can result from a variety of other causes.

The Liberty Development Project design and scope have evolved from an offshore stand-alone development field in the OCS (production/drilling island and subsea pipeline as described in the original *Final EIS* [FEIS], [MMS, 2002]) to use existing infrastructure involving an expansion of the Endicott *Satellite Drilling Island* (SDI)[9]. The present plan uses *ultra-extended-reach drilling* (uERD) from the SDI.[10] BPXA estimates (see main text) that the Liberty Development Project could recover approximately 105 million bbls of hydrocarbons by waterflooding and using the *LoSal*™ *enhanced oil recovery* (EOR) process.

Thus, the Liberty Development Project is properly viewed as an onshore facility that takes maximum advantage of existing infrastructure. Spill rates are assumed to be similar to those experienced historically on the ANS.

Types of spills

This section provides information on the various types of E&P crude oil and product spills that have occurred over the operating history of the ANS fields, including information on causes, effects, and corrective actions/countermeasures. Because of the importance of large spills to spill totals (see above) it is appropriate to focus on these spills. (This analysis includes both large and small spills, however.)

Table 1 provides a list of the crude oil spills greater than or equal to 200 bbls that have occurred on the North Slope since 1985.[11] These spills range in volume from 225 bbls to 4,786 bbls. The spills shown in Table 1 list the volume of crude oil released in the event, even though other liquids may have also been released (e.g., produced water in the case of spills from some pipelines).

Causes of ANS E&P spills reported in various environmental assessments and EISs (e.g., Parametrix, 1997; BLM, 1998; MMS, 2002) include leaks from or damage to storage tanks, faulty valves/gauges, faulty connections, vent discharges, ruptured lines, seal failures, various human errors (e.g., tank overfill, tank damage, and failure to ensure connections), and explosions. Several of these causes are reflected in the brief spill descriptions given in Table 1. Many of the spills were also contained and not released into the environment, but the volume given is the total amount that was released even if to secondary containment.

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[9] The SDI is not an onshore location. It is an existing gravel island attached to land via a causeway and is similar in construction to an onshore gravel pad facility. SDI facilities are also similar to onshore facilities (i.e., pipelines are aboveground and there is no need for an undersea buried pipeline). The SDI, while not an onshore facility more closely resembles an onshore facility than the offshore gravel island identified as the proposed action in the Liberty FEIS.

[10] BP has extensive experience with the use of extended reach drilling in overseas locations.

[11] Justification for use of the period from 1985 to 2006 is provided in a later section. The dates included are from 1 January 1985 until 31 December 2006.

Table 1. ANS crude oil spills greater than or equal to 200 bbls (1985-2006) – spill event description.

Rank	*Date*	*Volume (bbls)*	*Description of Spill Event*
1	2 Mar 06	4,786	Crude oil spill caused by corrosion and failure of a buried section of the pipe from GC-1 to GC-2.
2	28 Jul 89	925	The oil reserve tank overflowed because the high-level tank alarm system failed. The crude oil overflowed into a reserve pit.
3	21 Aug 00	715	Communication systems experienced a glitch which tripped some, but not all, shut down procedures. As a result, a tank continued to fill and overflowed.
4	17 Aug 93	675	A hole caused by external corrosion in a divert tank released a mixture of crude oil and produced water. Spill volume is crude oil only.
5	26 Sep 93	650	A Sulzer pump failure caused an overflow of Tank 7003. To alleviate rising tank levels, the inlet valve was closed and the outlet valve was opened, allowing material to spill into a containment dike. High winds carried some light oil mist to snow outside of the containment dike.
6	25 Aug 89	510	A 16 inch pipeline valve failed, allowing crude oil to leak from a piping system.
7	30 Dec 93	375	Wind-induced vibration caused a flowline leading from the well house to the manifold building to crack. Crude oil sprayed out of the crack. High winds carried some of the crude oil away from the pad towards Spine Road. At the time, the low-pressure safety system was disabled.
8	10 Jun 93	300	During a shutdown, a high-level alarm on a knockout drum failed.
9	20 Feb 01	225	During maintenance of a pipeline for thawing and displacement, pipeline ruptured, releasing the ‘dead’ crude mixture in the pipe.

Table 2 provides information similar to that given in Table 1 for ANS ***product spills.*** Table 2 provides information on spills greater than or equal to 50 bbls (rather than greater than or equal to 200 bbls). Spill volumes for the eleven largest product spills range from 50 bbls to 262 bbls – very much smaller on average than for crude oil spills. The largest product spills released diesel fuel, drilling oil, and drag reducing agent. As one would expect, the largest product spills involve materials kept on site in large quantities. However, the database also includes information on numerous small product spills for materials such as aviation fuel, brake fluid, chain saw oil, crankcase oil, cutting oil, engine lube oil, fuel oil, gasoline, gear oil, grease, hydraulic fluid, hydraulic oil, jet fuel, lube oil, motor oil, natural gas liquids, oil phase mud, slop oil, transformer oil, transmission fluid, turbine oil, used oil and waste oil as well as unknown products listed as ‘other’. Causes for many of these spills include vehicle accidents, corrosion, faulty valves, broken fuel lines, and human errors (e.g., accidental overfill).

The spill database

The statistical analyses presented here are based upon data collected in a database developed over several years and used in several earlier spill studies. Initially, the database was developed for use in the *Trans Alaska Pipeline System Environmental Report* (TAPS ER) in support of an application for renewal of the TAPS pipeline *right-of-way* (ROW). The TAPS ER was prepared by an internal task force assisted by a team

Table 2. ANS refined product spills greater than or equal to 50 bbls (1985-2006) – spill event description.

Number	*Date*	*Volume (bbls)*	*Description of Spill Event*
1	17 Nov 03	262	Human error allowed a tanker truck to overfill at the MCC fuel dock. A seam failed and released diesel to secondary containment.
2	19 May 97	180	A needle valve on the fill line of a diesel storage tank broke, causing the diesel to drain into a lined containment area.
3	2 Mar 00	143	A release of drag reducing agent. All material was recovered.
4	16 Oct 86	100	Broken fuel line.
5	22 May 85	95	A faulty connection on a diesel tank truck caused this spill. A camlock fitting failed, allowing diesel to spill next to the truck.
6	28 Feb 03	85	A filter on a diesel spill at the MCC fuel dock failed and released diesel. Majority of spill was to secondary confinement.
7	31 Jul 91	75	Diesel released from a hole in annulus.
8	22 Jan 01	68	A diesel spill at a well pad.
9	5 Oct 95	50	Drilling oils released and contained on pad.
10	25 Nov 89	50	A maintenance issue allowed a valve to vibrate open and release diesel.
11	25 May 85	50	Heavy vehicle accident released diesel.

of external experts retained by the TAPS Owners (TAPS Owners, 2001) to characterize oil spills from 1977, when the first barrels of ANS oil flowed through the TAPS system, until August 1999. Details on data sources, compilation methods, and consistency checks are discussed in the TAPS ER and related documents (TAPS Owners, 2001). Prior to the release of the ROW documents, TAPS Owners performed extensive data audits and validation checks and appropriate corrections and adjustments were made (Niebo, 2001a,b and Maxim, 2001; Maxim and Niebo, 2001).

In 2002, this database was updated to provide information for a study commissioned by the *National Research Council* (NRC). The NRC study documented and evaluated information on the cumulative environmental effects of ANS oil and gas activities (NRC, 2003). As part of the study, the oil spill database was updated with government and industry records for crude oil and refined product spilled through 31 December 2001.

The current version of the oil spill database includes ANS crude oil and refined product spills from 1977 to 31 December 2006. In total, the ANS oil spill database provides information on nearly 8,000 spill events totaling approximately 20,300 barrels of material (including both crude oil and refined product) spilled over the 30-year period.

-Updating the oil spill database for the Liberty Development Project

The oil spill database needed to be updated for the Liberty Development Project. The original database was compiled from spill records maintained by both the Alaskan oil industry and state and federal agencies.

To update the oil spill database for the Liberty Development Project, electronic spill records were collected from *Alaska Department of Environmental Conservation* (ADEC) spill database and those maintained by BP Exploration (Alaska) [BPXA] and ConocoPhillips. Records were requested for the period from 1 January 2001 to 31 December 2006[12]. Once received, spill records were sorted based on the type of material spilled and segregated into two lists; a list of crude oil spills and a list of refined products spills. The lists were examined for duplicate spill records and duplicate records were removed and kept for reference. Duplicate spills were identified by comparing the date of each spill, identity of the spilled material, reported spill volume, and spill location.

There are differences between the industry and ADEC spills databases. Current spill reporting regulations are described in 18 AAC 75.300 and summarized on the ADEC website at http://www.dec.state.ak.us/spar/spillreport.htm#requirements. Differences between the industry and ADEC databases include:

- By regulation, some small spills are not reportable to ADEC, but industry has generally kept records of these small spills. Thus, there are some spills included in the industry databases that are not included in the ADEC database.

- The ADEC database also includes some spills that are not listed in the industry databases. As might be expected, some spills on the North Slope are not directly attributable to the oil industry and some may be related to government or military installations. These spills are not frequent and are typically related to spills of refined products. By combining relevant spill data from both industry and ADEC datasets, the resulting ANS oil spill database proves a more accurate picture of the spill history on the North Slope.

- Some spills are included in both databases, but a different spill volume is listed in each. These discrepancies occur for several reasons. In some cases a spill volume is used in the ADEC data base, that is subsequently revised (either upwards or downwards) and the revised data may not be listed (i.e. the spill record may not have been updated). In other cases, for example, the large crude oil spill discovered in March 2006, ADEC includes a margin of error (+33%) to allow for possible errors of estimation, whereas the oil industry data report uses an estimated value.

[12] Requesting data from Jan. 1, 2001 provided a useful check against the 2001 data already in the database. Some of the 2001 spill records in the existing database required changes to account for information that was entered at a later date. For example, an initial spill volume in an August 2001 spill record may have been updated with a final volume during 2002.

For most spills, the ADEC and industry oil data match very well. When the records matched (e.g., had same volume, spilled material, date and location) the record with the most supplemental information was retained for the database. That is, if the industry record had information on the circumstances of the spill or clean up that were not provided with the ADEC record, the industry record was kept for the final database. If the ADEC record contained more information than the industry record, the ADEC record was retained.

In some cases, the ADEC database and industry database do not agree on spill volumes even though they report the same spill. There are three reasons for disagreement. First, the ADEC spill database sometimes provides information on the total amount of liquid spilled during a spill event. A single spill event may release numerous types of liquids (such as produced water and crude oil from a pipeline leak, or diesel fuel, motor oil and hydraulic fluid in the case of a vehicle accident). The industry records generally identify the volume of specific types of liquid spilled. In instances where it was clear by that the ADEC data record had not disaggregated the spilled materials, the industry data records were used.

Second, conversations with ADEC personnel[13] indicated that the ADEC oil spill database recently had gone through revisions and a software upgrade. As a result, some of the smaller spills (reported to the agency as less than one gallon or in fractional gallons) had been rounded up. For example, the ADEC data may list a spill of two gallons while the industry database lists it as 1.5 gallons. In these cases, the industry record was used because of the precision of the volume. In general, the rounding appears to primarily have occurred with small spill of less than 2 gallons.

Third, for more recent spills, records in the ADEC database have not been "closed." That is, some of the spill response activities are still ongoing and the spill volume listed may be preliminary. In those instances, the industry records were used. This issue is only relevant for spills occurring during 2006.

To update the database, North Slope spills were added to the database. Specifically, spills were added from the ANS E&P facilities and pipelines and from records tagged by ADEC as occurring on the North Slope. All TAPS facilities were excluded from the database. Thus, there are no spills attributed to the TAPS pipeline or associated pump stations on the North Slope. Spills occurring from facilities in the town of Deadhorse were included in the update because those spills might be related to oil and gas activities on the North Slope. Spills from the neighboring towns and villages were not included. Typically, spills from these villages are usually small volumes of refined products.

[13] Personal Comm. with Camille Stephens, ADEC Environmental programs Spec III (907) 465-5242, January 19, 2007.

-Period of analysis

The ANS oil spill database contains records back to the beginning of oil production on the ANS in 1977. However, there are fewer spill records during the years from 1977 to 1985 (see Fig. 1) and the completeness and accuracy of the older records has been questioned. In fact, several observers believe that the accuracy of oil spill data on the North Slope is naturally greater for the period after 1985 (MMS, 2002) or 1989 (BLM, 1998) than for the earlier years.

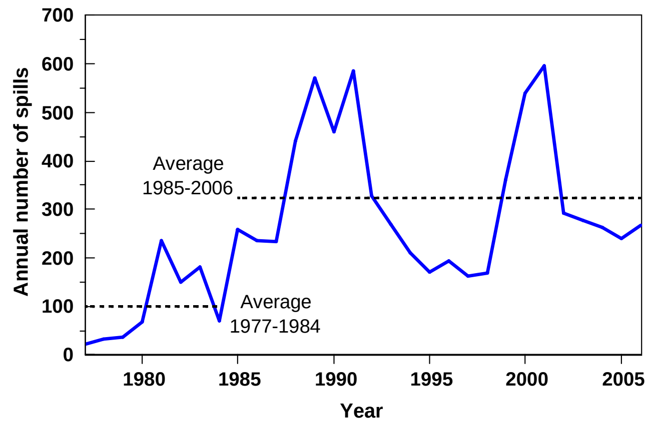

Fig. 1. Annual number of crude and product spills listed in ANS oil spill database, 1977 to 2006.

It has been suggested that spills may have been under-reported in the earlier years.[14] One report (AGRA, 2000) claims that prior to the 1990s only 10% of spills on tundra were reported to the ADEC and included in the State's files. We know of no reliable basis for estimating the extent (if any) of under-reporting prior to 1985.

Another issue that confounds accurate assessment of the spill record prior to 1985 is that prior to 1985, the ADEC spill records, the only source that may have been available for public scrutiny, were kept as paper files. After 1985, the system was converted to an electronic database. The written records for many spills prior to 1985 are now missing or incomplete; a search of the paper records by MMS contractor Hart Crowser in 1999 revealed that very little of the paper record existed publicly through ADEC.

Analysis of the updated spills database indicates that there are fewer spill records per year in the early years of ANS production. Figure 1 plots the annual number of crude oil and refined product spills in the database from 1977 through 2006. The average number of spills reported from 1977 to 1984 was 100 per year. The average number of spills reported from 1985 to 2006 was 324 spills per year—greater by a factor of three.

Currently, we have no definite explanation why fewer annual spills were reported in the early years. However, to avoid any possible under-estimation of future spill quantity projections, and to acknowledge that the data prior to 1985 can not be easily validated through a public source, we restricted our analysis to spills that occurred from

[14] It is difficult to assess the validity of this claim. On the one hand, reporting thresholds for spills have decreased over time, which would be consistent with this hypothesis. As well, spill awareness has also increased. However, on the other hand, large spills account for the bulk of the total volume and changes in the reporting threshold or spill awareness would probably not affect the likelihood of reporting large spills.

1 January 1985 to 31 December 2006—an assumption supported by MMS personnel. *The database used for this analysis includes 22 years of ANS spill history and thousands of spill records for statistical analysis.*

Spill data and spill rates

As the term is used here, "oil spills" are unintentional accidental releases of crude oil or product. Accidents are fundamentally probabilistic, rather than deterministic, events. Accordingly, it is appropriate to analyze spill data in statistical terms.

-Size distribution of ANS spills

As noted above, the reporting threshold by regulation is quite low, and the oil industry maintains records of spills below the reporting threshold. For this reason, ANS spill records in the database range more than six orders of magnitude in volume, from 0.01 *gallons* (7.5 teaspoons) to 4,786 *barrels*[15]. That is, relatively small spills are quite frequent, but there is a long "tail" to the distribution—the total volume is dominated by relatively few large spills. This characteristic (see below) has important implications for the appropriate choice of a spill metric—it is *the total volume, not the total number of spills* that is relevant.

A key conclusion of this analysis is that smaller spills, although more numerous, account for only a small proportion of the total spill volume. This is best illustrated by a *Lorenz diagram*, which plots the fraction of the spill volume (on the vertical axis) versus the fraction of the number of spills (on the horizontal axis). It is constructed as follows. First, the spill data are sorted in ascending order of spill volume. Next the cumulative fraction of the total volume spilled (y-axis) is plotted as a function of the cumulative fraction of the total number of spills (x-axis). Figure 2 provides a hypothetical illustration of a Lorenz plot. If all spills were exactly the same size, the fraction of the spill volume would correspond exactly to the fraction of the number of spills. The 45° line "AB" in Fig. 2 depicts this situation. However, if some spills were larger than others, then the fraction of the spilled volume would be less than the fraction of the number of spills, as shown by the curve "AB" beneath the 45° line in Fig. 2. The area between the curve

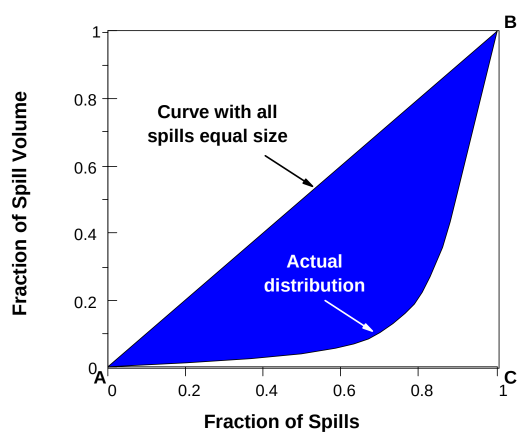

Fig. 2. A hypothetical Lorenz diagram: the size of the area between the line of constant spill volume and the actual Lorenz curve as a fraction of the bounding triangle ABC is used as a measure of inequality.

[15] One barrel is equal to 42 gallons.

and the straight line (the shaded area in Fig. 2) provides an indication of the degree of inequality in spill size distribution. Dividing the shaded area by the area of the triangle ("ABC" in Fig. 2) yields a normalized index or coefficient, denoted L, of the variability of spill volumes. L ranges from 0 (all spills the same size) to 1.

The diagram shown in Fig. 2 is hypothetical, included solely to illustrate the concept. The actual curves for ANS spills are more extreme. Figure 3 shows Lorenz plots for ANS crude (shown in red) and product spills (shown in blue) over the period from 1985 to 2006. As can be seen, there is substantial curvature in these plots (the computed Lorenz coefficients are 0.96 and 0.87 for crude and product ANS spills, respectively).

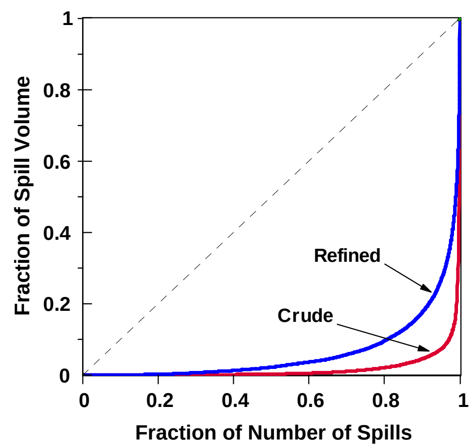

Fig. 3. Actual Lorenz curve for ANS crude and product spills (1985-2006).

The Lorenz plots provide a useful characterization of ANS spills. The clear message is that a few relatively large spills account for a majority of the total spill volume. This conclusion is suggested by numerous spill studies (Smith *et al.*, 1982; BLM, 1998, 2004, 2005; MMS, 2002, NRC, 2003; and Taps Owners, 2001). Most spills are relatively small:

- Fifty percent (the median) of ANS crude oil spills were less than or equal to 0.119 bbls (5 gallons). Fifty percent of product spills were less than or equal to 0.095 bbls (slightly less than 5 gallons).

- The smallest 90% of crude oil spills accounted for only approximately 4.4% of the total volume spilled and the smallest 95% of the spills accounted for only 7.4% of the spilled volume. The corresponding percentages for product spills were 17.6% and 26.6%, respectively.

- Another perspective on ANS spill volumes is evident from the *cumulative distribution function* (CDF). Figure 4 shows the CDF for ANS spills (crude and product) over the period from 1985 to 2006. The CDF plots the fraction of spills with a volume less than or equal to a specified amount x (on the y-axis) against the value of x (on the x-axis); crude oil spills are shown in red, product spills in blue. Because of the large variability in spill volumes, only a portion of the CDF is plotted in Fig. 4;

that for spills less than or equal to 5 bbls. This diagram clearly shows that most spills are relatively small. For ANS spills, 87.3% of crude oil spills and 94.7% of product spills are less than 2 bbls. A few specific spills are discussed below, but small spills are quite diverse (fueling vehicles, leaking drums, and splashes).

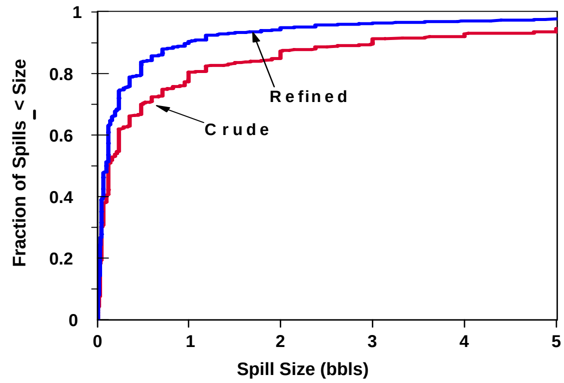

Fig. 4. Cumulative distribution function for ANS E&P spills less than 5 bbls (1985-2006).

Small spills are inherently of less concern than larger spills for the following reasons (TAPS Owners, 2001; McKendrick 2000 and references therein; NRC, 2003; BLM, 1998, 2005):

- Small spills are more likely to be contained on site,
- Small spills are also more likely to be fully recovered,
- Small spills have a lower potential to produce significant adverse environmental impacts, and
- Small spills collectively account for only a small proportion of the total volume spilled.

The above findings argue for an analytic focus on the *volume spilled*, rather than the *number of spills* and a corresponding emphasis upon the causes, effects, and consequences of larger spills.[16] Most EISs distinguish between small and large spills and, indeed, use separate methodologies for projection of future spills of each type.

In what follows, we first address large crude oil spills and develop methods for projection of future large spills associated with the Liberty Development Project. Next we develop projections for small crude oil and product spills for this project.

"Large" spill definition and projections

MMS and its contractors have developed useful methods for predicting "large spills" (Smith *et al.*, 1982; LaBelle and Anderson, 1985; Anderson and LaBelle, 1990, 1994; Amstutz and Samuels, 1984; MMS, 1987, 1990a,b, 1996, 1998, 2002; Eschenbach and Harper, 2006). (Historically, MMS has typically used 1,000 bbls as the threshold for a large OCS spill. We modify this definition below.)

[16] This is not meant to imply that North Slope operators disregard small spills. Many small spills (e.g., vehicle leaks) are easily prevented (e.g., periodic maintenance) or contained (e.g., use of drip pans) by simple devices and/or changes in operating procedures. Such measures (including simple housekeeping) are readily implemented and cost-effective. Each of the North Slope operators has developed *standard operating procedures* (SOPs) that are designed to combat both large and small spills.

This method examines the frequency of large crude oil spills in comparison to the volume of oil produced by calculating a spill rate expressed as the number of large spills per billion bbls produced.[17] Large spills are assumed to occur as a Poisson process and the Poisson distribution is used to estimate the future number of large spills for the forecast throughput over the planning horizon.[18] That is, if μ is the expected number of spills associated with a particular production volume, then the probability[19] of x = 0, 1, 2, 3,….k future spills is given by,

$$P\{x = k\} = \exp(-\mu)\,(\mu)^k/k!. \qquad (1)$$

Defining j as the observed number of large crude oil spills in the past associated with the production of y billion bbls (Bbbls), the observed (historical) large crude oil spill rate for pooled ANS facilities is calculated from the ratio j/y. If an additional z Bbbls are to be produced over some future time horizon, then the expected number of large spills over this horizon is calculated as $\mu = z\,(j/y)$.[20] The MMS methodology has been challenged by some,[21] but more recent analyses (e.g., Eschenbach and Harper, 2006) indicate that this basic model is appropriate[22]. For estimation of spill rates we use only data from ANS operations. We make no assumption that spill rates from other areas, such as the *Gulf of Mexico* (GOM), apply to the ANS.[23]

In principle, the threshold for definition of a large spill is (to a large extent) arbitrary, but prior analyses (chiefly those of spills in the GOM) have typically chosen a threshold of 1,000 bbls. However, in preparing the spill projections for the Liberty field (MMS, 2002), MMS used a lower large spill threshold of 500 bbls (MMS, 2002). There were both policy[24] and practical reasons for this choice; when this analysis was originally

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[17] Other exposure measures have been proposed and analyzed, such as time, pipeline km for pipeline spills, and platform years for oil platforms. Eschenbach and Harper (2006) show that these candidate exposure measures are generally correlated. In this analysis, we use production as the exposure metric. This is easy to understand, consistent with many earlier analyses, and does not require that pipeline and platform spills be disaggregated.

[18] Because of the limited number of large spills that have occurred it is not possible to distinguish between pad (platform) and pipeline spills. Instead, large spills are pooled for all *facilities*.

[19] The probability calculated using this question is expressed as a fraction, not in percentage terms.

[20] MMS has now developed a different model to describe offshore facilities that accounts for possible additional failure modes and mechanisms for undersea pipelines. As Liberty is properly viewed as an onshore development use of this new methodology was not considered necessary.

[21] For example, the *North Slope Borough Science Advisory Committee* (NSBSAC) made several trenchant comments on this methodology—or at least how this methodology was applied in recent EISs (NSBSAC, 2003). We believe that we have addressed their concerns in this analysis.

[22] Eschenbach and Harper (2006), in a study funded by MMS, have shown that the Poisson model provides an adequate representation. Specifically, they concluded:

> "The Poisson distribution for pipeline and platform spill rates is satisfactory. Other distributions could be chosen, but the Poisson
> 1. Fits with historical practice
> 2. Has a theoretical foundation – it is not just an empirical curve fit
> 3. Is "not rejected" at reasonable levels of statistical confidence
> 4. Even though the fit of any distribution may be imperfect, the key question when estimating rates, is 'how much do these imperfections change the estimated rate? Generally, the answer is very little.'"

[23] This was one of the concerns of the NSBSAC (NSBSAC, 2003) in reviewing MMS methodology—the possible lack of similarity between ANS and GOM operations.

[24] MMS typically uses a large spill volume of greater than or equal to 500 bbl for Alaska North Slope EIS documents.

undertaken, no spills greater than 1,000 bbls had ever occurred on the North Slope. More recently (Eschenbach and Harper, 2006) MMS has examined various thresholds for the definition of an OCS large spill as low as 50 bbls.

As noted above, the threshold for definition of a large spill is (to a large extent) arbitrary. Nonetheless, there are some practical reasons for choosing one threshold compared to another:

- The volume threshold must be sufficiently high to include a reasonable number of "large" spills in the data set for analysis. As described above, upper and lower confidence limits are calculated based on the available data—the width of the confidence interval depends upon the number of data points included. If there are only a few data points included, then the results will not be precise. This criterion argues for relatively lower volume threshold to increase the available sample size.

- It is possible that the statistical characteristics of "large" spills differ from that for "small" spills. If the threshold for a large spill is set too low, then the population of "large" spills would also include an appreciable proportion of small spills, which might bias the analysis. This possibility argues for a higher volume threshold.

In the end, it is a matter of judgment as to the appropriate threshold. In this analysis we have chosen 200 bbls as a practical compromise. Reference to Table 1 shows that using a threshold of ≥ 200 bbls implies that a total of nine large spills occurred over the period from 1985 to 2006.[25]

Probability calculations for future large spills from the Liberty Development Project

This section provides probability calculations for number of large crude oil spills associated with the development and production of the Liberty Development Project. For the *base case* we use a threshold of 200 bbls for the definition of a large spill. Over the period from 1985 through the end of 2006 nine large spills occurred, accounting for approximately 72% of the total volume of crude oil spilled. A total of 10.976 billion barrels (Bbbls) of crude oil was produced over this period.

The estimated mean spill rate μ (given these assumptions) is 9 spills/10.976 Bbbls = 0.82 large spills/Bbbls produced. This and other calculations are shown in Table 3.

-Estimate of future large spills from the Liberty Development Project

As noted above, the estimated total production from the Liberty Development Project is 105 million bbls (0.105 Bbbls). Thus the estimate of the expected number of large crude oil spills associated with this production volume (assuming that spill rates in the future are the same as those observed historically) is 0.82 large spills/Bbbls x 0.105 Bbbls = 0.086 large spills (see Table 3). Using this spill rate and the Poisson model (equation [1]) it is possible to estimate the probability of 0, 1, 2, 3…large spills

[25] If the threshold were set at 100 bbls, 17 large spills would have occurred. If the threshold were set at 500 bbls, then six large spills would have occurred.

associated with the development of the Liberty Project. As shown in Table 3[26], the best estimate of the probability of 0 large spills is approximately 0.9175 (nearly 92%), of exactly 1 large spill is 0.0789 (nearly 8%), of exactly 2 large spills is 0.0034 (0.3%) etc. The probability of 1 or more large spills from this facility is 1 – P(0) = 1 – 0.9175 = 0.0824 (approximately 8%).

Table 3. Calculation of large spill probabilities and confidence intervals for Liberty field.

Inputs:

Quantity	*Units*	*Value*	*Source/remarks*
Confidence level, p	NA	0.05	Conventional statistical assumption
Large spill threshold	Bbls	200	Assumption
# large spills in baseline period	NA	9	ANS data from 1985 through 2006 for all facilities
Throughput in baseline period	Bbbls	10.976	ANS data from 1985 through 2006
Large spill rate	spills/Bbbls	0.8200	ANS estimate of mean large spill rate
Exact LCL on spill rate	spills/Bbbls	0.3749	Computed exact lower confidence limit
Exact UCL on spill rate	spills/Bbbls	1.5566	Computed exact upper confidence limit
Throughput for Liberty Project	Bbbls	0.105	Estimated future production of Liberty field from Liberty Project description December 2006 (BPXA, 2006)

Future estimates:

	Lower confidence limit			*Best estimate*			*Upper confidence limit*		
Expected number of large spills over life of Liberty field	0.0394			0.0861			0.1634		
Number of large spills,	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***
x	**x**	**<= x**	**x| x>=1**	**x**	**<= x**	**x| x>=1**	**X**	**<= x**	**x| x>=1**
0	0.96139589	0.96139589		0.91750529	0.91750529		0.84921846	0.84921846	
1	0.0378492	0.99924508	0.98044466	0.0789944	0.99649968	0.95756918	0.13879525	0.98801372	0.92050563
2	0.00074504	0.99999013	0.01929956	0.00340059	0.99990027	0.04122189	0.01134227	0.99935598	0.07522317
3	0.00000978	0.9999999	0.00025327	0.00009759	0.99999786	0.00118303	0.00061792	0.9999739	0.00409813
4	0.0000001	1	0.00000249	0.0000021	0.99999996	0.00002546	0.00002525	0.99999915	0.00016745
5	7.58E-10	1	0.00000002	0.00000004	1	0.00000044	0.00000083	0.99999998	0.00000547
6	4.97E-12	1	1.29E-10	5.19E-10	1	6.29E-09	0.00000002	1	0.00000015
7	2.80E-14	1	7.24E-13	6.38E-12	1	7.74E-11	5.25E-10	1	0.00000003
8	1.38E-16	1	3.56E-15	6.87E-14	1	8.33E-13	1.07E-11	1	7.11E-11

Number of large spills, x	***Probability x or more large spills***	***Odds 1: y***	***Probability x or more large spills***	***Odds 1: y***	***Probability x or more large spills***	***Odds 1: y***
1	0.03860411	24.9	0.08249471	11.1	0.15078154	5.6
2	0.00075492	1,323.60	0.00350032	284.7	0.01198628	82.4
3	0.00000987	101,273.20	0.00009973	10,026.00	0.00064402	1,551.80
4	0.0000001	10,310,096.50	0.00000214	467,874.60	0.0000261	38,318.40

[26] Several decimal places are shown in these calculations to assist the reader interested in replicating these calculations, not because of any assumed accuracy. These estimates have been rounded in summary statements. Probabilities shown in this and other tables are expressed as fractions; multiply by 100 to convert these to percentage terms. Note also that this calculation applies only to large spills. Many small spills (addressed later in this appendix) are likely to occur.

In plain language, if the frequency of future large (≥ 200 bbls) crude oil spills is similar to those observed historically, then the following statements can be made with respect to large spills associated with the development of the Liberty Project:

- The estimated number of large crude oil spills is approximately 0.09,[27]
- The probability that there would be no large crude oil spill (expressed in percentage terms) is approximately 92%, and
- The odds against one or more large spills are approximately 11:1. The odds against two or more large spills occurring are nearly 285:1.

Formulas to calculate a (1 – p)% confidence interval on this rate are given in various sources (see e.g., Eschenbach and Harper (2006) and references contained therein).[28] If μ_L and μ_U denote the lower and upper confidence limits on μ based on a total of x spills, these are given by the following formulas:

$$\mu_L = 0.5\,\chi^2\,(2x,\ p/2)/\ \text{exposure variable} \quad (2)$$

$$\mu_U = 0.5\,\chi^2\,(2(x+1),\ 1-\ p/2)/\ \text{exposure variable} \quad (3)$$

where χ^2 is the value of the Chi-square distribution. In this example, the 0.025 and 0.975 confidence limits on the mean rate calculated from equations (2) and (3) are approximately 0.37 and 1.56 large crude oil spills/Bbbls, respectively (as shown in Table 3). And, therefore, the 95% confidence interval on the estimated number of large crude oil spills associated with the Liberty Development ranges from 0.37 spills/Bbbls x 0.105 Bbbls = 0.039 spills to 1.56 spills/Bbbls x 0.105 Bbbls = 0.163 spills.

Associated with each of these spill rates are probabilities similar to those cited above. Thus, for example:

- We have high confidence (95%) that the chance that there would be no large crude oil spill associated with the development of the Liberty Project is between 85% and 96%.
- If a large crude oil spill should occur, then the probability that there is exactly one large spill ranges from 0.92 (92%) to 0.99+ (> 99%). That is, it is very likely that no more than one large spill would occur, even if one spill did occur.

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[27] As noted elsewhere the number of large spills must be an integer, that is 0, 1, 2, 3, etc. The estimated number of spills is calculated by multiplying the number of spills (an integer) by the probability that this many spills would occur and summing over all possibilities. The significance of a very small number (0.09 in this instance) is that it is very likely that no large spills will occur.

[28] One of the NSBSAC criticisms of earlier MMS analyses was the omission of any calculation of confidence limits on projected quantities. Confidence limits are used extensively in this analysis. Other sources for equations to calculate confidence limits on the mean of a Poisson distribution are available electronically at http://hyperphysics.phy-astr.gsu.edu/hbase/math/poifcn.html#c2, http://www.math.mcmaster.ca/peter/s743/poissonalpha.html, and http://www.hep.fsu.edu/~harry/Public/Morelia2002-1.pdf.

- The odds against one or more large spills associated with development of the Liberty Project range from 5.6:1 to 24.9:1.

As noted above, we believe that 200 bbls strikes a reasonable balance among competing objectives in setting a threshold. To illustrate the sensitivity of this assumption, Tables 4 and 5 show replicate computations if the large-spill threshold were set at 500 bbls (65% of total spilled) or 100 bbls (82.3% of total spilled).

Table 4. Calculation of large spill probabilities and confidence intervals for Liberty field assuming a large spill threshold of 500 bbls.

Inputs:

Quantity	*Units*	*Value*	*Source/remarks*
Confidence level, p	NA	0.05	Conventional statistical assumption
Large spill threshold	Bbls	500	Assumption
# large spills in baseline period	NA	6	ANS data from 1985 through 2006 for all facilities
Throughput in baseline period	Bbbls	10.976	ANS data from 1985 through 2006
Large spill rate	spills/Bbbls	0.5466	ANS estimate of mean large spill rate
Exact LCL on spill rate	spills/Bbbls	0.2006	Computed exact lower confidence limit
Exact UCL on spill rate	spills/Bbbls	1.1898	Computed exact upper confidence limit
Throughput for Liberty Project	Bbbls	0.105	Estimated future production of Liberty field from Liberty Project description December 2006 (BPXA, 2006)

Future estimates:

	Lower confidence limit			*Best estimate*			*Upper confidence limit*		
Expected number of large spills over life of Liberty field	0.0211			0.0574			0.1249		
Number of large spills,	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***	***Probability***
x	**x**	**<= x**	**x| x>=1**	**x**	**<= x**	**x| x>=1**	**X**	**<= x**	**x| x>=1**
0	0.979156	0.97915626		0.944218	0.94421823		0.882558	0.88255763	
1	0.020625	0.99978124	0.989505	0.054196	0.99841443	0.971576	0.110259	0.9928166	0.938835
2	0.000217	0.99999847	0.010421	0.001555	0.99996981	0.027883	0.006887	0.999704	0.058645
3	1.53E-06	0.99999999	7.32E-05	2.98E-05	0.99999957	0.000533	0.000287	0.99999081	0.002442
4	1E-08	1	3.9E-07	4.3E-07	1	7.66E-06	8.96E-06	0.99999977	7.63E-05
5	3.38E-11	1	1.62E-09	0	1	9E-08	2.2E-07	1	1.91E-06
6	1.19E-13	1	5.70E-12	4.69E-11	1	8.41E-10	0	1	4E-08
7	3.57E-16	1	1.71E-14	3.85E-13	1	6.89E-12	8.32E-11	1	7.08E-10
8	9.41E-19	1	4.52E-17	2.76E-15	1	4.95E-14	1.30E-12	1	1.11E-11

Number of large spills, x	***Probability x or more large spills***	***Odds 1: y***	***Probability x or more large spills***	***Odds 1: y***	***Probability x or more large spills***	***Odds 1: y***
1	0.020844	47	0.055782	16.9	0.117442	7.5
2	0.000219	4,570.30	0.001586	629.7	0.007183	138.2
3	1.53E-06	652,203.30	3.02E-05	33,122.10	0.000296	3,377.30
4	1E-08	123,982,510.20	4.3E-07	2,314,985.10	9.19E-06	108,852.50

Table 5. Calculation of large spill probabilities and confidence intervals for Liberty field assuming a large spill threshold of 100 bbls.

Inputs:

Quantity	*Units*	*Value*	*Source/remarks*
Confidence level, p	NA	0.05	Conventional statistical assumption
Large spill threshold	Bbls	100	Assumption
# large spills in baseline period	NA	17	ANS data from 1985 through 2006 for all facilities
Throughput in baseline period	Bbbls	10.976	ANS data from 1985 through 2006
Large spill rate	spills/Bbbls	1.5488	ANS estimate of mean large spill rate
Exact LCL on spill rate	spills/Bbbls	0.9023	Computed exact lower confidence limit
Exact UCL on spill rate	spills/Bbbls	2.4798	Computed exact upper confidence limit
Throughput for Liberty Project	Bbbls	0.105	Estimated future production of Liberty field from Liberty Project description December 2006 (BPXA, 2006)

Future estimates:

	Lower confidence limit			*Best estimate*			*Upper confidence limit*		
Expected number of large spills over life of Liberty field	0.0947			0.1626			0.2604		
Number of large spills, **x**	***Probability*** **x**	***Probability*** **<= x**	***Probability*** **x| x>=1**	***Probability*** **x**	***Probability*** **<= x**	***Probability*** **x| x>=1**	***Probability*** **X**	***Probability*** **<= x**	***Probability*** **x| x>=1**
0	0.90961255	0.90961255		0.84990768	0.84990768		0.77075674	0.77075674	
1	0.08617355	0.99578609	0.95337953	0.1382184	0.98812608	0.92088923	0.20069154	0.97144828	0.87545231
2	0.00408189	0.99986799	0.04515994	0.01123906	0.99936514	0.07488098	0.02612828	0.99757656	0.11397621
3	0.0001289	0.99999689	0.0014261	0.00060926	0.9999744	0.00405924	0.00226778	0.99984434	0.00989247
4	0.00000305	0.99999994	0.00003378	0.00002477	0.99999917	0.00016504	0.00014762	0.99999197	0.00064396
5	5.78E-08	0.999999999	0.00000064	0.00000081	0.99999998	0.00000537	0.00000769	0.99999965	0.00003353
6	9.13E-10	1	0.00000001	0.00000002	0.999999999	0.00000015	0.00000033	0.99999999	0.00000146
7	1.24E-11	1	1.37E-10	5.07E-10	1	3.38E-09	1.24E-08	1	0.000000054
8	1.46E-13	1	1.62E-12	1.03E-11	1	6.87E-11	4.04E-10	1	0.000000002

Number of large spills, x	***Probability x or more large spills***	***Odds 1: y***	***Probability x or more large spills***	***Odds 1: y***	***Probability x or more large spills***	***Odds 1: y***
1	0.09038745	10.1	0.15009232	5.7	0.22924326	3.4
2	0.00421391	236.3	0.01187392	83.2	0.02855172	34
3	0.00013201	7,574.00	0.00063486	1,574.20	0.00242344	411.6
4	0.00000311	321,367.80	0.0000256	39,063.50	0.00015566	6,423.40

Empirical cumulative distribution function (CDF) of ANS large spill volumes

The above sections develop estimates (and associated 95% confidence limits) of the probability of 1, 2, 3… large crude oil spills associated with production from the Liberty Development Project. This and following sections develop an estimate of the probable *volume of a large spill* (if one occurs) and the cumulative number of large spills (if more than one occurs).

The available data for estimation of the volume of a large spill consist of the observed historical (over the period of interest) ANS large spill volumes x_i (i = 1, n), in ascending order so that $x_1 \le x_2 \le x_3 \ldots \le x_n$. If μ denotes the cutoff volume used to define a large spill, then $\mu \le x_i$ for all i, by definition. As noted above, for example, if ≥ 200 bbls is defined as the cutoff volume for definition of a large spill, based on the ANS spill data, then there are nine large spills (n = 9). As shown in Table 1, these volumes are (rounded) as follows; 225, 300, 375, 510, 650, 675, 715, 925, and 4,786 bbls.[29]

The CDF is a plot of the fraction (or percentage) of the observed large spill volumes less than or equal to a specific volume x, denoted F(x), versus the spill volume x. Because the observed number of large spills is finite, the CDF can be directly[30] estimated only at each of the individual data points, $F(x_i)$. The conventional estimator of $F(x_r) = r/n$, where x_r is the volume corresponding to the r^{th} data point in the ordered list.[31] Thus, for example, F(225) = 1/9, F(300) = 2/9 etc.

Other estimators of $F(x_r)$ suggested in the literature include; (r – 0.3)/(n + 0.4), Gross (1996);[32] (r - ½)/n, Guttman *et al.*, (1982) or Gilbert (1987); (3r – 1)/(3n + 1), Koch and Link, (1971); and r/(n + 1), Mosteller and Rourke (1973) or Uusitalo (2004).[33] When n is large, these different estimators do not differ materially, but when n is small (as it is in this case) the differences are more appreciable. Unless otherwise noted, we use the convention $F(x_r) = (r – 1/2)/n$. Given this plotting convention, Fig. 5 shows the empirical CDF of large ANS spills (assuming γ = 200 bbls). As can be seen, the empirical CDF

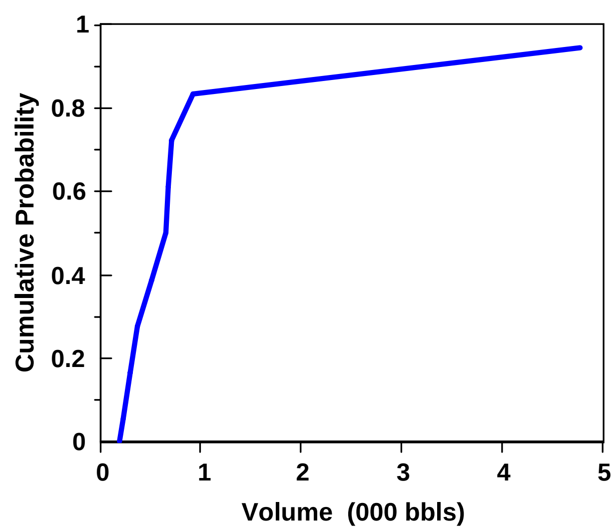

Fig. 5. Empirical CDF of ANS large (≥ 200 bbls) spills 1985-2006.

[29] As noted above, the largest spill volume is given as 4,786 bbls, which is the calculated estimate of the spill volume for the spill detected on 2 March 2006. The source of the spill was an above-ground 34 inch diameter crude oil transit line between Gathering Center 2 (GC-2) and GC 1, Western Operating Unit, Prudhoe Bay. ADEC lists this volume in their database as 6,357 bbls, the upper confidence limit of a range of approximately +/- 33%. Additional studies are underway to estimate this spill volume. Lacking more precise estimate of this spill volume, we use the calculated estimate of 4,786 bbls in this analysis.

[30] Other percentiles of the CDF can also be estimated by fitting distributions (see e.g., Gilbert, 1987).

[31] See, e.g., the probability-probability plots entry within an online glossary of statistical terms at http://sunsite.univie.ac.at/textbooks/statistics/glosp.html.

[32] This was suggested specifically for the three-parameter Weibull, see Gross, B., (1996). Least Squares Best Fit Method for the Three Parameter Weibull Distribution: Analysis of Tensile and Bend Specimens With Volume or Surface Flaw Failure, NASA Technical Memorandum 4721, NASA Lewis Research Center, Cleveland, OH, available electronically at http://gltrs.grc.nasa.gov/reports/1996/TM-4721.pdf.

[33] See, Uusitalo, K., (2004). The empirical cumulative distribution function, its inaccuracy and probability plotting, Helsinki, Finland, available electronically at http://www.helsinki.fi/ ~kuusital/doc/ecdf-inaccuracy-and-probability-plotting.pdf.

shows that most of the large spills (if fact 8 out of 9) were less than 1,000 bbls.[34] The empirical CDF appears irregular because the number of large ANS spills over the period from 1985 to 2006 is relatively small.

There are two basic approaches for handling the large spill data in order to make an estimate of the likely volume of any future large spills associated with the Liberty Development Project; (1) fitting the empirical data to a defined statistical distribution and (2) analyzing the empirical data directly. Both approaches are explored in this analysis.

-Fitting the large spill data to a probability distribution

Prior analyses of large spill volume data by MMS and others (see, e.g., Anderson and Labelle, 1990, 1994, 2000; Eschenbach and Harper, 2006; Hart Crowser, Inc., 2000; Lanfear and Amstutz, 1983; MMS, 2002; Smith *et al.*, 1982; Stewart, 1976; Stewart and Kennedy, 1978; and TAPS Owners, 2001) suggest that these spill volumes appear to conform to, or at least can be satisfactorily described by, a statistical probability distribution. Several candidate distributions have been suggested in the literature, including the Weibull, Gamma, and lognormal models. The three-parameter Weibull distribution (favored by several authors), for example, has the following density and cumulative distribution functions:

$$f(x) = (\alpha/\beta)((x-\gamma)/\beta)^{(\alpha-1)} \exp(-((x-\gamma)/\beta)^{\alpha}) \quad (4)$$
$$F(x) = 1 - \exp(-((x-\gamma)/\beta)^{\alpha}) \quad (5)$$

where:

α = continuous *shape* parameter ($\alpha > 0$)
β = continuous *scale* parameter ($\beta > 0$), and
γ = continuous *location* parameter (γ = minimum spill volume).

The three-parameter Weibull distribution has found wide applicability for such diverse applications as modeling spill volumes, environmental pollution, reliability theory, weather forecasting, and the breaking strengths of materials. Apart from any theoretical justification, this model is quite flexible and capable of mimicking many other continuous distributions.[35]

The parameters of the Weibull distribution (α, β, and γ[36]) can be fitted using several statistical approaches, including (1) matching the observed CDF with the empirical CDF, (2) maximum likelihood, and (3) the method of moments. By matching CDFs (squared error criterion, using (r – ½)/n as the basis for the empirical CDF) we developed the following best-fit estimates; γ = 200 bbls (definition) α = 1.213 and β =

[34] Using Table A-22 in Natrella (1963) the 95% confidence bounds on the proportion of samples that would be expected to be less than 1,000 bbls range from 0.557 to 0.994. Thus, there is high confidence that the median spill volume is less than 1,000 bbls for this data set.

[35] See e.g., Eschenbach and Harper, (2006); Gilbert, (1987); and Johnson and Kotz, (1970). Some readily available electronic references include: http://en.wikipedia.org/wiki/ Weibull_distribution and http://www.itl.nist.gov/div898/handbook/ apr/section1/apr162.htm.

[36] In this case it is not necessary to fit γ as this is specified in the definition of the large spill threshold.

493.54.[37] Figure 6 shows the best-fit three-parameter Weibull CDF (the solid line) and the empirical CDF (the points) using the above parameter estimates. The fit appears quite good. Another way of examining the quality of the fit is to show a P – P diagram; this diagram (shown in Fig. 7) plots the fitted CDF versus the empirical CDF. As illustrated in Fig. 6, this plot shows that the quality of the fit is quite good.

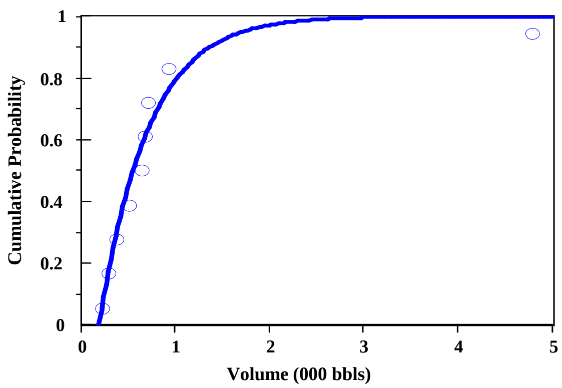

Fig. 6. A comparison between the observed (plotted points) and best-fit three-parameter Weibull distribution to ANS large (≥ 200 bbls) spill data.

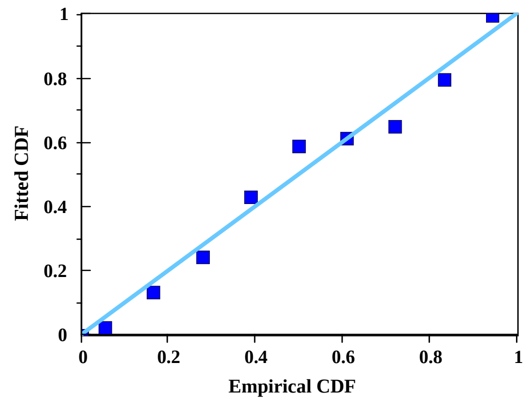

Fig. 7. A "P-P" plot showing the comparison between observed and fitted ANS large (≥ 200 bbls) spill CDFs.

The choice of fitting technique affects the resulting parameter estimates. For example, the best-fit parameter values determined using a commercially available computer program are; γ = 200 bbls (definition) α = 0.84 and β = 426.88,[38] which has a very similar CDF to that estimated by matching CDFs. Figure 8 shows a comparison of the fits made by matching the CDFs (the blue line) and maximum likelihood (the green line). Table 6 shows the Kolmogorov-Smirnov and Anderson-Darling statistical tests on this fit. These tests indicate that the three parameter Weibull distribution provides an adequate fit to the observed data.

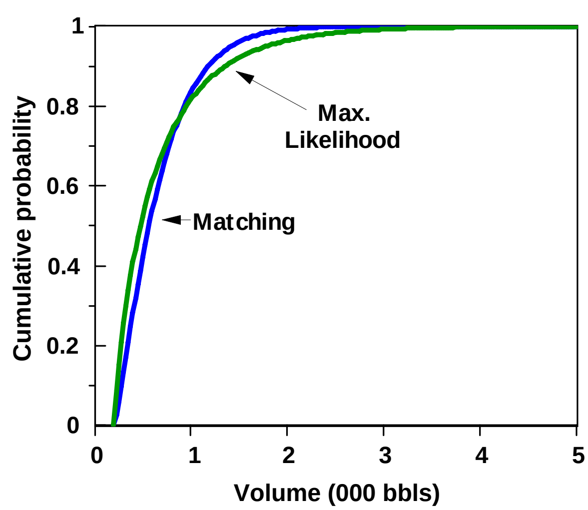

Fig. 8. Best-fit three-parameter Weibull distributions using two fitting criteria.

[37] These estimates were derived using as a criterion function the sum of squared differences between the empirical CDF values (nine points) and the predicted CDFs. The criterion function was minimized using the *Solver*™ routine in the spreadsheet program *Excel*™.

[38] Fitted using EasyFit™ software from Mathwave Technologies, see http://www.mathwave.com/products/easyfit.html.

Table 6. Statistical tests of adequacy of fit for the three-parameter Weibull model.

Goodness of Fit – Details
Three-parameter Weibull

Kolmogorov-Smirnov					
Sample Size	9				
Statistic	0.09934				
P	0.2	0.15	0.1	0.05	0.01
Critical Value	0.339	0.36	0.388	0.432	0.514
Reject?	No	No	No	No	No

Anderson-Darling					
Sample Size	9				
Statistic	0.7809				
P	0.2	0.15	0.1	0.05	0.01
Critical Value	1.3749	1.6024	1.9286	2.5018	3.9074
Reject?	No	No	No	No	No

Direct maximization of the likelihood function in *Excel*™ using the *Solver*™ subroutine results in slightly different parameter estimates; γ = 200 bbls (definition) α = 0.744467 and β = 654.8.

Once an adequate statistical representation is found, the best-fit model can be used to estimate the mean or any percentile of the spill volume distribution, given that a large spill occurs.[39] For the three-parameter Weibull distribution, the equations for the mean and $1 - p^{th}$. percentile volumes of the large spill size distribution are:

$$\text{Mean} = \gamma + \beta\, \Gamma(1 + 1/\beta) \tag{6}$$

$$x_{(1-p)} = \gamma + \beta\, [- \ln(p)]^{(1/\alpha)} \tag{7}$$

where

Γ = Incomplete gamma function and

$x_{(1-p)}$ = The volume of the $(1-p^{th})$ percentile of this distribution (bbls).

Thus, for example, if the CDF is approximated by (r – ½)/n, and the "matching CDFs" fitting criterion is used, the best-fit parameters are γ = 200 bbls (definition) α = 1.213 and β = 493.54. Using equations (3) and (4) the estimated median (p = 0.5), mean, and 95% percentile (p = 0.05) of the large crude oil spill volume distribution are approximately 565 bbls, 663 bbls and 1,419 bbls, respectively.

[39] This provides a conceptual advantage over the use of the data directly for small sample sizes where estimation of extreme quantiles may be difficult, as it is in this case.

As shown in Table 7, these estimates are a function of the fitting technique and the convention used to estimate the CDF. This said, the estimates do not differ by much for the median and mean values. Depending upon the conventions used, the estimated median large spill volumes range from approximately 480 to 600 bbls and the estimated mean large spill volumes range from approximately 620 – 984 bbls. The differences are larger for the estimated 95% upper confidence limit on size; these range by a factor of approximately two from 1,400 to 3,060 bbls. The reason for the greater discrepancy of the 95% percentile values is the differential "leverage" of the largest spill in the data on the parameter estimation techniques.

Table 7. Summary of results for fitting a three-parameter Weibull distribution to the ANS large spill data (≥ 200 bbls threshold).

Fit criterion	***Matching CDFs Empirical CDF estimated as:***				***Maximum likelihood***	***EasyFit™***
Quantity	r/n	(r - 1/2)/n	(3r-1)/(n+1)	r/(n+1)	N/A	N/A
Parameters:						
γ	200	200	200	200	200	200
β	429.39	493.58	499.56	513.20	654.81	426.88
α	1.0698	1.2135	1.1400	1.0105	0.7445	0.8378
Spill sizes (bbls):						
Median	505	565	562	557	600	476
Mean	618	663	677	711	984	669
95% percentile	1,397	1,419	1,508	1,720	3,058	1,782

The estimates shown in Table 7 all assume that the three-parameter Weibull model provides an adequate fit to the data—as, indeed, it does (see Table 6). Fitting the data to a different model would produce slightly different estimates. However, these differences are relatively small. For example, fitting a three-parameter lognormal model to the data results in median and mean large spill volumes of approximately 530 and 1,029 bbls, respectively. Both the Gamma and generalized extreme value (see e.g., Castillo *et al.*, 2005 or Evans *et al.*, *2000*) models estimate comparable median and mean spill sizes. Thus, use of a variety of plausible statistical distributions (which have generally comparable fits) leads to similar estimates for typical spill volumes.

-Using the raw data directly (nonparametric methods)

The second approach for estimating a typical size of a large spill is to use the raw data without assuming a particular model for fitting this distribution. The median large spill volume from these data is 650 bbls. (The median value is that value which divides the data in half, i.e., 50% of the values is greater than the median and 50% of the values are less than the median.) The arithmetic mean large crude oil spill volume is 1,018 bbls. (The median of a data set is often preferred to the mean as a measure of central tendency if outliers might be present in the data.)

Summary: likely large crude oil spill volume

Use of the data directly or fitting a three-parameter Weibull model to the large spill volume data produce estimates of the mean spill volume that are equal to or less than 1,000 bbls. This figure is used as an average or expected large spill volume—or point of departure—for estimation of possible environmental impacts of future large crude oil spills.

Future cumulative spill volumes

As noted above, 1,000 bbls is taken as a nominal large spill volume, given that one large spill occurs. Use of the Poisson model based on the actual number of large spills that have occurred over the period from 1985 to 2006 indicates it is highly likely that number of large spills associated with development of the Liberty Project would be zero, but it is also possible (though highly unlikely) that 1, 2, 3 or more large spills would occur. This section estimates the expected total large spill volume.

Table 8 (see also Table 3) shows these calculations for the most likely large spill rate (0.82 spills per Bbbls) assuming that a large spill is at least 200 bbls and an average large spill has a volume of 1,000 bbls. Two sets of calculations are made; (1) based on the estimated probabilities that 0, 1, 2, 3, large spills would occur throughout the life of the Liberty Project and (2) based on the assumption that at least one large spill occurs. The total expected spill volumes corresponding to these two cases are approximately 86 and 1,043 bbls, respectively.

If the nominal volume of a large crude oil spill is 1,000 bbls, why is it that the expected large crude oil spill volume is only 86 bbls? The answer is that there is a very high probability (approximately 92%, see Tables 3 or 8) that there would be no large crude oil spills over the lifetime of the Liberty Project. The 86-bbls figure weighs each of the possible spill volumes; zero if there are no large spills, 1,000 bbls if there is exactly 1 large spill; 2,000 bbls if there is exactly 2 large spills, etc, by the estimated probability of 0, 1, 2, … spills.

The second calculation shown in Table 8 estimates the average total large spill volume *given that at least one large spill occurs* (itself an unlikely event). This quantity is 1,043 bbls. Why 1,043 bbls when the possibilities are 1,000 bbls, 2,000 bbls, etc? The result, 1,043 bbls, weights these values by the probabilities of 1, 2, 3, 4, …spills given that at least one occurs. In this instance, the total volume is slightly larger than the volume of 1 large spill because, even assuming that at least one spill has occurred, it is unlikely that 2 or more have occurred. *Thus, our best estimate of the total large crude oil spill volume is low—86 bbls because it is unlikely that any large spills would occur. However, if at least one large crude oil spill occurs, then the expected large spill volume would be approximately 1,043 bbls—only marginally higher than the nominal large spill volume because the estimated probability of 2 or more large spills is so small.*

Table 8. Calculation of aggregate large spill volume for Liberty field.

Inputs:

Quantity	*Units*	*Value*	*Source/remarks*
Confidence level, p	NA	0.05	Conventional statistical assumption
Large spill threshold	bbls	200	Assumption
# large spills in baseline period	NA	9	ANS data from 1985 through 2006 for all facilities
Throughput in baseline period	Bbbls	10.976	ANS data from 1985 through 2006
Large spill rate	spills/Bbbls	0.8200	ANS estimate of mean large spill rate
Exact LCL on spill rate	spills/Bbbls	0.3749	Computed exact lower confidence limit
Exact UCL on spill rate	spills/Bbbls	1.5566	Computed exact upper confidence limit
Throughput for Liberty Project	Bbbls	0.105	Estimated future production of Liberty field from Liberty Project description December 2006 (BPXA, 2006)

Future estimates:

	Best estimate
Expected number of large spills over life of Liberty field	0.0861
Expected volume of large spill (bbls)	1,000.00

Number of large spills,	***Probability***	***Extension***	***Probability***	***Extension***
X	**x**		**x| x>=1**	
0	0.91750529	0.0000		
1	0.07899440	78.9944	0.95756918	957.5692
2	0.00340059	6.8012	0.04122189	82.4438
3	0.00009759	0.2928	0.00118303	3.5491
4	0.00000210	0.0084	0.00002546	0.1019
5	0.00000004	0.0002	0.00000044	0.0022
6	5.19E-010	0.0000	6.292E-009	0.0000
7	6.384E-012	0.0000	7.739E-011	0.0000
8	6.871E-014	0.0000	8.3283E-013	0.0000
Expected total spill volume		86.10		1,043.67

-Confidence intervals

The above estimates are based on expected values, including the expected number of large crude oil spills and the expected volume of a large crude oil spill or total volume given that a spill occurs. It is useful to estimate lower and upper confidence limits for these quantities. To do this we conservatively assume that the large spill distribution matches the empirical large spill distribution—that is, it includes the 4,786 bbls spill discovered in March 2006. Accordingly, Table 9 shows the results of 50,000 Monte Carlo simulations calculating the total large crude oil spill volume over the lifetime of the Liberty Project. Two cases are included (1) using the expected large spill rate and (2) using a 95% upper confidence limit on this rate. The mean total spill volumes are quite close to those calculated above. However, the upper 95% confidence limit (95th percentile) total spill volume is 4,786 bbls.

Table 9. Results of large crude oil spill simulations.

	Expected spill rate		
Quantity	*Best estimate*	*Upper 95% confidence limit*	*Units*
Number of trials	50,000	50,000	trials
Average total spill volume	1,055	1,108	bbls
Minimum total spill volume	225	225	bbls
Median total spill volume	650	650	bbls
75th percentile spill volume	925	945	bbls
95th percentile spill volume	4,786	4,786	bbls

Large crude oil spill estimates in this analysis compared to FEIS estimates

The Liberty Final EIS (USDOI, MMS, 2002) offered the following comments on the chance of a large oil spill occurring:

> "The analysis of historical oil-spill rates and failure rates and their application to the Liberty Project provides insights, but not definitive answers, about whether oil may be spilled from a site-specific project. Engineering risk abatement and careful professional judgment are key factors in confirming whether a project would be safe.
>
> We conclude that the designs for the Liberty Project would produce minimal chance of a significant oil spill reaching the water. If an estimate of change must be given for the offshore production island and the buried pipeline, our best professional judgment is that the chance of an oil spill greater than or equal to 500 bbls occurring from the Liberty Project and entering the offshore waters is on the order of 1% over the life of the field…
>
> We base our conclusion on the results gathered from several spill analyses done for Liberty that applied trend analysis and looked at causal factors. All showed a low likelihood of a spill, on the order of a 1 – 6% chance or less over the estimated 15 – 20 year life of the field."

While not identical, the projections made in this report are broadly consistent with the results of the final Liberty EIS; both estimates indicate that it is unlikely that a large crude oil spill would occur. As to differences:

- The original analysis defined a large spill as one 500 bbls or greater, whereas this analysis uses ≥ 200 bbls as the threshold of a large spill.[40] As shown below, the probability that no large spill would occur (assuming a 500 bbl threshold) is 94.4%--numerically closer[41] to that estimated in the final EIS. (The 95% confidence interval on the probability that no large crude oil spill would occur assuming a 500 bbl threshold is from 88.3% to 97.9%. This confidence interval overlaps the 94% - 99% range specified in the final Liberty EIS.)

[40] This choice of 200 bbls as the threshold was made on statistical grounds.
[41] This estimate is within the range of plausible estimates given in the final EIS.

- The original spill estimates were based on the definition of a large crude oil spill from the offshore production island and buried pipeline reaching the water. This analysis addresses the occurrence of a large crude oil anywhere in the facility and makes no assumption regarding whether or not the spill reaches the water.

- The estimate developed in this document is based solely on the assumed production volume of Liberty and actual spill statistics from ANS operations updated through 2006. That presented in the final EIS used data from several sources and ultimately was based on engineering judgment.

Small spills

As noted above, spills have been divided into large and small spills. For crude oil, the base case large spill threshold was assumed to be ≥ 200 bbls. What can be said of the small spills?

-Small crude oil spills

Experience at ANS and elsewhere shows that typically there are many more small crude oil spills than large spills. Using ANS data, for example, over the period from 1985 to 2006, a total of 1,662 small (< 200 bbls) crude oil spills were reported—compared to only nine large spills. Thus, small spills accounted for 99.46% of the total *number* of spills. However, the average spill size of small spills is very much smaller than that of large spills. For the same period, the average volume of a small spill was approximately 2.14 bbls. (The median small crude oil spill volume, approximately 0.12 bbls, is even smaller.) Figure 9 shows the empirical CDF (x-axis plotted as the natural logarithm of the spill volume) of all small ANS crude oil spills for the period from 1985 to 2006. The irregularities in the CDF reflect rounding of spill volumes in the reporting process.

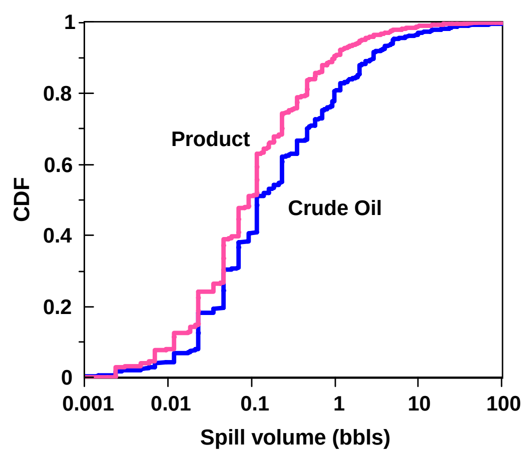

Fig. 9. Empirical CDFs of 1,662 small crude oil spills and 5,456 produced spills for ANS 1985-2006. Note that x-axis shows natural logarithm of spill size.

Figure 9 also shows the empirical distribution of refined product spills (n = 5,456) that occurred over the same time period. (Product spill data are discussed below.)

In aggregate small crude oil spills accounted for slightly less than 28% of the total volume spills over the period from 1985 to 2006, even though these occurred much more frequently.

The analytical method used in this analysis (and many others, see, e.g., TAPS Owners, 2001) to estimate future small spill volumes is to calculate a *volumetric spill rate* (VSR) defined as the ratio of the aggregate small spill volume (bbls) to the ANS production (Bbbls). Next, we multiply the appropriate VSR by the estimated total production of the Liberty Development Project (0.105 Bbbls) to estimate the total small spill volume that would result from operation of Liberty. This procedure assumes that the observed VSR for Liberty will be the same as that experienced historically for the North Slope as a whole.[42] Before accepting this assumption uncritically, however, it is appropriate to see if there are any time trends in the observed small spill VSRs. If, for example, VSRs tended to decrease (increase) with time, use of an average VSR would overstate (understate) future spill volumes.

Table 10 provides relevant data and computed small ANS crude spill VSRs for the period from 1985 to 2006. Figure 10 shows a time series of the observed VSRs (solid line) and the average VSR (dashed line) of 324 bbls spilled per Bbbls production. Earlier analyses (see e.g., TAPS Owners, 2001[43]) found no statistically significant trend in these data although visually there appeared to be a slight downward trend. Linear regression of the data plotted in Fig. 10 indicates that there is a slight, but not statistically significant ($p = 0.58$), downward trend. The VSR for 2006 has a studentized residual of 2.945, which indicates that this point might be an outlier. And, indeed, if this point is deleted, the downward time trend in VSR is statistically significant ($p = 0.03$).

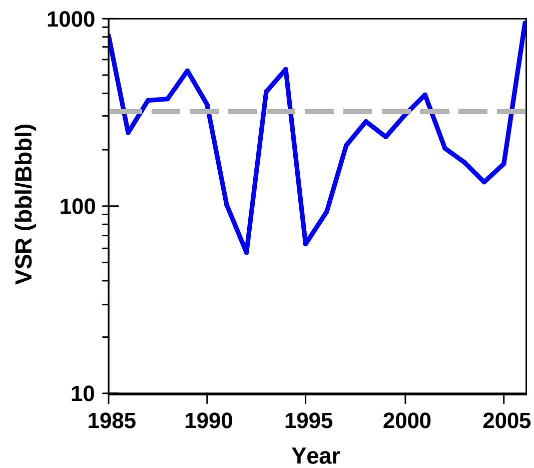

Fig. 10. Volumetric spill rates (VSRs) for ANS small crude oil spills, 1985-2006.

However, to avoid possible understatement of spill volumes, we have not made any allowance for a possible time trend in the data.

[42] It is probably appropriate to see if there is any statistically significant relation between the annual small spill volume and the production in any year. Analysis shows that there is a weak ($R^2 = .24$), but statistically significant ($p = 0.021$) relation.

[43] The estimated VSR for ANS obtained in this source was 860 bbls/Bbbls. This VSR included both large and small crude oil spills as well as product spills and applied to a different time period (1977 – 1999). If we add the estimated VSR for product spills (400 bbls/Bbbls see Table 11) a total of 724 bbls/Bbbls results. This estimate is consistent with the earlier TAPS ANS analysis, which includes the contribution of spills > 200 bbls.

Table 10. Small crude oil spill characteristics, 1985-2006.

Years since 1985	*Year*	*Production volume (Bbbls)*	*Number of spills*	*Total volume (bbls)*	**Volumetric spill rate** *(VSR) (bbls spilled / Bbbls produced)*	*Average Spill volume (bbls)*
0	1985	0.649	91	535.429	824.641	5.884
1	1986	0.664	91	164.667	248.091	1.810
2	1987	0.700	97	256.643	366.734	2.646
3	1988	0.722	129	270.702	374.702	2.098
4	1989	0.669	161	355.048	531.022	2.205
5	1990	0.636	101	223.264	350.953	2.211
6	1991	0.641	140	65.562	102.280	0.468
7	1992	0.612	70	34.800	56.852	0.497
8	1993	0.564	57	230.534	409.005	4.044
9	1994	0.553	51	298.758	539.852	5.858
10	1995	0.526	39	33.333	63.355	0.855
11	1996	0.495	52	46.260	93.375	0.890
12	1997	0.461	39	97.888	212.470	2.510
13	1998	0.417	44	118.494	284.124	2.693
14	1999	0.372	50	87.025	233.762	1.741
15	2000	0.345	94	106.802	309.926	1.136
16	2001	0.340	90	134.917	396.915	1.499
17	2002	0.348	52	70.778	203.364	1.361
18	2003	0.346	60	59.965	173.547	0.999
19	2004	0.324	62	44.210	136.350	0.713
20	2005	0.308	42	52.062	168.863	1.240
21	2006	0.284	50	271.647	957.938	5.433
Totals		**10.976**	**1,662**	**3,558.786**	**324.232**	**2.141**

Note: Production volume data taken from US Dept. of Energy, Energy Information Administration, data for crude oil production on Alaska's North Slope as presented in January, 2007. Only partial data for year 2006 was available. To calculate an annual figure, the monthly 2006 production values were averaged and added to the partial year total. Current data area available at ttp://tonto.eia.doe.gov/dnav/pet/hist/manfpak1M.htm

The estimated total volume of small crude oil spills associated with the operation of the Liberty Project is, therefore, 324 bbls/Bbbls x 0.105 Bbbls = 34 bbls in total.[44] This estimate is much smaller than the expected total large spill volume (86 bbls) or the expected volume (~1,000 bbls) given that a large spill were to occur. Taking the empirical VSRs over the period from 1985 to 2006, the approximately 95% confidence limits on the total spill volume range from approximately 6 to 100 bbls.

[44] If the average small size for Liberty matches that observed for ANS historically, then this means that there would be approximately 34/2.14 ~ 16 small crude oil spills.

-Product spills

As noted above, spills are not limited to crude oil. Refined product spills also occur—indeed, product spills have historically been more numerous than crude oil spills. Over the period from 1985 to 2006 a total of 5,456 product spills have been reported on the North Slope. Most of these are quite small—smaller on average than small crude oil spills, although as shown in Table 2 a few larger product spills have resulted.[45] Product spills sizes range from approximately 8 teaspoons (0.01 gallons) to 262 bbls (approximately 11,000 gallons) in size.

Figure 9 also shows the empirical CDF of ANS product spills. Compared even to small crude oil spills, product spills are typically smaller. For example, the median and mean product spills over the period from 1985 to 2006 were 0.095 and 0.8 bbls, respectively. 90% of product spills were less than 1 bbls. For purposes of this analysis we treat all product spills as being small spills. That is, we do not use the MMS methodology for large crude oil spills to represent data on product spills. Instead we use the volumetric spill rate method described earlier for use on small crude oil spills.

Figure 11 shows the time trend in VSR for product spills (compare to Fig. 10 for crude oil spills.) and Table 11 shows the data. There is no statistically significant time trend in the data ($p = 0.257$). As with the small crude oil spills, we use the average VSR for the entire time period, 400 bbls/Bbbls of production. *Based on this average, the estimated product spill volume for the Liberty Project is 400 (0.105) = 42 bbls. The 95% confidence interval on this estimate is [10, 125 bbls].*

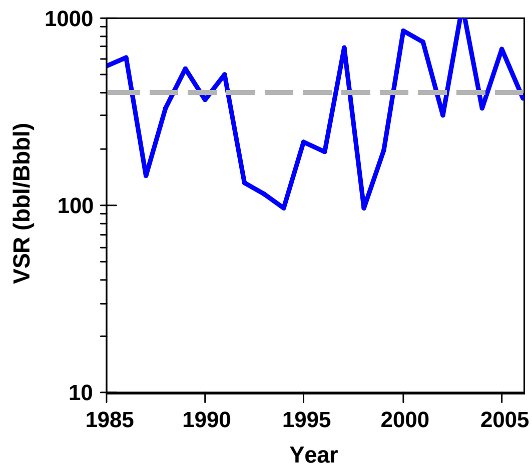

Fig. 11. Volumetric spill rates (VSRs) for ANS product spills, 1985-2006.

Summary of small spill projections

To summarize briefly, this analysis considers small spills for both crude oil and product spills associated with the development of the Liberty Project. For small crude oil spills, it is estimated that 34 bbls will be spilled (expected value) over the life of the project; the 95% confidence interval on this estimate ranges from 6 to 100 bbls. For product spills, it is estimated that 42 bbls will be spilled (expected value); the 95% confidence interval on this estimate ranges from 10 to 125 bbls.

[45] Because of the very small number of "large" refined product spills it is unrealistic to model these separately. Instead, we use the same VSR spill rate approach used for small crude oil spills.

Table 11. Small product spill characteristics, 1985-2006.

Years since 1985	*Year*	*Production volume (Bbbls)*	*Number of spills*	*Total volume (bbls)*	*Volumetric spill rate (VSR) (bbls spilled / Bbbls produced)*	*Average Spill volume (bbls)*
0	1985	0.649	168	363.167	559.331	2.162
1	1986	0.664	145	410.405	618.325	2.830
2	1987	0.700	137	102.101	145.899	0.745
3	1988	0.722	312	240.940	333.506	0.772
4	1989	0.669	408	364.638	545.365	0.894
5	1990	0.636	359	234.846	369.159	0.654
6	1991	0.641	445	324.861	506.797	0.730
7	1992	0.612	259	81.796	133.629	0.316
8	1993	0.564	209	65.213	115.699	0.312
9	1994	0.553	159	54.226	97.986	0.341
10	1995	0.526	132	115.865	220.219	0.878
11	1996	0.495	141	97.307	196.415	0.690
12	1997	0.461	123	321.655	698.164	2.615
13	1998	0.417	124	40.562	97.259	0.327
14	1999	0.372	311	74.117	199.088	0.238
15	2000	0.345	444	297.554	863.465	0.670
16	2001	0.340	505	253.905	746.969	0.503
17	2002	0.348	241	107.111	307.761	0.444
18	2003	0.346	218	410.586	1188.296	1.883
19	2004	0.324	200	107.316	330.976	0.537
20	2005	0.308	199	213.568	692.708	1.073
21	2006	0.284	217	106.087	374.107	0.489
Totals		**10.976**	**5456**	**4,387.827**	**399.764**	**0.804**

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Appendix B

Prevention Plan from Endicott and Badami Oil Discharge Prevention and Contingency Plan

2 PREVENTION PLAN [18 AAC 75.425(e)(2)]

2.1 PREVENTION, INSPECTION AND MAINTENANCE PROGRAMS [18 AAC 75.425(e)(2)(A)]

2.1.1 Prevention Training Programs [18 AAC 75.007(d)]

BP Exploration (Alaska), Inc. (BPXA) and contractor personnel are trained in company and state pollution prevention measures applicable to their duties affected by 18 Alaska Administrative Code (AAC) 75 Article 1 as required by 18 AAC 75.007(d). Trained personnel sign a training roster. BPXA's training courses are assigned a number and have course specifications e.g., objectives, material, and trainer qualifications. BPXA makes a computerized record to document the training.

BPXA and contractor oil-handling personnel receive training on the operation and maintenance of oil equipment, oil spill protocols, general facility operations, and contents of the Spill Prevention, Control, and Countermeasures (SPCC) Plan. Oil spill prevention training and oil spill prevention briefings for oil-handling personnel are held annually and meet U.S. Environmental Protection Agency SPCC training requirements in 40 CFR 112.7(f)(1) and (3).

Unescorted workers on BPXA leases receive spill prevention training through the North Slope Training Cooperative program. The one-day training seminar, mandatory for workers on the North Slope, covers the following topics:

- *North Slope Environmental Handbook*,
- *Alaska Safety Handbook*,
- Camps and Facilities Safety Orientation,
- Environmental Excellence,
- Hazard Communication (HAZCOM),
- Hazardous Waste Operations and Emergency Response (HAZWOPER) Awareness,
- Personal Protective Equipment (PPE), and
- Hydrogen Sulfide.

BPXA employees and contractor personnel working on the North Slope receive copies of the *North Slope Environmental Field Handbook* and *Alaska Safety Handbook*. The *North Slope Environmental Field Handbook* provides an overview of state and federal spill prevention regulations and programs applicable to the North Slope oil fields and summarizes procedures to comply with those regulations. In particular, the handbook explains fluid transfer procedures, drip liner usage, secondary containment and spill reporting.

The *Alaska Safety Handbook* provides standardized safety instructions for BPXA and contractor personnel. The handbook covers employee safety, including PPE, equipment safety, chemical handling, transportation safety, work permitting, and incident reporting.

Facility and response personnel are provided a mandatory site orientation that includes familiarization with facility Emergency Response Plans.

Facility personnel also receive training on the BPXA Environmental Management System Awareness & Hotline. BPXA's Environmental Management System promotes continual improvement in environmental performance. The system uses direct input from technical specialists and field personnel and information developed through routine loss control and incident investigations to minimize the potential recurrence of events. Safety and environmental communications and bulletins are regularly distributed to ensure specific safety and environmental issues are communicated. Most supervisors discuss safety and environmental communications and bulletins with their crews during daily and weekly toolbox safety meetings.

Waste management training using the *Alaska Waste Disposal and Reuse Guide*, also known as the "Red Book," is designed to familiarize North Slope personnel with the regulatory classification and disposal requirements for industrial wastes. The training covers waste classification, transportation requirements, and a description of waste disposal facilities on the North Slope. BPXA and ConocoPhillips Alaska, Inc. track waste by manifesting waste destined for a disposal facility. The course is mandatory for waste generators, transporters, and receivers.

BPXA maintains records of its employees' oil spill prevention training required by 18 AAC 75 Article 1. Records are kept for at least five years. They are provided to the Alaska Department of Environmental Conservation upon request.

The BPXA Learning and Organizational Development Group maintains a database with records of courses completed by BPXA employees. Access to the database is through the BPXA intranet. Individual training records are available through an employee's immediate supervisor or by contacting the Training Coordinators. Contractors maintain their own training records.

In summary, personnel who handle oil equipment receive training in general North Slope work procedures, spill prevention, environmental protection awareness, safety, and site-specific orientation. Personnel receive training in oil spill notification protocols, oil spill source control, and HAZWOPER safety. The *Alaska Safety Handbook* and the *North Slope Environmental Field Handbook* supplement spill prevention training.

2.1.2 Substance Abuse Programs [18 AAC 75.007(e)]

BPXA policy provides guidance for an environment free of substance abuse, related accidents, and emergencies. This environment is maintained through adherence to strict alcohol and drug abuse policies and professionally recognized rehabilitation programs. The company has jurisdiction to intervene and impose disciplinary measures when problems are identified.

The BPXA drug policy promotes the safety of employees, contractors, and non-employees, and provides a safe working environment. The company prohibits the following in the workplace or on the job:

- Possession of illicit drugs,
- Possession of controlled substances without a physician assistant's knowledge,
- Use of drug or alcoholic substances, and
- Distribution or sale of drugs or alcohol.

BPXA complies with regulations promulgated by the U.S. Department of Transportation (DOT) at 49 CFR 40, which mandates biological testing and supervisory training programs. BPXA employees involved in safety-sensitive positions within natural gas, liquefied natural gas, and hazardous liquid pipeline operations are required to undergo pre-employment biological testing and testing for reasonable cause following reportable accidents, alcohol or drug rehabilitation, and on a random basis in accordance with this regulation. Other BPXA employees fall under the company's drug testing program. Each of these groups is randomly tested at a rate of a minimum of 25 percent per year. Contract personnel maintain their own drug testing records. The testing must meet the minimum standards set by BPXA.

BPXA employees and contract personnel must be free from the influence of drugs or alcohol on company premises. Implementation of the BPXA Substance Abuse Program is divided into three parts as follows:

- **Education.** Training is available to both employees and supervisors to teach them to detect signs of abuse in themselves and the people with whom they work. Information is provided on the available rehabilitation programs.
- **Intervention.** The company has jurisdiction to perform a drug test on employees when there is legitimate cause, such as medical surveillance following rehabilitation, or as periodic drug screening. The company makes every effort to support its employees and strongly encourages medical rehabilitation.
- **Discipline.** Upon the discovery of illicit drug use, controlled substance abuse, or alcoholic beverage possession, an employee will be suspended.

The BPXA Work Life and Employee Assistance Program (EAP) is an elemental part of rehabilitation. EAP is a confidential counseling and referral service provided free-of-charge to employees and their families. BPXA also supports medical rehabilitation programs outside of the EAP program, which are covered by the BPXA medical plan.

2.1.3 Medical Monitoring [18 AAC 75.007(e)]

New BPXA employees receive an entrance physical to establish baseline health conditions. Under federal Occupational Safety and Health Administration (OSHA) and Alaska Department of Occupational Safety and Health requirements, medical monitoring is conducted as required by the type of work performed. Emergency response personnel have annual medical examinations, which include a physical exam, audiogram, respiratory exam, electrocardiogram, x-rays, and blood work. All other BPXA employees who are field workers receive annual respiratory exams and audiograms.

2.1.4 Security Programs [18 AAC 75.007(f) and 40 CFR 112.20(h)(10)]

Access to BPXA's North Slope operations is controlled through BPXA security checkpoints and with Security personnel and records in the operating areas. Each BPXA employee and contractor is issued an identification badge with the employee's or contractor's name and badge number. The security badge system provides a method for monitoring personnel moving on and off BPXA leases.

2.1.5 Fuel Transfer Procedures [18 AAC 75.025]

Measures are taken to prevent spills or overfilling during a transfer of oil into Alaska Department of Environmental Conservation (ADEC)-regulated storage tanks, as required by 18 AAC 75.025(a). Loading rates are reduced at the beginning and end of a transfer, as required by 18 AAC 75.025(a).

Each person involved in a transfer of oily fluids into an ADEC-regulated tank is capable of clearly communicating orders to stop a transfer at any time during the transfer, as required by 18 AAC 75.025(d).

A positive means is provided to stop a transfer of oily fluid into an ADEC-regulated tank in the shortest possible time, as required by 18 AAC 75.025(e).

Before beginning a transfer to or from an ADEC-regulated tank at an area not protected by secondary containment, the valves in the transfer system are checked to make sure they are in the correct position, as required by 18 AAC 75.025(f). Manifolds not in use are blank flanged or capped. Transfer piping and hoses used in the transfer are checked for damage or defects before the transfer and during the transfer. The lowermost drain and the outlets of a truck oily fluid tank are examined for leaks before the truck's tank is filled and again before the truck departs, as required by 18 AAC 75.025(g). The truck's manifold is blank flanged or capped and valves are secured before it leaves the transfer area. Surface liners at inlet and outlet points are the primary prevention mechanisms against discharge to the ground during the transfer of liquids.

Effective communication and planning are key factors in preventing spills. Trucks are continuously staffed during fluid transfers and transfer personnel have radios. For transfers from trucks to ADEC-regulated tanks, manual shutoff valves are available to the truck operator to stop transfers.

The Endicott fuel transfer area, Skid 610, is located approximately 40 feet north of the gasoline and diesel storage tanks. Mobile equipment such as trucks and forklifts park on a lined containment area during fueling. The diesel and gas lines are buried, coated with a protective wrapping, and are cathodically protected.

Badami's fueling system consists of one storage tank (TK-0004), two transfer pumps and one vehicular diesel pump. Two emergency shutdown valves (ESDV-1209 and 1210) provide isolation of the storage tank within the dike. The transfer pumps can be stopped and started manually from the local panel, or they can be stopped remotely. Valve ESDV 1210 opens when either of the pump motors is started and is closed whenever both motors are off. A low-pressure trip is provided on the common pump discharge header in case of pressure loss due to a leak. Alarms are triggered when the transfer pumps are stopped.

The dispenser operation requires that one of the diesel transfer pumps be started from the motor starter panel. Valve ESDV-1210 will then open. The hose is removed from the fuel dispenser, and the dispenser on switch is activated. The vehicular diesel pump on the fuel dispenser will start and fuel is pumped at a regulated pressure. Once the dispenser switch is turned off, the vehicular diesel pump stops.

2.1.6 Operating Requirements for Exploration and Production Facilities [18 AAC 75.045]

Produced oil from flow tests and other drilling operations is handled to prevent spills (18 AAC 75.045(a)). Oil produced from flow tests may be flowed directly to the plant or stored in mobile tanks. Facilities are staffed 24 hours a day. At each shift change, personnel inspect oil tank levels and tankage, sumps, drains, piping, valves, glands, wellheads, pumps, and other machinery for indications of oil leaks.

The requirements for platform integrity inspections and isolation valves for pipelines leaving platforms do not apply (18 AAC 75.045(b) and (c)).

Catch tank requirements do not apply (18 AAC 75.045(e)).

Information pertaining to oil storage tanks and facility oil piping is found later in Part 2 and in Part 3. Impermeable well cellars at Endicott fulfill the requirements for drip pans or curbing at offshore facilities and well head sumps for onshore facilities (18 AAC 75.045(d)). Well cellars with concrete floors at Badami fulfill the requirement for well head sumps for onshore drilling (18 AAC 75.045(d)).

2.1.7 Leak Detection, Monitoring, and Operating Requirements for Crude Oil Transmission Pipelines [18 AAC 75.055]

The crude oil transmission pipeline is equipped with a system capable of detecting a leak with a daily rate equal to one percent of daily throughput, as required by 18 AAC 75.055(a)(1). Flow is verified at least once every 24 hours, as required by 18 AAC 75.055(a)(2). The flow of incoming oil can be stopped within one hour after detection of spill, as required by 18 AAC 75.055(b). The control board operator proceeds through a series of steps to determine the cause of the alarm. Ground-based surveillance may be requested. Verification of a leak would facilitate pipeline shut in. See also Section 2.5.6.

ADEC is notified in writing within 24 hours if a significant change occurs in or is made to the leak detection system and if as a result of the change the system does not meet the “equal to not more than one percent of daily throughput” criterion [18 AAC 75.475(d)(1)].

2.1.8 Oil Storage Tanks [18 AAC 75.065 and 0.066]

This section describes the management of ADEC-regulated tanks, i.e., oil tanks greater than 10,000-gallon capacity whether stationary or portable and that are “in service.” In this plan the term “in service” describes oil tanks that remain in regular inspection and maintenance programs whether the tank holds oil or not, unless noted otherwise, a usage consistent with 18 AAC 75 Article 1. The meaning differs from that in API 653. Part 3 provides information for stationary and portable oil storage tanks greater than 10,000 gallons as required by 18 AAC 75.425(e)(3)(A). Containers are constructed of materials compatible with the stored products. Tanks for processing muds and cuttings on drill rigs are not oil storage tanks.

Inspections

Stationary oil storage tanks greater than 10,000 gallons and in service on BPXA leases are maintained and inspected consistent with API Standard 653, third edition 2001, and Addendum 1, September 2003, or API Recommended Practice 12R1, fifth edition 1997, as required by 18 AAC 75.065(a). Inspection intervals for field-constructed tanks are not based on similar service as outlined in API 653. Furthermore, a tank’s inspection interval may not be risk-based as outlined in API 653 unless ADEC approves.

As required by API Standard 653, Section 6.3.1, monthly visual inspections are conducted on tanks that are “in service” as the term is used by API 653. API 653 uses the term “in service” to mean in operation, e.g., storing product. Consequently, tanks not in operation are not required to receive monthly in-service inspections.

Shop-fabricated oil tanks are not precluded from the similar service and risk-based inspection interval procedures outlined in API 653.

Inspection results and corrective action descriptions of oil storage tanks greater than 10,000 gallons are kept for the service life of the tanks. They are provided to ADEC for inspection and copying upon request, as required by 18 AAC 75.065(d).

Notifications and Service Status

BPXA's CIC group follows its written procedure to notify ADEC before a BPXA-owned field-constructed oil storage tank greater than 10,000 gallons and on a BPXA lease undergoes "major repair" or "major alteration" as defined in API 653, Section 12.3.1.2 and again before the tank is filled [18 AAC 75.065(e)]..

A field-constructed oil tank greater than 10,000 gallons capacity that has been removed from a maintenance and inspection program required by 18 AAC 75.065 for more than one year is made free of accumulated oil, marked with the words "Out of Service" and the date taken out of service, secured to prevent unauthorized use, and blank flanged or disconnected from facility piping. BPXA notifies ADEC when those tasks are complete and when the tank has been out of service for up to one year. Shop-constructed tanks have no service status notification and placarding requirement.

Construction

Internal steam heating coils are designed to control leakage through defects, as required by 18 AAC 75.065(f).

If an oil storage tank greater than 10,000 gallons has an internal lining system, it is installed in accordance with API 652, as required by 18 AAC 75.065(g).

As required by 18 AAC 75.065(i), field-constructed oil storage tanks greater than 10,000 gallons and installed after May 14, 1992, meet the following construction standards unless they have an ADEC waiver:

- Constructed and installed in compliance with API 650, 1988 edition, or API 12, D, ninth edition 1989, F tenth edition 1989, and P first edition 1986, or another standard approved by ADEC, and
- Not of riveted or bolted construction, and
- With cathodic protection or another ADEC-approved corrosion control system to protect the tank bottom from external corrosion if local soil conditions warrant, and
- Having a leak detection system that an observer from outside the tank can use to detect leaks in the tank bottom, such as secondary catchment under the tank with a leak detection sump, or a sensitive gauging system or another leak detection system approved by ADEC.

As required by 18 AAC 75.065(h), field-constructed oil storage tanks greater than 10,000 gallons and installed before May 14, 1992, meet the following standards unless they have an ADEC waiver:

- Having a leak detection system that an observer from outside the tank can use to detect leaks in the tank bottom, such as secondary catchment under the tank with a leak detection sump, or a sensitive gauging system or another leak detection system approved by ADEC, or
- Cathodic protection in accordance with API 651, first edition 1991, or
- A thick film liner in accordance with API 652, first edition 1991, or
- Another leak detection or spill prevention system approved by ADEC.

Shop-fabricated, ADEC-regulated oil tanks first placed in service before December 30, 2008, are not subject to an ADEC-requirement for construction standards.

As required by 18 AAC 75.065(k) and .066(g), stationary and portable oil storage tanks greater than 10,000 gallons have one or more of the following overfill protection means:

- High liquid level alarm with signals that sound and display, or
- High liquid level automatic pump shutoff device, or
- A means to immediately determine the tank's liquid level, including close monitoring of the liquid level during a transfer to the tank, or
- Another system approved by ADEC which notifies the operator of high liquid level.

Overfill Protection Device Inspections

Overfill protection devices on ADEC-regulated tanks are tested before each transfer to them or monthly, whichever is less frequent. However, if the monthly test would interrupt the operation of a continuous flow system, then the device is inspected monthly and tested annually, as required by 18 AAC 75.065(l).

Overfill protection devices on ADEC-regulated tanks that are part of continuous flow systems, such as process tanks, and that can be tested without interrupting operations are tested monthly as required by 18 AAC 75.065(k). Overfill protection devices on ADEC-regulated tanks not part of continuous flow systems are tested monthly or just before filling, whichever is less frequent. See the tank tables in Part 3.

A test of the overfill protection device is a manipulation of part of the system for the purpose of eliciting a response. Devices are tested in a variety of ways depending on how they are used and frequency of use. Overfill protection devices are tested by level transmitter calibration, level transmitter calibration with annunciation of the alarm, level transmitter calibration with annunciation of the alarm and strapping, testing the level indicators and alarms by lowering the high liquid level alarm set point to below the actual liquid level to force a false alarm, checking the circuit continuity, changing the level in the tank to verify the level transmitter or alarm enunciator, strapping to calibrate the continuous level indicator in the control room and comparing sight glasses to a measured volume. Some methods are part of regular preventative maintenance procedures.

Inspections for each type of overfill protection device on continuous flow oil storage tanks over 10,000 gallons whose operation would be interrupted by a test are visual observations of one or more parts of the device's system that are visible from the outside of the tank. An example is daily reading sheets which show recordings of the tank liquid level heights reported by the level sensor from the control room readout.

2.1.9 Secondary Containment for ADEC Oil Storage Tanks [18 AAC 75.075]

Stationary and Portable Oil Storage Tanks

Single-wall oil storage tanks greater than 10,000 gallons are located within secondary containment with the capacity to hold the volume of the largest tank plus precipitation within the containment, unless there is a waiver of this requirement by ADEC. Secondary containment areas are constructed of bermed/diked/retaining walls. The containment areas are lined with materials resistant to damage and are impermeable as required by 18 AAC 75.075. Oil storage tanks are listed in Part 3.

Portable, shop-built aboveground oil storage tanks of a vaulted, self-diked, or double-walled design are not required to be placed within bermed, lined, secondary containment areas if they are equipped with catchments that positively hold overflow due to tank overfill or divert it into an integral secondary containment area [18 AAC 75.075(h)].

Secondary containment systems are maintained free of debris, vegetation, and other materials or conditions, including excessive accumulated water that might interfere with the effectiveness of the system as required by 18 AAC 75.075. Debris and vegetation that might interfere with the secondary containment effectiveness is that which threatens the containment integrity or reduces its capacity to less than 110 percent. Some fabric liner bottoms are held in place with a gravel layer.

Facility personnel visually check for the presence of oil leaks or spills within ADEC tank secondary containment daily, and conduct documented inspections of secondary containment areas. The containment areas are visually inspected for holes weekly. The records of the daily and weekly inspections are entered weekly as noted in Table 2-7.

Snowmelt runoff, debris, and accumulated rainwater are vacuumed out, or dewatered, and disposed of through the waste handling procedure. See Table 2-7 for visual inspection for sheens on discharge water.

BPXA notifies ADEC in writing within 24 hours if a significant change occurs in or is made to an ADEC-regulated tanks secondary containment system and if as a result of the change the system no longer meets the ADEC performance requirement [18 AAC 75.475(d)]. Vegetation, debris and accumulated water that does not interfere with the impermeability of the system or reduce its capacity below 110 percent of the largest tank capacity are not significant changes.

Tank Truck Loading and Unloading Areas

Endicott has two permanent tank truck unloading areas, one at the 305 Module ADEC-regulated tanks and another at the diesel and gasoline fuel tanks. Badami has a single permanent tanker truck loading area at the 15,000-barrel (bbl) diesel tank TK-0004.

The tank truck loading areas are maintained free of debris that might interfere with the effectiveness of the system. The areas have warning signs to prevent premature vehicular movement as required by 18 AAC 75.075(g)(4).

The tank truck loading and permanent unloading areas are visually inspected before transfers or at least monthly (see Table 2-7).

2.1.10 Facility Oil Piping and Flow Lines

Corrosion Management Program

Facility oil piping is in a corrosion control program as required by 18 AAC 75.080(b). The Corrosion Management Program meets the commitment made by BPXA to the State of Alaska in the “Charter for Development of the Alaskan North Slope” by providing the ADEC an annual report *Commitment to Corrosion Monitoring* on BPXA’s corrosion monitoring programs. The report provides data and discussion relating to the corrosion control, monitoring and inspection programs that together form the core of the integrity management system.

The Corrosion Management Program covers pipelines, flow lines, well lines, wellheads, headers, pressure vessels and tanks, as well as other field and facility piping systems. Corrosion monitoring and mitigation tools can include but are not limited to corrosion weight-loss coupons, electrical resistance probes, non-destructive examination inspection techniques, smart pigs, visual inspections, Kinley caliper surveys, monitoring of process flow conditions, and bioprobes. Badami currently has no specific corrosion monitoring program because production fluids are considered low risk from a corrosivity standpoint; however, an inspection program for corrosion detection is in place.

Corrosion management entails two main functions, corrosion monitoring and corrosion control. Corrosion control is the action of preventing or reducing corrosion to acceptable levels. Corrosion control measures reflect the active or potential corrosion mechanisms in the system. For pipelines, corrosion control measures can be broadly subdivided into internal and external corrosion mechanisms. The external corrosion mechanism is constant for all services while the internal differs with service. The metal loss criteria for pipe replacement are in American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME) B31G-1984, *Manual for Determining the Remaining Strength of Corroded Pipelines, A Supplement to ANSI/ASME B31 Code for Pressure Piping*. Corrosion control measures encompass a range of alternatives including chemical inhibition, materials selection, coatings, cathodic protection, and process control. These may be applied individually or in combination.

Inspection programs share similarities with monitoring programs but measure corrosion directly. Inspection provides documentation of equipment fitness for service. Inspections are generally performed on a quarterly to annual basis, but in some cases it may be five years or longer between inspections. Examples include ultrasonic testing, radiographic testing and smart pig inspections.

Internal Corrosion and Erosion of the Endicott Production System

The Endicott production system transports multiphase fluids. The properties of fluids are similar throughout the system, although temperature, pressure, and velocity vary. The water cut, gas-to-oil ratio (GOR), and solids content vary from line to line. There is a low risk of corrosion for the Badami pipelines, as there is little water production and low carbon dioxide content. Table 2-1 summarizes the significant corrosion mechanisms.

TABLE 2-1: INTERNAL CORROSION MECHANISMS RELEVANT TO ENDICOTT PRODUCTION SYSTEM

CORROSION MECHANISM	SEVERITY OF MECHANISM	CONTROL METHOD
Carbon dioxide corrosion	High	Materials
Velocity enhanced carbon dioxide	High	Materials Velocity control
Erosion	Medium/High	Velocity Well POP procedure Erosion monitoring
Microbially Induced Corrosion (MIC)	Low	Materials
Chemical attack	Low	Chemical selection Operating procedures Equipment design

Carbon dioxide corrosion is the primary corrosion mechanism. The control of carbon dioxide corrosion is achieved primarily through materials selection. The majority of the producing system is constructed from corrosion-resistant duplex stainless steel. The only surface production equipment made of carbon steel is the C-spools that connect the well to the well lines. The C-spools are inspected frequently to assure their integrity and are repaired or replaced as needed.

Velocity-enhanced carbon dioxide corrosion has become more predominant as mixture velocities have increased with increases in gas handling capacity. Velocity-enhanced carbon dioxide corrosion is managed via velocity control.

Erosion is associated with extremely high velocities and solids production. Solids production is unpredictable because it is the result of an event downhole, such as the breakdown of a cement job or production of unconsolidated reservoir rock. Velocity limits for erosion control rely on the approach defined in API RP 14E, using the C-factor of 100. Lines are ranked approximately monthly in terms of risk using the ratio V/Ve, where V is the mixture velocity and Ve is the calculated erosion velocity limit. An operating limit of 3.0 is used. These limits are subject to revision as more experience is gained at managing erosion.

Microbially induced corrosion (MIC) has not been accurately quantified in the Endicott production systems. However, sulfate-reducing bacteria (SRB) and general anaerobic bacteria (GAnB) are present. Control of MIC is through materials selection, the same as carbon dioxide corrosion.

Chemical attack has been associated with highly corrosive scale inhibitor pooling in production pipework during shut-ins. There have also been instances of injection quill failure, leading to contact of the neat (pure) chemical with the pipewall during normal operations. Chemical attack at Endicott is no longer a concern as the scale inhibition program has been discontinued.

Internal Corrosion of the Produced Water and Seawater System

The produced water injection system is defined as starting at the water outlets off the separation vessels and ending at the reservoir. It includes the process piping, storage tanks, injection pumps, flow lines and well lines that store or transport produced water, and the injection wells. At Endicott, the produced water is co-mingled with very low amounts of seawater and injected simultaneously into the formation. Table 2-2 summarizes the major corrosion mechanisms relevant to this produced water/seawater system.

TABLE 2-2: INTERNAL CORROSION MECHANISMS RELEVANT TO PRODUCED WATER AND SEAWATER INJECTION SYSTEM

CORROSION MECHANISM	MECHANISM SEVERITY	CONTROL METHOD
Carbon dioxide corrosion	Low	Corrosion inhibition
MIC	High/Medium	Corrosion inhibition Biocide injection Maintenance pigging
Oxygen corrosion	Medium/Low	De-aeration and oxygen scavenger injection
Chemical attack	Medium	Chemical selection Operating procedures Equipment design

Carbon dioxide corrosion is a significant issue for the upstream system but the oil stabilization process removes the vast majority of the carbon dioxide, substantially reducing its partial pressure. The carbon dioxide corrosion inhibitor is dosed into the produced water/seawater system and is fully capable of controlling carbon dioxide corrosion.

MIC is an issue in the injection system because the low fluid velocities in tanks and pipework allow bacteria colonies to become established and thrive. The current corrosion inhibitor is known to be toxic to

SRBs and GAnBs and the bacteria count has decreased. In addition, the Inter-Island Water Line that transports injection water from the production facility to the Satellite Drilling Island is regularly pigged to displace solids and bacteria. Periodic biocide treatment on this line is also conducted.

The Endicott crude oil transmission pipeline is scheduled to be maintenance pigged quarterly depending on pipeline condition and fluid velocity. The Badami crude oil transmission pipeline is maintenance pigged two times per year. These frequencies are subject to change as data and conditions dictate.

Oxygen corrosion is not an issue in production water systems alone. However, because the production water and seawater are co-mingled at Endicott, the chance increases of introducing oxygen into the injection system from dissolved oxygen in the seawater. Raw seawater is highly corrosive to carbon steel due to the presence of high levels of dissolved oxygen. Due to the extreme corrosivity of raw seawater, it is only handled in corrosion-resistant materials, such as stainless steels, copper or nickel based alloys, or plastics. The seawater treatment plant removes the vast majority of the oxygen from the water by mechanical means. Additionally, dissolved oxygen is further lowered by supplemental injection of oxygen scavenger into the seawater. At current levels seawater is only mildly corrosive, and carbon steel is a suitable material.

Internal Corrosion of the Gas Lift, Gas Injection, and Miscible Injectant Systems

The gas lift, gas injection, and miscible injectant systems contain dehydrated gas, which is non-corrosive. There are therefore no active corrosion mechanisms and correspondingly no corrosion control activities.

External Corrosion

External corrosion is a risk to equipment outside of modules and facilities. It can be subdivided into atmospheric corrosion and corrosion under insulation (CUI). No production equipment is buried directly in the tundra. Therefore, external corrosion at pipewall/soil interfaces is not an issue. Atmospheric corrosion in the Arctic is a slow process due to the low relative humidity, lack of rainfall, and low temperatures. External corrosion is only a significant issue for insulated equipment, where the polyurethane (PU) foam insulation can trap moisture next to the pipewall. This warm, moist environment, together with the oxygen in the air, can lead to corrosion.

Insulation-and-jacket systems or tape wrap that exclude water serve as one means of protective coating. The insulation systems used on pipelines is a combination of shop-applied PU foam on the linepipe spools with an external galvanized steel jacket. Badami facility piping does not utilize galvanized steel jacketing. The insulation is completed at weld joints using a range of methods, but involve the application of PU foam and galvanized steel jacketing. This insulation is generally resistant to moisture ingress, except at areas of damage. The major challenge in managing external corrosion is detection. Once it is detected it can be easily and effectively mitigated by removing wet insulation.

Evidence of external corrosion is investigated to determine the extent of corrosion. Pipeline repairs necessitating pipe replacement are cause for an internal inspection of the affected sections of pipe in the immediate vicinity to establish repair boundaries.

Pipeline Examination and Replacement

In compliance with 18 AAC 75.080(g), buried or below-grade facility oil piping is inspected for damage and corrosion any time it is exposed in accordance with API 570, Section 9.2.6, *Piping Inspection Code:*

Inspection, Repair, Alteration and Rerating of In-Service Piping Systems. If damage is found, piping is repaired or replaced with fusion-bonded epoxy-coated or stainless steel piping.

Replacement buried or below-grade facility oil piping installed after May 14, 1992, will be corrosion-protected and welded with no clamped or threaded connections in accordance with 18 AAC 75.080(d).

Corrosion Surveys

Corrosion surveys are part of the Corrosion Management Program. Corrosion survey methods include smart pigging, conventional nondestructive testing (NDT) methods, guided wave inspections, and excavation and visual inspection. The technologies are discussed in detail in Part 4.10. Table 2-3 demonstrates the Corrosion Survey Programs for various pipeline segments.

TABLE 2-3: SUMMARY OF PIPELINE CORROSION SURVEYS

PIPELINE	NUMBER OF ROAD/ANIMAL CROSSINGS	CORROSION SURVEY METHOD	FREQUENCY
Endicott			
Crude Oil Transmission Pipeline	25	NDT, Smart pig, Excavation & Visual	1 to 10 years, depending on method
Diesel/Gas Line	1	NDT, Excavation and Visual inspection	5 years
Inter-Island Water Injection &, Inter-Island Gas Line	1	NDT, guided wave validation	5 years
Well Line Water Injection Line	2	Guided wave validation for carbon steel line;	5 years
Three-Phase Production Line	1	NDT & Visual inspection in vaults	Annually
Badami			
Crude Oil Transmission Pipeline	1	Smart Pig	Every 5 years if flows allow

The three-phase Endicott production pipeline is fabricated of duplex stainless steel, which is corrosion-resistant. The three-phase line at the road crossing between Satellite Drilling Island (SDI) and Main Production Island (MPI) is in a vault, and is visually inspected annually for corrosion. The well water injection line is also fabricated of duplex stainless steel, servicing Well 5-03.

Other Requirements

Aboveground facility piping is supported consistent with the ASME B31 standard to which it was built.

As required by 18 AAC 75.080(n)(1), aboveground facility piping and valves are inspected visually as described in Table 2-7.

In compliance with 18 AAC 75.080(n)(2), the aboveground diesel transfer lines at MPI and the Badami facility pad pipelines exposed to traffic are protected from damage by vehicles with bollards marked with reflectors.

As required by 18 AAC 75.080(o), BPXA notifies ADEC within one year after facility oil piping is no longer in ADEC-required maintenance and prevention programs and the tasks to remove facility piping from service are complete. Facility piping removed from service for more than one year is free of accumulated oil, identified as to origin, marked with the words “Out of Service” and the date taken out of service, secured to prevent un-authorized use, and blank-flanged or isolated from the system. Notification of the out of service status and the task completions may be made by the one-year anniversary of removal from the maintenance and prevention programs.

Flow line regulations 18 AAC 75.047 do not apply to Badami.

Endicott flow lines no longer maintained under an ADEC-required corrosion monitoring and preventive maintenance program are within one year made free of accumulated oil and isolated from the system. The pipe is treated with a cleaning pig, completely drained of oil, or blown with air or with another method to evacuate standing oil. ADEC is then notified within one year of the removal from service and when the tasks are complete [18 AAC 75.047(f)]. Placarding is not required. For the purposes of complying with ADEC flow line regulations, “in-service” means included in a regular maintenance and inspection program required by 18 AAC 75.047, whether the piping holds oil or not. Notification of the out of service status and the task completions may be made by the one-year anniversary of removal from the maintenance and prevention programs.

The aboveground portions of flow lines are supported as outlined in *Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids* (ASME B31.4) [18 AAC 75.047(g)].

2.2 DISCHARGE HISTORY [18 AAC 75.425(e)(2)(B)]

Discharge history of oil spills to water or tundra and other oil spills greater than 55 gallons was obtained for the period January 1992 through June 2006 by querying BPXA’s spill reporting database. The discharge history is provided in Appendix B and includes the following information:

- Date of discharge,
- Material discharged,
- Amount discharged, including the volume that reached navigable waters as applicable,
- Cause, and
- Corrective and preventive actions taken.

2.3 POTENTIAL DISCHARGE ANALYSIS [18 AAC 75.425(e)(2)(C) and 40 CFR 112.20(h)(4)]

The potential for oil spills is understood from historical spill data. Examples of potential oil spills are described in Table 2-4. Table 2-5 summarizes potential pipeline spills and release quantities. Spill prevention actions involve the training, operating procedures, leak detection, inspections, and secondary containment outlined in Part 2.

TABLE 2-4: POTENTIAL SPILLS FROM VARIOUS SOURCES

LOCATION	CAUSE	PRODUCT	SIZE	DURATION	ACTIONS TAKEN TO PREVENT POTENTIAL DISCHARGE
Fuel tank	Rupture Overflow	Fuel	595 bbl 20 bbl	4 hours 8 minutes	Bermed and lined storage areas and double-walled tanks.
Fuel lines transfer	Rupture	Fuel	500 bbl	varies	Berms are provided and liners are used in sensitive areas that may be affected by a spill.
Fuel delivery vehicle	Rupture Broken hose	Fuel	200 bbl 75 bbl	4 hours 1.5 hours	Unified Fluid Transfer Procedures.
Fuel transfer on land	Line rupture	Fuel	100 bbl	2 hours	Permanent and portable liners.
Wellhead	Leak	Crude Oil	100 bbl	varies	Cellar boxes initially and automatic shut-off.
Well	Uncontrolled flow from wellbore	Crude Oil	2,250 bbl per day	varies	Blowout prevention equipment.
Diesel transfer to tank truck	Tank overfill	Diesel	200 gallons	30 seconds	Transfer procedures in place; secondary containment.
Diesel transfer from barge to diesel tank	Hose rupture	Diesel	440 to 880 gallons	1 to 2 minutes	Transfer procedures in place; secondary containment; hose watch.
Diesel tank	Tank rupture	Diesel	15,000 bbl	Instant	Secondary containment; tank inspection program.

TABLE 2-5: POTENTIAL PIPELINE SPILLS AND RELEASE QUANTITIES

PIPELINE SEGMENT	TYPE OF FAILURE	LENGTH OF PIPE (feet)	POTENTIAL LOSS (bbl)	ACTIONS TAKEN TO PREVENT POTENTIAL DISCHARGE
Endicott				
MPI to Y	Corrosion or accident	16,541	3,800	Leak detection system & corrosion management
Y to 200-ft. breach	Corrosion or accident	2,794	640	Leak detection system & corrosion management
200-ft. breach	Corrosion or accident	352	90	Leak detection system & corrosion management
200-ft. breach to 500-ft. breach	Corrosion or accident	4,962	1,140	Leak detection system & corrosion management
500-ft. breach	Corrosion or accident	595	140	Leak detection system & corrosion management
500-ft. breach to shore valve	Corrosion or accident	12,848	2,950	Leak detection system & corrosion management
Shore to Sagavanirktok River	Corrosion or accident	44,899	10,300	Leak detection system & corrosion management
Sagavanirktok River to Trans Alaska Pipeline System	Corrosion or accident	46,940	10,780	Leak detection system & corrosion management
Badami				
Sagavanirktok River	Corrosion or accident	3,604 ft.	543 bbl	Leak detection system & corrosion management
Shaviovik River	Corrosion or accident	3,953 ft.	593 bbl	Leak detection system & corrosion management
No Name River	Corrosion or accident	1,152 ft.	189 bbl	Leak detection system & corrosion management
Other low point (Mile 17)	Corrosion or accident	4,000 ft.	600 bbl	Leak detection system & corrosion management
Kadleroshilik River	Corrosion or accident	1,406 ft.	203 bbl	Leak detection system & corrosion management

2.4 CONDITIONS INCREASING RISK OF DISCHARGE [18 AAC 75.425(e)(2)(D)]

Conditions specific to BPXA's North Slope operations that potentially increase the risk of an oil spill, and actions taken to reduce the risk of a spill, are as follows:

- Heat may cause gases to expand, increasing the likelihood of discharge. North Slope facilities are engineered to accommodate temperature fluctuations.

- Icy roads, white-out conditions, and cold snaps present obvious threats to field operations. BPXA Security's strict adherence to vehicle safety, speed limits, and the posting of warning signs assist in minimizing the potential for vehicular accidents that may result in a spill. In addition, North Slope facilities are engineered to withstand arctic conditions.

- Changes in traffic patterns may increase the risk of vehicles colliding into well lines. BPXA Security's strict adherence to vehicle safety, speed limits, and the posting of warning signs or traffic cones helps to minimize the potential for vehicular accidents that may result in a spill.

- If the Trans Alaska Pipeline System (TAPS) unexpectedly shuts down the pipeline, the risk to BPXA systems increases. BPXA's advanced communication system enables immediate communication between TAPS and the North Slope operators, which allows for the coordination of impacts and minimizes the risks due to a shutdown of the pipeline.

- High winds could increase the risk of discharge during fuel transfers, particularly during barge to tank transfers. If wind speed appears to pose a threat to communications or hoses and booming, transfer operations will be postponed until the wind subsides.

- As the fields age, the discharge potential increases. To minimize spills related to aging facilities, BPXA uses a computerized preventative maintenance program, has a corrosion control program, does valve inspections in accordance with Alaska Oil and Gas Conservation Commission (AOGCC) regulations, has leak detection monitoring, and conducts regular visual inspections.

- High water and/or ice during break-up could increase the risk of discharge over river crossings. The pipeline support members have been designed to withstand ice conditions expected at the river crossings. High water and ice conditions are monitored during weekly overflights of the Badami pipeline as well as during routine flights to and from Badami.

The Endicott pipeline has one river crossing at the Sagavanirktok River. To prevent damage to the crossing from ice floes, slots are cut in river ice prior to break-up each year. In addition, river water levels are monitored during high water to ensure that lateral bridge support members do not become submerged. The crossing is observed daily by Security personnel who are responsible for reporting abnormal conditions.

2.5 DISCHARGE DETECTION [18 AAC 75.425(e)(2)(E) and 40 CFR 112.20(h)(6)]

2.5.1 Drilling Operations

Each drilling rig has a system of controls, monitors, alarms and procedures to assist in the early detection of potential discharges. For both down hole and surface operations, these detection systems include automated monitoring devices as well as standard operating procedures (SOPs) governing the monitoring, handling and containment of fluids.

During down hole operations, much of the discharge detection effort centers on well control with an emphasis on detecting wellbore influxes (kicks). The primary control to prevent a discharge associated with a kick is the density of the hydrostatic column of drilling fluid in the wellbore. The drilling fluid density and other critical parameters are closely monitored by drilling fluid specialists and trained members of the rig crew. Modifications to the mud density are made in accordance with the AOGCC approved well plan to maintain the proper fluid density at various intervals. The BOPE (blow out prevention equipment) and associated mechanical well control equipment is defined as the secondary well control system. The AOGCC requires frequent documented testing of these safety systems and such tests are normally witnessed and verified by AOGCC field representatives.

For surface operations, discharge detection systems use automated equipment, visual, audio or manual detection in combination with policies and procedures governing the handling and containment of fluids. Rig pit systems are equipped with pit volume totalizers (PVT) that constantly monitor and record pit volume gains and losses. Unexpected gains or losses of drilling fluids initiate alarms, which sets in motion initial crew responses to secure the well. The well is monitored to further identify the cause of the event. If events indicate a kick or loss of circulation, countermeasures are initiated through written procedures to ensure well control is maintained. Countermeasures are initiated by means of the secondary well control equipment until the well can be stabilized with the primary well control means (e.g., weighted drilling muds) or installed barriers (e.g., cement plugs, bridge plugs).

Rig surface systems are continuously monitored for external leakage as well. Fluid transfers associated with drilling operations are carefully planned, permitted and monitored using BPXA and contractor fluid transfer guidelines. Strict adherence to these procedures ensures immediate detection of spills associated with fluid transfer operations, which significantly reduces the probability of occurrence.

2.5.2 Automated Methods

Operator control of the system is through computers. The system is reliable as the communications network is completely redundant. Each of the three operator consoles is a separate entity, and critical process loops are under redundant control.

Automated control systems and visual monitoring of instrument/control panels are used to control flow rates as well as detect potential discharges. The control systems and instrumentation consist of a “process control” system as well as an independent emergency shutdown (ESD) system. Several independent ESD systems limit the scope of any single failure. An ESD can be initiated by process conditions outside set limits or manually by operators at the instrument/control panels and by personnel at ESD punch-button locations throughout the facility. Process conditions that will trigger the ESD system include loss of pressure in a pipeline, excess pressure or equipment malfunction within a production facility, or high or low liquid levels in vessels and tanks. The ESD system is provided and maintained for the explicit purpose of stopping oil flow when these pipeline or facility problems are encountered. A cascading shutdown system is used to shut in wells and pipelines prior to relieving pressure on vessels or other process systems at the production facilities.

The Endicott control system monitors and operates the oil production wells, process facilities, and pipelines. The control system involves a microprocessor-based distribution control system (DCS) that employs three major categories of digital instrumentation and control, integrated into a single system. The three categories are the DCS, the Supervisory Control and Data Acquisition (SCADA), and the Programmable Logic Controller (PLC). The combined system interfaces with the communications network.

When an emergency requiring shutdown of one or more of the facilities occurs, the PLC system is used. The PLC system is integrated into the DCS. The PLC processor can accept operator commands and transfer status/alarm information to the main operator's console. The MPI and SDI have redundant PLC systems that provide maximum system integrity for performance of ESD functions. Operational and ESD procedures are discussed in the following paragraphs.

At each process center, control systems and visual monitoring of instrumentation are used to control injection flow rates, pressures, and distribution. Pressure-relieving devices are installed on pressurizing

units. The facilities are visually inspected on a routine basis for detection of spills and equipment malfunctions.
Production facilities at Endicott are continuously monitored with a microprocessor-based DCS. Incoming alarms from the facilities, wells, or pipelines are documented by date and time via an alarm typewriter in the Unit 601 control room. This system capability allows for the quick tracking of cause-and-effect relationships during upset conditions. In addition, a manually operated, fully automated shutdown system is available if the computerized system is down and the facilities experience excess pressure or malfunction during production. Production wells automatically shut in when low producing pressures are detected.

Automated control systems and visual monitoring of instrument/control panels at the Badami facility are used to control flow rates as well as detect potential discharges. Programmable Logic Controllers (PLC) based control systems control the process in the plant. The operators interface with the PLCs by using the HMI (Human Machine Interface). The HMI system consists of two redundant personal computer servers with operating software that allows the operator to monitor the process, start up and shut down the plant and individual processes and equipment, and make process adjustments. As part of the PLC system, an independent ESD system automatically limits the scope of any single failure. An ESD can be initiated by process conditions outside set limits or manually by operators at the instrument/control panels and by personnel at ESD punch-button locations throughout the facility. Process conditions that will trigger the ESD system include excess pressure or equipment malfunction within a production facility, or high or low liquid levels in vessels and tanks. The ESD system is provided and maintained for the explicit purpose of stopping oil flow when pipeline or facility problems are encountered.

2.5.3 Oil Storage Tanks

Badami's two stationary tanks, the diesel storage tank and slop oil tank, are fitted with level transmitters for control room monitoring of tank liquid levels.

The diesel tank is equipped with leak detection for the tank bottom and has been installed in accordance with API 650, Appendix I. The system includes a bathtub-shaped liner imbedded approximately 12 inches into the foundation gravels and coming up to the outside edge of the tank. A drain is installed in the center of the bottom of the liner. The drain consists of high-density polyethylene piping routed to a steel sump outside of the perimeter of the tank to allow for visual inspection for hydrocarbon leaks from the bottom of the tank. The tank is inspected as described in Table 2-7.

The slop oil tank is elevated above a secondary containment area that is visually inspected for leaks as described in Table 2-7.

Endicott stationary tanks are aboveground and mounted on modules or skids within secondary containment. Additional containment is provided via overflow lines to the secondary containment basins. The tanks are fitted with a level transmitter for control room monitoring of tank liquid levels. The tanks are visually inspected as described in Table 2-7.

Portable tanks may be used for oil storage, well work and dewatering operations. The tanks are monitored while they are in use and during fluid transfers. The tanks' secondary containments are visually inspected as described in Table 2-7 when the tanks are storing oil.

Badami's stationary and portable oil storage tanks less than 10,000 gallons and regulated by 40 CFR 112 are described in Appendix A.

2.5.4 Flow Lines

Lines from oil-producing wells are equipped with low-pressure transmitters used to isolate producing wells in the event of a line rupture. If the pressure in the line drops below thresholds the line shuts in. Small leaks that would not activate the low-pressure switch would be identified by operations personnel performing routine checks. Given that production fluids are mostly gas and water, with smaller amounts of oil, leaks would involve relatively large amounts of visible steam and gas easily identified by both sight and sound.

2.5.5 Wells

The production wells at Endicott are fitted with trees that consist of a manual master valve, a manual swab valve, hydraulically actuated Sub-Surface Safety Valve (SSSV), hydraulically actuated Surface Safety Valve (SSV), and hydraulically actuated wing valve (SDV-Shut Down Valve). When the low-pressure transmitter senses a pressure below the threshold it will close the SSSV and SSV simultaneously.

The Badami production wells are fitted with trees that consist of a manual master valve, a manual swab valve and hydraulically actuated SSV and wing valve (SDV-Safety Divert Valve). When the low-pressure transmitter senses a pressure below the threshold it will close the SDV first followed by the SSV.

2.5.6 Crude Oil Transmission Pipelines

The Endicott pipeline leak detection system monitors the crude oil transmission pipeline from the Main Production Island (MPI) to Pump Station 1 (PS1) for a loss of fluid. The system has demonstrated the ability to detect a daily discharge equal to not more than one percent of daily throughput.

Additionally, as a voluntary measure, Security provides daily drive-by visual surveillance of the Endicott crude oil transmission pipeline. The Endicott pipeline route is entirely road-accessible, and therefore does not require aerial surveillance. Visual pipeline inspection is facilitated by the aboveground construction of the pipelines.

Leak detection for the Badami sales oil pipeline consists of weekly aerial visual inspection unless precluded by safety or weather conditions and monitoring of flow variations in the pipeline. At the Central Processing Facility, meters are installed on the A, B and C meter runs. The C Meter run provides metering flows less than 1,056 barrels of oil per day (bopd). A flow conditioner smoothes the oil flow upstream from the meter. At the Badami pipeline tie-in with the Endicott pipeline, the flow of oil from the Badami pipeline into the Endicott pipeline is measured with a sensing elements designed to handle flow rates up to 2,000 barrels of oil per hour (boph). Oil flow data are transmitted from the meter at Remote Terminal Unit No. 3 (RTU-3) to the Badami control room and then relayed to Endicott via the process control network. The meter supports API equations for net oil calculations. The data also are used for leak detection in the Ed Farmer and Associates (EFA) Leak Net host computer at Endicott. MassPack segment 5 performs the oil mass balance calculations for the pipeline segment from Badami to RTU-3.

Custody transfer metering systems on the Endicott MPI, at Badami and at Pump Station 1 of the TAPS measure volumes accurately and enhance the performance of the leak detection system. The systems provide corrected flow data to the LeakNet System via connected Allen-Bradley PLC-5s on the MPI, Badami, and at PS1. Pressure, temperature, and instantaneous flow information is provided from both the MPI and PS1 locations.

The Endicott/Badami pipeline system to Pump Station 1 (PS1) is monitored using an EFA LeakNet system. Currently only the MassPack algorithm is used for leak detection.

The EFA Mass Pack software performs conventional mass balances over 1 minute, 1 hour, and 24 hours with three corresponding alarm thresholds. The system displays a volumetric flow balance and acquires total inlet and outlet (PS1) crude flow data every minute. Calculations are carried out as shown in Table 2-6.

TABLE 2-6: VOLUMETRIC FLOW BALANCE CALCULATIONS

FREQUENCY	WARNING (bbl)	ALARM (bbl)
Endicott to PSI		
Last minute	15	40
Last 60 minutes	60	300
Last 24 hours	150	170
Badami to Endicott Tie-In		
Last minute	20	25
Last 60 minutes	n/a	n/a
Last 24 hours	15	16

Results exceeding these tolerances trigger alarms and initiate a response to investigate the cause and shut down production if required.

Mass Pack includes intelligence for smoothing the volume balances for transients. Increases (line packing) in the inlet flow rate can be tuned to show up in the outlet over time. Mass Pack leak detection is based on first principles and is often the most reliable of the three software detection methods.

Leak Alarm Response

In the event of a catastrophic rupture of the Endicott/Badami crude oil transmission pipeline, the control operator would immediately detect a total loss of pressure while simultaneously sensing no reduction in flow. Following confirmation, the pipeline would be shut down.

The leak detection system also will alarm for smaller continuous leaks.

If a leak alarm sounds upstream of the Flow Station 2 bypass, the Eastern Offtake Center contacts the Endicott Control Room to determine whether the alarm can be explained. If the alarm is downstream of the Flow Station 2 bypass, Eastern Offtake Center personnel will explain the alarm.

If the alarm can be explained, the leak detection system is reset.

Following an "unexplained" alarm from Endicott and Badami to Pump Station 1, the Eastern Offtake Center contacts Security to request a ground-based visual surveillance of the specific pipeline segment. The Eastern Offtake Center provides Endicott with the results.

If weather or safety prevents ground-based surveillance, then Security requests a Forward Looking Infrared (FLIR) overflight by Shared Services Aviation. If the FLIR overflight reveals an anomaly, the aircraft radios Kuparuk Security which notifies BPXA Security.

BPXA notifies ADEC in writing within 24 hours if a significant change occurs in or is made to the crude oil transmission pipeline leak detection system, and if as a result of the change, the system no longer meets the ADEC performance requirements in 18 AAC 75.055 (18 AAC 75.475). Suspension of the leak detection capability trigger notices to ADEC only if they preclude detection within 24 hours of a leak as large as 1 percent of the annual average daily throughput.

2.5.7 Visual Inspections

Table 2-7 summarizes the visual inspections performed on regulated equipment. Supervisors regularly review the records of daily visual inspections of ADEC-regulated tanks' secondary containments that are required by 18 AAC 75.075.

Flow lines and pipelines are inspected at least monthly, as required by 18 AAC 75.080(n)(1).

More specifically, the following personnel have been identified to support the inspection process:

- Security fills out inspection forms following pipeline inspections. In addition, during routine trips, Security will report oil or gas discharges to the spill reporting telephone line.
- Employees are responsible for conducting visual inspections of their work areas and contacting the operator or Environmental Advisor for clean-up.

Contractors are responsible for visual inspections of work areas and cleaning up spills they may cause. The Environmental Advisor is available to provide support or verification of clean-up efforts.

2.5.8 DOT Pipeline Safe Operations and Emergency Response Equipment Inspection

Inspections of the DOT-regulated sales oil pipeline are conducted as follows:

- Visual inspections at intervals not exceeding three weeks, but at least 26 times per year,
- Mainline and branch valve inspections at intervals not exceeding 7.5 months, but at least two times each year,
- Vertical support member (VSM) inspections annually during the walking-speed survey, and
- A VSM elevation survey at least once every five years.

TABLE 2-7: VISUAL SURVEILLANCE REQUIREMENTS

INSPECTION	RESPONSIBLE POSITION	REGULATING AGENCY	INSPECTION DESCRIPTION	FREQUENCY	REGULATORY CITATION	RECORD KEEPING
Oil Storage Tank in Operation	Badami Operations Lead Tech Endicott O&M Team Lead	EPA (Badami)	Visual inspection bulk oil storage containers 55 gallons to 10,000 gallons	Annual	40 CFR 112.9(c)(3), 112.9 (d)	Appendix A-1, A-3, "EPA Storage Tank Integrity Inspection Procedure" or PRIDE
		ADEC	Visual inspection of external conditions of oil storage tanks >10,000 gallons in operation	Monthly	18 AAC 75.065 and .066 following API 653	ADEC-Regulated Oil Storage Tank Monthly In-service Inspection Report
Wastewater Tank 1802	Endicott O&M Team Lead	ADEC	Visual inspection of tank	Every 12 hours	See ADEC waiver letter in Part 2.6	Daily log
Secondary Containment Areas at ADEC-Regulated Tanks	Badami Operations Lead Tech Endicott O&M Team Lead	ADEC	Visual inspection for oil leaks or spills, defects and debris	Daily, without record and weekly with record	18 AAC 75.075	Visual field inspection form
		EPA (Badami)	Visual inspection	Regular	40 CFR 112.9(c)	Appendix A-1, A-3, "EPA Storage Tank Integrity Inspection Procedure" or PRIDE
Secondary Containment at ADEC Tank Truck Loading Areas	Badami Operations Lead Tech Endicott O&M Team Lead	ADEC	Visual Inspection	At transfer or at least monthly	18 AAC 75.075(g)	Visual field inspection form; Daily field shift log
Overfill protection device on field-built oil storage tanks >10,000 gallons	Badami Operations Lead Tech Endicott O&M Team Lead	ADEC	Test overfill protection device	Monthly	18 AAC 75.065(l)	Monthly In-Service Inspection Report
Facility Oil Piping and Valves outside Process Modules, from Well through Manifold Building; to and from ADEC Tank	Badami Operations Lead Tech Endicott O&M TL	ADEC	Visual inspection of oil piping and valves that are visible	Daily contingent on weather and safe access	18 AAC 75.080(n)(1)	Visual field inspection form; Daily field shift log; Wells daily review sheet
		EPA (Badami)	Examine for maintenance	Periodic	40 CFR 112.9 c (3)	Appendix A-1, A-3, "EPA Storage Tank Integrity Inspection Procedure" or PRIDE
Crude Oil Transmission Pipeline	Badami Operations Lead Tech/Shared Services Aviation Endicott Security	ADEC (Badami)	Aerial surveillance for remote pipelines	Weekly, unless precluded by safety or weather conditions	18 AAC 75.055(a)(3)	Visual field inspection form
		DOT	Surveillance of sales oil pipeline right of way surface conditions	26 times a year, not to exceed 3 weeks between surveillances	49 CFR 195.412(a)	Surveillance form (Badami); DOT Pipeline Inspection Checklist Report (Endicott)

2.6 COMPLIANCE SCHEDULE AND WAIVERS [18 AAC 75.425(e)(2)(G)]

Waivers follow this page. Waiver content is as follows:

- Request for Secondary Containment Waiver for [Endicott] Waste Water Tank (Tag No. T-E3-1802). ADEC Letter No. 96-43-RKW, File No. 305.50 (089) (December 17, 1996).
- Temporary Waiver of Requirement for Secondary Containment at Tank T-E3-1810 Tank Truck Loading Area (October 12, 2004)
- Waiver of Requirement for Secondary Containment at Tank BAD-01 Tank Truck Loading Area (October 12, 2004)
- Waiver of Daily Secondary Containment Area Inspection Requirements during Bad Weather at Greater Prudhoe Bay, Milne Point, and Endicott and Badami (March 4, 2005)

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Appendix C

Consultation with USDOI, Fish and Wildlife Service (ESA Threatened Species)

ru

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

SURNAME
CK, Acty RSLE

FEB 17 2006

Memorandum

To: Regional Director
Fish and Wildlife Service, Region 7

From: Regional Director,
Alaska OCS Region

Subject: Endangered Species Act Consultations: Designation of a Non-Federal Representative

This memorandum serves as notification that pursuant to 50 CFR 402.08 the Minerals Management Service (MMS) has designated BP Exploration (Alaska) Inc. (BPXA) as the non-Federal representative for Endangered Species Act (ESA) consultations for the Liberty development project. The BPXA is also the applicant in the proposed federal action. As the designated non-Federal representative, BPXA will conduct informal consultations with the U.S. Fish and Wildlife Service (FWS) and prepare any requisite Biological Assessment (BA).

In accordance with 50 CFR 402.07, we are also advising the FWS that the MMS will be the lead agency for ESA consultations for the Liberty development project. The MMS will independently review and evaluate the scope and contents of the BA and is ultimately responsible for compliance with section 7 of the ESA.

Liberty is an oil field located about 5.5 miles offshore in the central Beaufort Sea. The BPXA is proposing to develop Liberty from onshore using extended reach drilling (ERD) technologies. The Liberty ERD project envisions an on-shore satellite with production sent by pipeline to an existing processing facility (Badami or Endicott).

Attached for your information is a copy of a Memorandum of Understanding (MOU), dated February 2, 2006, between the MMS, the Army Corp of Engineers (COE) and BPXA. This MOU sets forth responsibilities and a schedule to affect timely National Environmental Policy Act (NEPA) and permit evaluation processes for the Liberty development project. Attachment 2 to the MOU is a schedule for conducting the ESA and EFH consultations.

Jeff Walker with this office and Peter Hanley, BPXA Liberty HSE Manager, briefed you and your staff on the Liberty ERD project last fall. Additional briefings were also provided to the FWS Fairbanks office. We would be pleased to arrange an update briefing at your convenience. We would also appreciate information regarding your designated point of contact for the ESA consultation.

RD CHRC

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

MAR 26 2007

Memorandum

To: Regional Director, Region 7
Fish and Wildlife Service

From: Regional Director [signature] (acting)

Subject: Endangered Species Act, Section 7 Consultation, Beaufort Sea OCS Planning Area

BP Exploration (Alaska) Inc. (BPXA) is proposing to develop the Liberty reservoir using ultra-extended reach drilling technology drilling from the existing Endicott satellite development island (SDI). The Liberty reservoir is located in the Outer Continental Shelf (OCS). All development activities will be conducted from the Endicott SID. No activities are proposed to be conducted on the OCS.

The Federal actions associated with this project are the approval of a Development and Production Plan (DPP) from the Minerals Management Service (MMS) and a Section 10 and 404 permit from the U.S. Army Corps of Engineers (CORPS) for expansion of the Endicott SDI.

As required under Section 7 of the Endangered Species Act (ESA), the MMS and CORPS will be evaluating potential effects of authorizing this action to species listed and designated critical habitat under the ESA and will consult with the U.S. Fish and Wildlife Service (FWS) regarding the proposed actions.

By this memorandum, we request that the FWS specify what ESA listed, proposed, or candidate species, as well as designated critical habitat, may be in or near the Liberty development project area. Attached is the vicinity map of the project area from BPXA's draft Liberty Development Project Description. The MMS has designated BPXA as the non-federal representative to prepare the Biological Evaluation. We will provide the list to BPXA to assist them in preparing the evaluation of potential effects to ESA-listed species.

We are aware of the following species in or near the Beaufort Sea with status under the ESA for which FWS has management authority and that may be potentially affected by the proposed actions:

Common Name	Scientific Name	ESA Status
Spectacled eider	*Somateria fischeri*	Threatened
Steller's eider	*Polysticta stelleri*	Threatened
Kittlitz's murrelet	*Brachyramphus brevirostris*	Candidate
Polar bear	*Ursus maritimus*	Listing proposed

The MMS is also aware that the FWS has received a petition to list the yellow-billed loon (*Gavia adamsii*) under the ESA. We request that you inform us as to whether you foresee this species being listed or designated as a candidate species under the ESA within the next two years.

Please notify us of your concurrence with, or necessary revisions to, the above list of species and add any critical habitats that you believe would need to be considered in any biological evaluations related to the proposed actions.

If you have any questions on this consultation request or require additional information, please contact Mr. Mark Schroeder, MMS, 3801 Centerpoint Drive, Suite 500, Anchorage, Alaska 99503-5823, (907) 334-5247, or by email at mark.schroeder@mms.gov.

Attachment

cc: Field Supervisor, FFWFO
Judy Wilson, Chief ECU (MS 4042)
Jill Lewandowski, ENVD-EAB
Mike Holley, U.S. Army Corps of Engineers
Peter Hanley, BPXA

United States Department of the Interior
U.S. FISH AND WILDLIFE SERVICE
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701

April 3, 2007

John Goll, Regional Director
Minerals Management Service
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, AK 99503-5823

Re: Liberty Project
Beaufort Sea OCS Planning Area
Endangered Species List

Dear Mr. Goll:

This letter responds to your March 26, 2007 request for a list of endangered, threatened and candidate species and critical habitats pursuant to section 7 of the Endangered Species Act of 1973, as amended (Act). The following information is provided for the Minerals Management Service (MMS) in regards to the BPXA Liberty Project Development and Production Plan. The information below addresses only species and critical habitats that may be affected by activities within the Liberty project planning area. The following listed or candidate species are present:

Common Name	Scientific Name	Status
Steller's eider	*Polysticta stelleri*	Threatened
Spectacled eider	*Somateria fischeri*	Threatened
Polar Bear	*Ursus maritimus*	Listing Proposed
Kittlitz's murrelet	*Brachyramphus brevirostris*	Candidate

The Liberty project area is within the breeding ranges and migratory routes of the threatened Steller's eider and spectacled eider. Critical habitat has been designated for each threatened eider species, but none occurs in or near the Liberty project area.

The Liberty project area is within the range of the polar bear, which has been proposed for listing as a threatened species. No critical habitat has been proposed for the polar bear. A decision regarding the polar bear listing is expected in late 2007. While the polar bear is proposed for listing, the MMS may conference with the U.S. Fish and Wildlife Service (FWS) regarding potential effects of the Liberty project to polar bears.

Kittlitz's murrelet, a candidate species, occurs throughout southeast Alaska, and portions of the Bering and Chukchi Seas. Although Kittlitz'z murrelet is distributed outside of the immediate project area, they do occur within the maritime transportation corridor along coastal Alaska.

The Liberty project area is also within the breeding range of the yellow-billed loon (*Gavia adamsii*). The FWS has received a petition to list the yellow-billed loon under the Act, and a regional recommendation is currently under review by management in the FWS Washington office. A finding regarding the yellow-billed loon will hopefully be put forth in the near future.

This list applies only to endangered and threatened species under our jurisdiction. It does not preclude the need to comply with other environmental legislation or regulations such as the Clean Water Act. Please contact the National Marine Fisheries Service to determine the status of listed and proposed species under their jurisdiction in the shoreline and off-shore action areas.

Thank you for your query, and for your cooperation in meeting our joint responsibilities under the Act. The Fairbanks Fish and Wildlife Field Office is responsible for consultation, pre-listing, listing, and recovery activities pursuant to the Endangered Species Act for Interior and northern Alaska. If you need further assistance regarding the Liberty project, please contact Jewel Bennett with the Fairbanks Fish and Wildlife Field Office at (907) 456-0239.

Sincerely,

Jewel Bennett
Acting Branch Chief

Ted Swem
Branch Chief
Endangered Species

BIOLOGICAL ASSESSMENT
FOR SPECTACLED AND STELLER'S EIDERS
THE LIBERTY DEVELOPMENT PROJECT

Prepared by

LGL Alaska Research Associates, Inc.

1101 E. 76th Ave, Suite B, Anchorage, AK 99518

for

BP Exploration (Alaska) Inc.

P.O Box 196612

Anchorage, AK 99519-6612

May 2007

May 2007
P837

BIOLOGICAL ASSESSMENT
FOR SPECTACLED AND STELLER'S EIDERS
FOR THE LIBERTY DEVELOPMENT PROJECT

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May 2007

Suggested format for citation:

LGL Alaska Research Associates, Inc. 2007. Biological assessment for spectacled and Steller's eiders for the Liberty Development Project. Report prepared by LGL Alaska Research Associates, Inc. for BP Exploration (Alaska), Inc. Anchorage, Alaska. 55 p.

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1. INTRODUCTION AND BACKGROUND

The Liberty Development Project is being proposed by BP Exploration (Alaska) Inc. (BPXA) to develop an offshore oil reservoir located east of the existing Endicott Development in the Alaskan Beaufort Sea (Figure 1). The Liberty Development may have the potential to affect two bird species, the spectacled (*Somateria fischeri*) and Steller's (*Polysticta stelleri*) eiders, which are listed as "threatened" under the Endangered Species Act (ESA). Prior to development a Section 7 consultation with the U.S. Fish and Wildlife Service (USFWS) will be required. This Biological Assessment was prepared to provide an overview of the proposed Liberty Development and to present information on the distribution, abundance, and habitat use of the proposed project area by threatened eiders that can be used to determine how impacts from the proposed development may affect eiders. In addition, mitigation measures are presented that may be helpful in reducing or minimizing the potential impacts of the development on threatened eiders. This document is intended to provide support to the USFWS for the issuance of a Biological Opinion that will assess the proposed development and its potential to impact spectacled or Steller's eiders. The USFWS has also prepared Recovery Plans for both spectacled and Steller's eider (USFWS 1996, 2002) which will provide relevant information in development of a Biological Opinion.

The Liberty Development Project design and scope have evolved from an offshore stand-alone development on the Outer Continental Shelf (production/drilling island and subsea pipeline) — as described in the 2002 *Liberty Development and Production Plan Final Environmental Impact Statement* — to use of existing infrastructure involving an expansion of the Endicott Satellite Drilling Island (SDI) located on the Endicott causeway (Figure 1). This project evolution reflects a number of factors including environmental mitigation, advances in ultra-extended-reach drilling (uERD) technology, use of depth-migrated three-dimensional (3D) seismic data, and advances in reservoir modeling among others. As a result, BPXA believes Liberty can be developed with relatively few wells (up to six) and less environmental footprint and impacts than the originally proposed offshore development.

The Project Description that follows this introductory chapter is a summary of BPXA's *Liberty Development Project Development and Production Plan* (DPP; BPXA 2007) submitted to the Minerals Management Service (MMS) in April 2007. The DPP will initiate the permitting process and National Environmental Policy Act (NEPA) review.

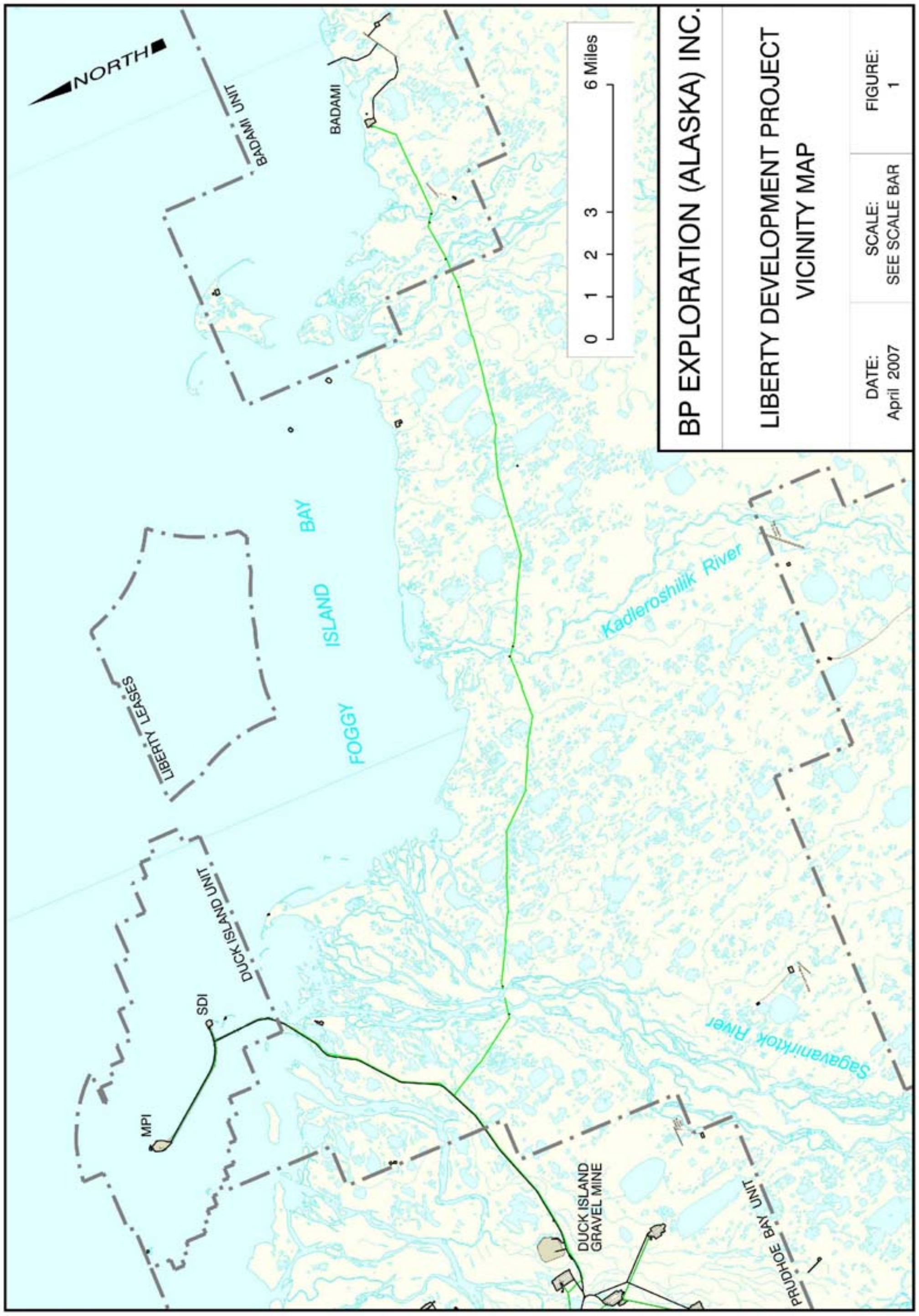

Figure 1. The Liberty Project area showing the offshore Liberty leases, the Endicott Main Production Island (MPI), and the Satellite Drilling Island (SDI) and the Endicott causeway.

Liberty Project History

BPXA has been moving forward on the Liberty Development Project since the fall of 1996, when BPXA first acquired Tract OCS-Y1650 in OCS Lease Sale 144 and initiated permitting activity for the Liberty #1 exploration well. The well was drilled and tested in the first part of 1997, and based on interpretation of geologic data, seismic data, and well tests, BPXA confirmed the discovery of the Liberty field on 1 May 1997. On 17 February 1998, BPXA submitted a DPP to MMS for review and approval of a Liberty Development Project based on a man-made gravel island with full production facilities and a buried subsea pipeline to shore. MMS issued a final environmental impact statement (FEIS) on the offshore project in 2002 (USDOI/MMS 2002). However, BPXA put the project on hold to further review design and economics after completion of its Northstar Project.

In August 2005, BPXA decided to pursue use of uERD from an onshore location. Such a project eliminates the offshore impacts of island and pipeline construction. Recent advancements in drilling technology have made such a project feasible. This change in project scope significantly mitigated the potential offshore environmental impacts related to the Boulder Patch, marine mammals, and concerns of the North Slope Inupiat communities related to the bowhead whale and subsistence whaling. It also made issues related to offshore pipeline design moot. This decision encouraged BPXA in August 2006 to pursue development of Liberty from an expansion of the existing Endicott SDI as summarized below. This decision to evaluate development using the existing infrastructure at Endicott further mitigates impacts of other options that were under consideration by avoiding construction of a pad on the shoreline of Foggy Island Bay or the coast near the Kadleroshilik River and an access road and pipelines crossing the Sagavanirktok River delta.

Project Overview

The Liberty prospect is located about 5.5 miles (8.8 km) offshore in about 20 ft (6 m) of water and approximately 5-8 miles (8-13 km) east of the existing Endicott SDI (Figure 1). To take advantage of the infrastructure at Endicott, BPXA has elected to drill the uERD wells from the SDI by expanding the island to support Liberty drilling. Liberty is one of the largest undeveloped light-oil reservoirs near North Slope infrastructure. BPXA estimates the Liberty Development could recover approximately 105 million barrels of hydrocarbons by waterflooding and using the ***LoSal™*** enhanced oil recovery (EOR) process (***LoSal™*** is a trademark of BP p.l.c.).

The development drilling program will include one to four producing wells and one or two water injection wells. No well test flaring is planned for this drilling program. Production from the Liberty uERD project will be transported by the existing Endicott production flowline system from the SDI to the Endicott Main Production Island (MPI) for processing. The oil will then be transported to the Trans Alaska Pipeline System via the existing Endicott sales-oil pipeline. Produced gas will be used for fuel gas and artificial lift for Liberty, with the balance being re-injected into the Endicott reservoir for enhanced oil recovery. Water for waterflooding will be provided via the existing produced-water injection system available at the SDI. This supply will be augmented by treated seawater if needed from the Endicott Seawater Treatment Plant. The ***LoSal™*** EOR process will be employed during a portion of the flooding and will be supplied by a ***LoSal™*** facility constructed on the MPI.

Associated onshore facilities to support this project will include upgrade of the existing West Sagavanirktok River Bridge or construction of a new bridge, ice road construction, and development of a new permitted mine site adjacent to the Endicott Road to provide gravel for expanding the SDI. Two new pipelines will be constructed from SDI to MPI for transport of water for injection and high pressure gas. Existing North Slope infrastructure will also be used to support the project.

All wells for this project will be outside current industry performance for this depth. As a result, the state-of-the-art of uERD must be advanced. BPXA first plans to drill a single well in order to assure that such drilling is feasible. If that well is successful and the technology is proven, then BPXA will proceed with drilling additional wells and installing new facilities to complete the project. The project will need to secure access to Duck Island Unit lands and Endicott area equipment for construction, drilling, and production operations. Terms for access must be agreed upon with the Endicott owners in a comprehensive facility sharing agreement. Negotiations on this agreement are ongoing.

2. PROJECT DESCRIPTION

Schedule

Figure 2 shows the overall project schedule for the proposed Liberty Development. The project currently includes the following milestones contingent on permits and facility access agreements:

- Construction of a purpose-built drill rig commencing in early 2008;
- SDI pad expansion and facilities installation in 2009;
- Construction of a new or upgrade of the existing West Sag River bridge in 2009;
- Fabrication and installation of well pad facilities in 2009;
- Rig assembly, commissioning, and crew training in early 2010; and
- Drilling the initial Liberty Development well starting in early 2010, with completion and first oil production in the first quarter of 2011.

Once the initial uERD technology has proven to be successful, BPXA will proceed with the remaining wells and facilities:

- Drilling of additional production and injection wells from mid- 2011 through the end of 2012;
- Installation of the Liberty inter-island pipelines in 2012; and
- Fabrication and installation of the ***LoSal™*** EOR process modules from mid-2011 through the end of 2012.

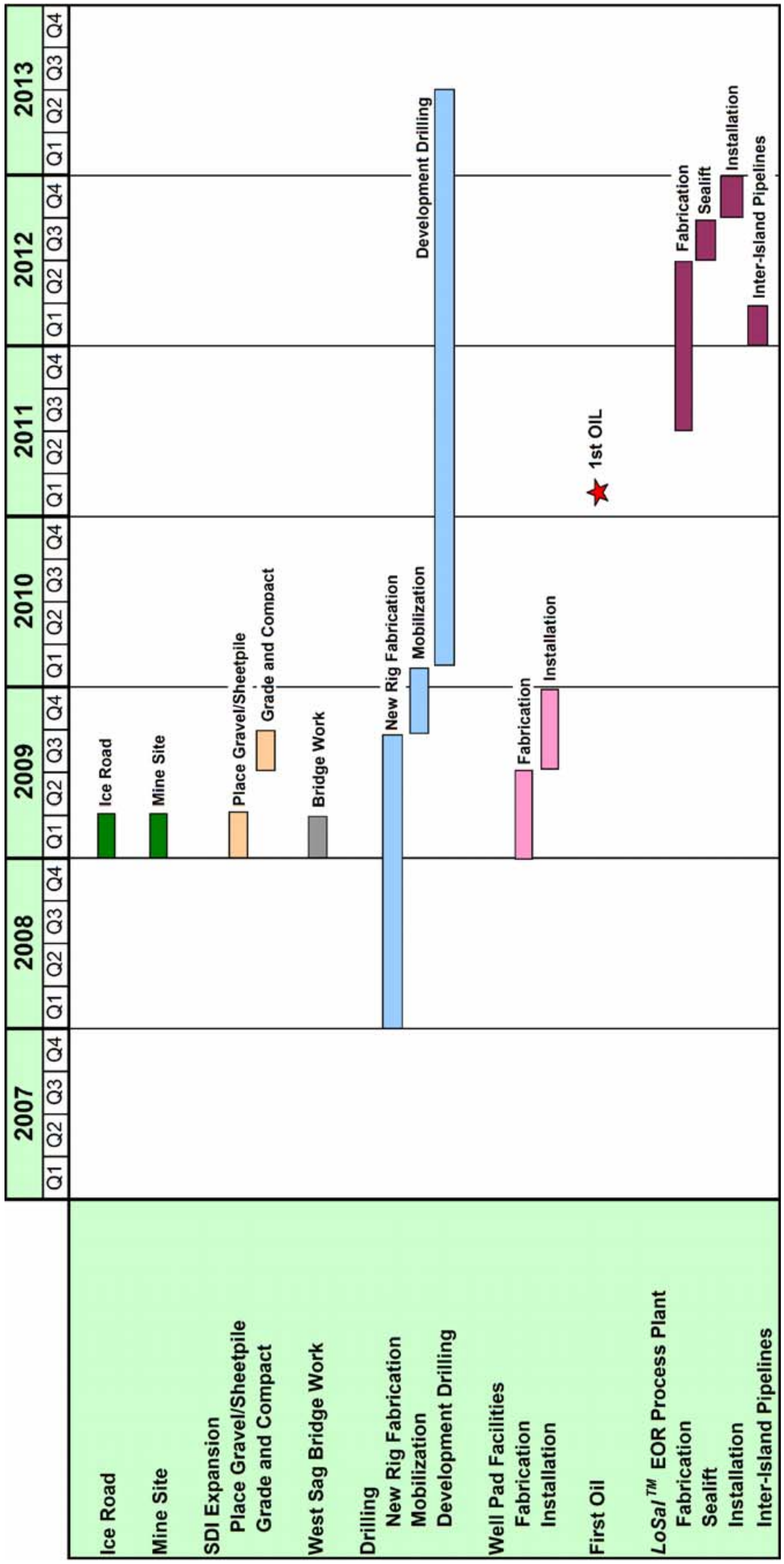

Figure 2. Schedule of development activities for the Liberty development.

Drilling operations may be required in subsequent years to accommodate development wells and/or existing well workovers. Final project abandonment would begin when project facilities are no longer needed, consistent with plans for abandonment of the Endicott facilities.

Construction

Liberty will use conventional North Slope construction methods, and the schedule will be governed by the usual seasonal constraints on North Slope activities.

Ice road construction

In order to expand the Endicott SDI, an ice road will be built starting in January 2009, or when seasonal conditions allow (Figure 3). The ice road is proposed to start from a new gravel mine site near the Duck Island mine site on the west side of the Endicott Road. The ice road will cross under one of the Endicott Causeway bridges (depending on water depth) in the Sagavanirktok (Sag) River delta and cross the sea ice to the south side of the SDI. This ice road will allow the gravel-haul trucks direct, unobstructed access to the SDI without affecting normal traffic on the causeway, which has a single-lane bridge.

Mine site development

The source of gravel for the SDI expansion is currently planned to be a new site east of the existing Duck Island mine site in the Sag River delta (Figure 3). Snow clearance and removal of unusable overburden will take place in January 2009 while the ice road is being built, followed by gravel excavation and hauling. The gravel haul will take place during a single winter season (early 2009). A mining and rehabilitation plan has been submitted to the State of Alaska, Department of Natural Resources, Division of Mining, Land and Water, for review and approval. Disposition of the overburden, plus any other stipulated reclamation measures, will be done according to the approved mining plan.

Satellite drilling island expansion

The Endicott SDI will be expanded to accommodate the new drilling rig, the Liberty wells, and the various production facilities and piping required to support the Liberty Development. The existing slope protection may be removed while the ice road is being built. The gravel haul will begin as soon as the ice road is ready, and the haul will be complete before breakup in mid-April 2009. In June and July following breakup, the fresh gravel on the SDI will be compacted to provide a suitable working surface, and new slope protection will be placed around the island.

West Sag River Bridge

BPXA is evaluating whether to upgrade the West Sag River Bridge or to construct a new bridge with up to two lanes upstream of the existing bridge. During 2009, the bridge may be upgraded or a new bridge may be constructed to accommodate increased traffic and vehicular loads for the project..

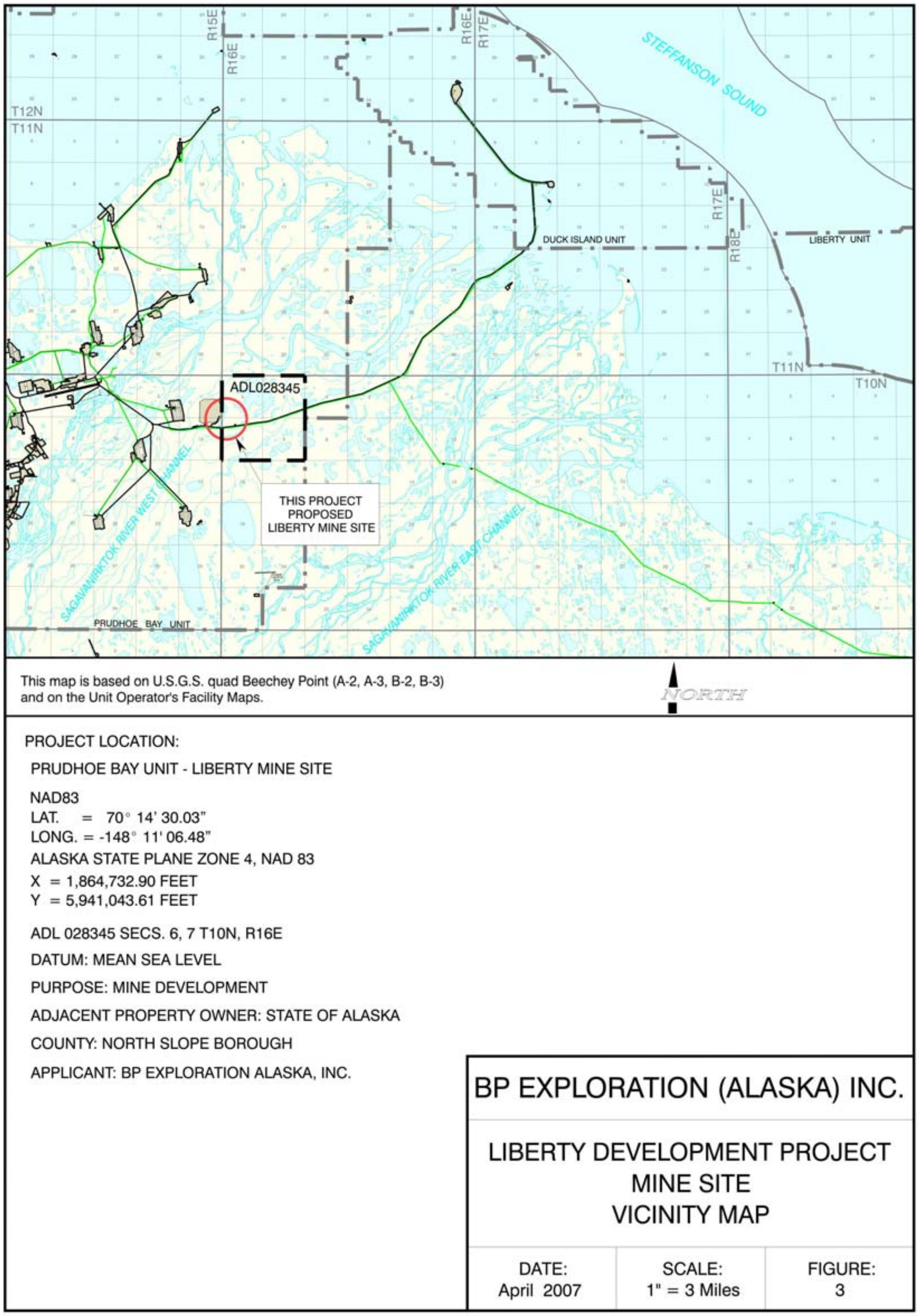

Figure 3. Location of proposed Liberty gravel mine site adjacent to existing Duck Island Mine Site.

Fabrication

Process facilities to support the initial drilling stage of the Liberty Development will be fabricated as truckable modules and shipped to the North Slope by road. These facilities include:

- A fuel gas conditioning skid to provide fuel to the rig engines;
- Interconnect piping, including production and test, gas lift, and water injection lines, for the initial wells; and

This work will commence in 2009 in order to be in place when drilling commences in the first quarter of 2010. A ***LoSal™*** enhanced oil recovery (EOR) process plant and supporting facilities will be fabricated during the second half of 2011 and first half of 2012 and sealifted to the site. This fabrication will be done at a site to be chosen later.

Pipeline construction

Two new pipelines will be constructed for ~3 miles between the Endicott MPI and SDI parallel to the existing inter-island pipelines: a ***LoSal™*** EOR process water injection pipeline and a high-pressure gas pipeline. Since these lines will be constructed on the Endicott Causeway, there are no seasonal constraints on their construction, however, installation of the pipeline is scheduled for winter 2012 in order to be operational by the time the ***LoSal™*** EOR process modules arrive. The current plan is for traditional North Slope elevated pipes placed on vertical support members (VSM).

Facilities installation

Facilities installation will take place in two stages. The relatively minor facilities required to support drilling and production of the first few wells will be installed in second half of 2009, while the ***LoSal™*** EOR process plant and associated modules will be installed in late 2012. Revamps to the Endicott Seawater Treatment Plant will occur during the summer of 2012 to support the ***LoSal™*** EOR process.

Drilling

Construction of the new, purpose-built drilling rig for the project is expected to begin by the first quarter of 2008. The first well should be spudded in 2010, with drilling of the remaining wells likely to extend through 2013.

Operations

Production operations will commence following hook-up of the first well in early 2011.

Project Access

Liberty Project transportation needs include safely transporting personnel, supplies, and equipment on a daily basis to and from the SDI during construction, drilling, and operations. During construction, quantities of pipe and gravel will be moved to the site. Drilling operations will require movement of a large quantity of pipe materials, heavy modules, chemicals, water, drilling mud, drill cuttings, and other supplies to and from the island. During ongoing field operations, limited equipment and supplies will be transported to the site. Equipment, supplies, and personnel will have access to and from the site via the existing Endicott road system, which connects with roads at Prudhoe Bay and with the Dalton Highway. Several different modes of transportation are currently available, and the following sections describe the basic features and limitations of each mode. Before construction begins, a detailed emergency evacuation plan will be completed addressing all phases of the project.

Air access

No regularly scheduled helicopter access to the Liberty area is needed because the Liberty Development is proposed as an extension to the SDI and is accessible from the existing Endicott road system. There will be sufficient area for helicopter landing for emergency evacuation of personnel on the SDI.

Ice roads

Ice roads are commonly used on the North Slope for winter travel, typically from late December through mid-April. Onshore and offshore ice roads will be built to support project construction, and in subsequent years, possibly to support drilling operations.

Marine access

Significant marine traffic is not needed to support Liberty construction and operation. A sealift by barge is planned to transport the ***LoSal*™** EOR process and power generation modules to the existing MPI dock. In addition, a dock is provided in the SDI design primarily for launching oil spill response boats and equipment. Extensive dredging is not expected to occur; however, some localized removal (e.g., screeding) of high spots on the seafloor may be required and will be determined by field survey.

Road access

The existing road system will provide access to Liberty facilities throughout the project. The West Sag River Bridge connecting the Endicott Road to the Prudhoe Bay road system provides access to the MPI and SDI from Deadhorse and other oilfield infrastructure, as well as the Dalton Highway. It is therefore a major transportation link for the project, but cannot support the load and traffic requirements for Liberty. BPXA is evaluating whether to upgrade the existing West Sag River Bridge or to construct a new bridge with up to two lanes upstream of the existing bridge.

The Liberty drilling rig is being designed in truckable modules for virtual year-round delivery. Following barging to Valdez or another suitable Alaskan port, from a fabrication site in the lower 48 states, approximately 460 tractor-trailerloads will be required via highway from Valdez to the SDI to transport the rig to the SDI drilling site for reassembly. The final rig mobilization plan will be developed as the rig construction schedule evolves and the fabrication site is chosen.

The existing road system will support the needs of Liberty uERD wells. Transportation of all drilling consumables, services, and support for Liberty will be similar to that for any other land-based project on the Prudhoe Bay road system. Because of the scale of each Liberty well, more of each product will be used per well, but the requirement will be spread over a much longer time. Thus, the daily traffic for moving drilling consumables will be about the same as for a typical North Slope well.

Drilling Pad

Conventional gravel placement will be used to extend the eastern and southern sides of the SDI to support project drilling, production operations, and infrastructure support functions (Figure 4; Table 1). The size of the SDI expansion is dictated primarily by the size of the drilling rig, storage requirements for drilling supplies, and a safe area for emergency evacuation and protection of workers.

The current working area of the existing SDI is approximately 11 acres, and the Liberty pad expansion will add approximately 20 acres of working area for facilities and drilling. Thus, the total combined working area will be 31 acres. Based on the slopes of the existing SDI and the expansion, the total footprint on the seabed of the expanded SDI will be approximately 40 acres versus the current 20 acres.

Island coordinates (NAD83) are 70°19'17.51"N, 147°34.8"W The island extension will be located in approximately 4 to 11 feet of water. Table 1 summarizes the SDI island design features.

Table 1. Summary of SDI design features.

ITEM	DESCRIPTION
Surface Dimensions (approximate)	704 by 1,394 feet
Height (working surface)	13 feet above MLLW
Gravel Volume	860,000 cubic yards
Dock Size	150 by 160 feet
Rock Riprap for Slope Protection	Approx. 6,000 cubic yards

Drilling pad structure

The extension of the SDI to accommodate the Liberty Project will be constructed of gravel from a new permitted gravel mine to the west of the Endicott Road; approximately 860,000 cubic yards of gravel will be required. The currently proposed island extension will have surface dimensions of 704 feet by 1,394 feet, and the gravel will be placed within a sheet-piled perimeter wall as protection from summer wave action and winter ice load. Consequently, the design bottom dimensions will be roughly the same as the

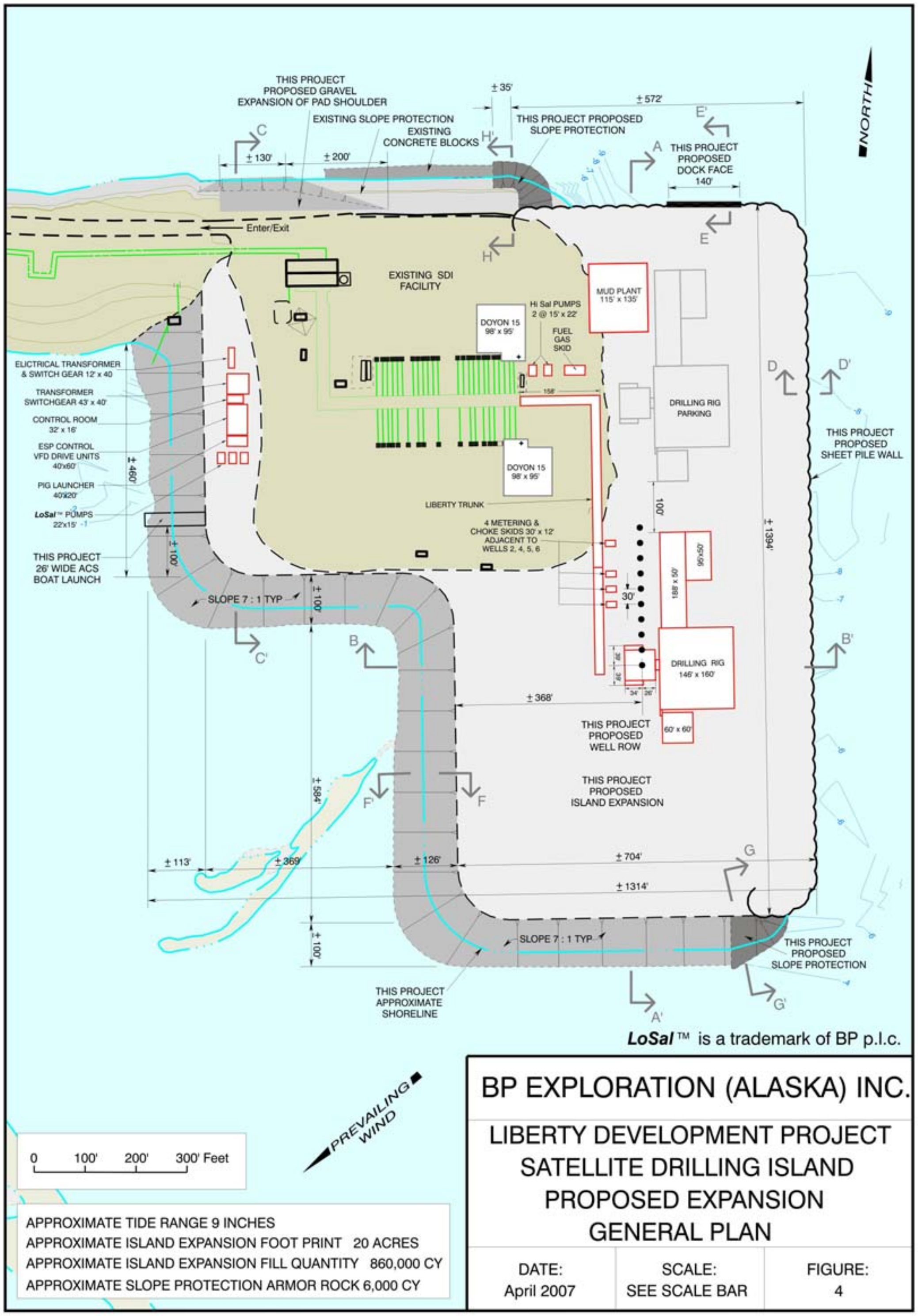

Figure 4. SDI expansion area and pad layout.

surface dimensions for the north and east sides. Where the sheet piling merges with the existing island slope protection, large pieces of rock will be used as riprap to stabilize the transition from the sheet piling to the existing concrete mat slope protection.

The island will have a working surface elevation of 13 ft above mean lower low water. The proposed sheet pile wall will protect the island form the erosive forces of waves, ice ride-up, and currents.

SDI surface layout

A single row of wells will be oriented north-south and offset from the existing SDI well rows by approximately 200 feet (Figure 4). The well row will start approximately 250 feet north of the southern end of the gravel expansion and will include 10 well slots (including spare slots) with the slots on 30-ft centers. The drilling rig will be capable of moving up and down the well row to access the desired well. The new Liberty wells will be tied into production, test, and water injection headers, which will in turn be tied into the existing SDI production test and injection headers.

The east side of the SDI expansion will be dedicated to drilling. Much of the work surface area on the island will be for storage of drilling consumables. The SDI has road access to the Prudhoe Bay drilling infrastructure for re-supply of drilling consumables.

Surface facilities that will be located on the SDI will include the following:

- Pipe rack and well tie-in piping
- Fuel-gas conditioning skid
- Booster pumps for high-salinity water injection
- Electrical transformer and switchgear
- Control room
- Transformer module for the electrical submersible pump variable frequency drive (ESP VFD)
- ***LoSal™*** pipeline pig-launcher module
- ***LoSal™*** EOR process injection pumps

The fuel-gas conditioning skid and the booster pumps for high-salinity water injection will be located to the north of the Liberty header tie-in to the existing Endicott pipe rack, while the ***LoSal™*** EOR process injection pumps will be located south of the existing Endicott SDI Module 405 on the south side of the existing pipe rack. The electrical transformer and switchgear and ESP VFD transformer module and the pig launcher module will be located south of Module 405 on the west side of the existing pipe rack.

Civil construction

Construction will commence during the winter of 2009. An ice road will be constructed along the west side of the Endicott Road in order to establish a traffic loop between the gravel mine site and the SDI for gravel hauling. The ice road will pass under one of the Endicott Causeway bridges depending on water depth.

The SDI island slope protection will be removed from east side of the existing island. This will occur progressively as gravel is dumped and pushed outward by front end loaders just beyond the intended expanded island perimeter. Gravel dumping and placement will continue until the whole footprint is complete. The island surface will be overbuilt to allow for settlement during the first summer.

A new gravel mine will be blasted and excavated just to the east of the existing Duck Island mine site. An ice road approximately 1,500 feet long will be constructed for access from the Endicott Road to the mine site. Vegetation and overburden will be stripped separately and stockpiled for restoration purposes. The gravel layer will be mined and hauled to the SDI using B70 haul units or similar.

Gravel will be hauled and dumped to build up the initial surface to approximately 1 to 2 feet above sea level. A vibratory roller will be used to provide initial compaction and provide a working surface for traffic. A mound of gravel will be stockpiled at the southwest corner of the island for eventual use for grading after the island has seasoned for the first summer. The existing slope protection on the east side of the SDI would be removed immediately prior to placing gravel.

Sheet piling would commence on the north side of the SDI, progress east and then south, and terminate at the southeast corner of the island expansion. The south end of the new island extension would not be sheet piled as it is not affected by ice or erosion forces. The sheet pile wall would be driven by a vibratory hammer to create an interlocking open-cell sea wall. Construction equipment would be supported on wooden mats. Additional gravel would be filled in behind the sea wall, which would be terminated at 13 feet above the MLLW sea level. A vibra-compaction roller would be used to consolidate the fresh gravel lift as placement progresses.

The gravel island will be overbuilt and allowed to settle during the summer after the placement of gravel. The gravel will be machine-graded during the summer to encourage settlement before the drilling equipment arrives on-site. If required, additional gravel will be hauled to the pad to make up for any localized settlement that may occur. The new island will be graded to integrate the surface drainage with the existing SDI drainage system, and a perimeter road will confine surface water drainage inside the island.

Pipeline System

Liberty production will be routed through facility piping from the wellheads into a new production header that will be tied into the existing SDI 24-inch-diameter production header. The commingled production from the SDI and Liberty will flow to the MPI for processing through Endicott's existing 28-inch-diameter flowline.

A ***LoSal™*** EOR process water injection line independent from the existing MPI-SDI water injection line will be routed between the MPI to the SDI. Additionally, a high-pressure gas line will be installed alongside the new water injection line.

Pipeline route

The pipeline route for the 10-in ***LoSal***™ water injection and the 6-in gas-lift pipelines will be along the existing Endicott gravel causeway between the SDI and MPI, a distance of approximately 3 miles (Figure 5). The pipeline will be on a new VSM system and on the lagoon side (west) of the existing Endicott SDI VSM system.

Design basis

The ***LoSal™*** and gas-lift pipelines will be elevated on standard VSMs. The ***LoSal™*** line will have a polyurethane foam insulation jacket. Expansion loops will be in an "L" loop configuration, spaced approximately 3,300 feet apart. The pipeline will have a minimum elevation of 7 feet above the ground surface.

Construction

The pipelines will be constructed in the first quarter of 2012. An ice road may be installed on the lagoon side of the Endicott Causeway to allow equipment access in winter. The water injection and gas pipelines will be supported on new VSMs between the MPI and SDI facilities. The above-ground pipeline will include expansion loops or offsets to account for thermal movement of the pipeline. Design and installation of the VSMs will be completed following typical procedures used for other elevated pipelines on the North Slope.

Safety and leak prevention measures

The proposed Liberty pipelines include the following measures to assure safety and leak prevention:

- The pipelines will be externally coated to prevent corrosion.
- Cleaning and inspection pigs will be run during operations.
- The elevated overland pipeline section will be conventional, proven North Slope design.

The existing 16-inch-diameter Endicott sales oil line will be used to export Liberty oil to Pump Station 1 of the Trans Alaska Pipeline System (TAPS). This line has isolation valves installed at both sides of the causeway bridges. The pipeline is monitored for leaks using the industry-standard mass-balance line-pack compensation system. The leak detection system meets all current Department of Transportation (DOT) and Alaska Department of Environmental Conservation (ADEC) leak detection requirements.

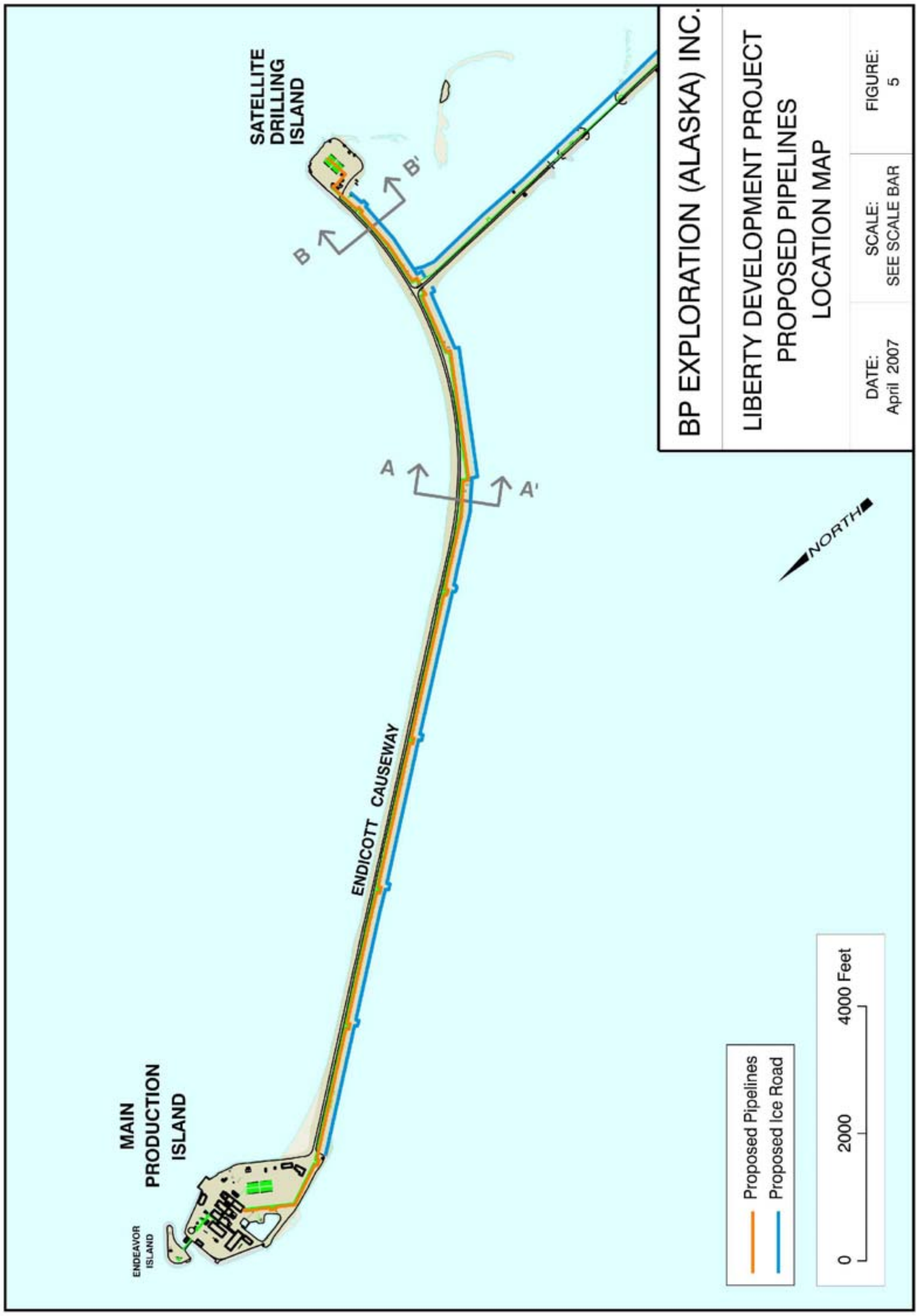

Figure 5. Location of proposed pipelines between SDI and the Endicott MPI, and possible winter ice road locations.

Monitoring and surveillance

Following is a summary of monitoring and surveillance for existing Endicott pipelines and planned new Liberty lines based on existing Endicott procedures. The *Oil Discharge Prevention and Contingency Plan* will provide detailed information on the proposed pipeline surveillance and monitoring program. The Liberty and Endicott pipelines will comply with ADEC regulations for surveillance, monitoring and record keeping for pipelines and flowlines (18 AAC 75).

- **Three-phase pipeline:** This existing 28-inch-diameter line is inspected annually to verify its condition. The pipeline material is duplex stainless, which is highly resistant to corrosion. It is not possible to smart-pig the line due to the non-magnetic properties of the steel. BPXA will conduct annual visual inspections combined with spot-item ultrasonic wall-thickness gauging, as well as digital radiography, to assess continuing pipeline integrity. Additionally, the line will be pigged annually with a cleaning pig to ensure that there is no deposition of sediment in the line.
- **Gas-lift pipeline:** This existing 14-inch-diameter line will be used initially to provide fuel gas for the Liberty Project. This line is visually inspected for external corrosion every year, with particular emphasis at the pipeline vault under the Endicott Causeway "T" junction.
- **Water injection pipeline:** This existing 14-inch-diameter water line is routinely pigged approximately once a month. The line was also smart-pigged in 2006 and its integrity was confirmed.
- **Gas and *LoSal*™ EOR water injection pipelines:** When Liberty production warrants, a new 6-inch-diameter gas line and 10-inch-diameter water line will be installed, and they will be smart-pigged at start-up to provide baseline wall-thickness data against which future pigging runs can be compared. The lines will then be pigged and inspected at a similar frequency to the existing Endicott gas and water injection lines.
- **Sales oil line:** The existing 16-inch-diameter Endicott sales line will be used to export Liberty production to Pump Station 1. This line was smart-pigged in 2006 to confirm its integrity. The line was verified to be in good condition, and it will continue to be smart-pigged every 5 years. The line is subject to routine cleaning pig runs every 3 months.

3. DESCRIPTION OF LISTED EIDERS OCCURRING IN THE LIBERTY PROJECT AREA

Spectacled Eider

Population status

The spectacled eider is a medium-sized sea duck that breeds along coastal areas of western and northern Alaska and eastern Russia, and winters in the Bering Sea (Petersen et al. 2000). Three breeding populations have been described: one in the Yukon-Kuskokwim (Y-K) delta in western Alaska, a second on the North Slope of Alaska, and the third in arctic Russia. During the 1970s approximately 50,000 female spectacled eiders nested in western Alaska. Data collected by the USFWS from ground-based study plots in the Y-K delta suggested that the number of female spectacled eiders nesting in the delta declined by approximately 8 to 14% per year from the 1970s to 1992 (Stehn et al. 1993; Ely et al. 1994). By 1992 the Y-K delta spectacled eider population was reduced to approximately 4% of the population existing there in the 1970s and it was federally listed as a threatened species in 1993 (58 *FR* 27474).

Little information is available describing the status of the North Slope spectacled eider population prior to 1992. Historically the North Slope population has likely been much smaller than the Y-K delta population. The USFWS began conducting aerial surveys for breeding eiders on the North Slope in 1992 that have continued annually through the 2006 breeding season (Larned et al. 2006). The 1992 survey was flown too late in the season to be included in analyses with subsequent years, but since 1993 the North Slope spectacled eider population has remained relatively stable with a non-significant decreasing trend (Larned et al. 2006). During this time period the indicated total spectacled eider population index for the North Slope survey area has ranged from approximately 5,000 to 9,000 birds. This index represents an unknown proportion of the population occupying the survey area during the nesting season that is based on the presence of adult males. The proportion is assumed to be constant among years and the index is used to track population changes through time. Eider nesting phenology on the North Slope is related to environmental conditions such as temperature and snow melt, and the timing of surveys can be an important factor when considering results of spectacled eider surveys (TERA 1997).

The largest spectacled eider breeding population is located in arctic Russia. The population there has been estimated at >140,000 individuals (Hodges and Eldridge 2001). Based on estimates of the wintering population in the Bering Sea, the total world population may number around 375,000 birds (Larned and Tiplady 1999).

Spring migration

Spring migration routes of spectacled eiders are not well documented. Most of the data are from counts of eiders as they pass Point Barrow in late May and early June (Suydam et al. 1997, 2000). During spring migration thousands of king (*Somateria spectabilis*) and common (*S. mollissima*) eiders follow offshore leads and small numbers of spectacled eiders have been recorded during spring counts. Richardson and Johnson (1981) also reported small numbers of spectacled eiders offshore during spring migration east of the Colville River at Simpson Lagoon although some of these birds may have been local breeders rather than migrants. Few researchers have conducted inland counts of migrating birds on the North Slope, but Myers (1958) reported that spectacled eider was the most abundant eider species migrating along river systems south of Barrow in spring. Since only small numbers of spectacled eiders have been recorded migrating along the coast during spring, it may be that most birds migrate overland across the Arctic Coastal Plain (ACP) following river drainages.

Nesting

Spectacled eiders arrive on the North Slope in late May or early June. They occur in low densities across the North Slope from Wainwright to at least the Shaviovik River east of the Prudhoe Bay area. The highest concentrations occur within ~70 km of the coast in the Northwest National Petroleum Reserve-Alaska (NPR-A) between Barrow and Wainwright, and in the Northeast NPR-A north of Teshekpuk Lake (USDOI/BLM/MMS 1998; USDOI/BLM/DU 2002; Larned et al. 2006). Overall densities during the eider breeding population surveys on the ACP have ranged from ~0.174 to 0.305 birds/km^2 between 1993 and 2006 (Larned et al. 2006). The density during the 2006 breeding population survey was 0.219 birds/km^2.

In general, spectacled eider density on the ACP is greater in the western portion of its range and decreases to the east although localized areas of relatively high density occur in the eastern portion of the range near the Colville River and Prudhoe Bay (Larned et al. 2006). The Liberty project area is located near the eastern edge of the ACP spectacled eider range. Spectacled eider density ranged from 0.02-0.44 birds/km^2 at locations relatively close to the Liberty project area (Table 2). TERA (2000) reported few spectacled eiders east of the Badami oil field during aerial surveys in 1999.

Table 2. Spectacled eider densities reported at various locations near the proposed Liberty project area.

Location	Density (birds/km^2)	Reference
Eastern NPR-A	0.02-0.04	Burgess et al. 2003a
Colville River Delta	0.2	Burgess et al. 2003b; Johnson et al. 2003a
Kuparuk Oil field	0.08	Anderson et al. 2003
Milne Point Area	0.22-0.44	TERA 1997
Prudhoe Bay Area	0.18-0.38	TERA 1996
Sagavanirktok River Delta	0.04-0.32	TERA 1996
Kadleroshilik River Area	0.12-0.22	TERA 1995
Shaviovik River Area	0.08-0.14	TERA 1995

In general on the ACP spectacled eiders breed near large shallow productive thaw lakes, often with convoluted shorelines and/or small islands (Larned and Balogh 1997) and nest sites are often located within 1 meter of a lake shore (Johnson et al. 1996). Spectacled eiders on the Colville River delta nested in salt-killed tundra, aquatic sedge with deep polygons, and patterned wet meadow, although only salt killed tundra was preferred based on an analysis of habitat selection (ABR 2002; Johnson et al. 2003a). However, because of the low sample size, the analysis may have lacked the power to determine significant preferences. In the Kuparuk oilfield Anderson et al. (1999) reported that spectacled eider nests were located in basin wetland complexes, a mosaic of water bodies with stands of emergent vegetation and complex shorelines with numerous islands and peninsulas. Spectacled eiders on the ACP nest mainly in areas near the coast rather than at inland locations (Derksen et al. 1981; Burgess et al. 2003b). Of 62 nests reported in the Colville River delta, none were further than 13 km from the coast (Burgess et al. 2003b).

Based on a small sample size of band returns, there is some evidence that spectacled eider males as well as females may exhibit both breeding site and mate fidelity (TERA 1997). Females begin to lay eggs during the second week of June and clutch sizes range from 4 to 9 eggs, although 5 to 6 is more common (Dau 1974). The incubation period is approximately 24 days and males depart the breeding grounds with the onset of incubation. Broods are quite mobile and may move as much as 1 to 3 km from the nest site within the first few days after hatching (TERA 1996). TERA (1996) reported that some broods moved to areas used for feeding by females prior to the onset of incubation. In the Y-K delta, Grand et al. (1994, cited in TERA 1995) reported that 1 spectacled eider brood moved as far as 14 km from the nest site. In most cases brood-rearing apparently does not occur in ponds adjacent to nest sites even if suitable habitat is present (TERA 1995) indicating that not only is the nest site location important, but spectacled eiders may also require a much larger area in the general vicinity of the nest site for brood-rearing. After an initial post-hatch dispersal in the Prudhoe Bay area there was a tendency for broods to settle into a particular area for a time, and then abruptly move to a new area. Juvenile birds in the Y-K delta departed the breeding grounds approximately 59 days after hatch (Flint et al. 2000a).

Post-nesting period

Most males depart the breeding grounds in mid-June after the onset of incubation moving to coastal bays and lagoons to molt and stage for fall migration. Important molting and staging areas include Harrison Bay and Simpson Lagoon, Smith Bay, Peard Bay, Kasegaluk Lagoon, Ledyard Bay, and eastern Norton Sound (LGL 1992; Larned et al. 1995; Springer and Pirtle 1997; Petersen et al. 1999; TERA 1999; Troy 2003). TERA (1999) and Troy (2003) reported that some males may travel overland to the Chukchi Sea, but that some birds also remain about 10 km offshore in Harrison Bay for 7 to 10 days before continuing their fall migration to molting areas such as Ledyard Bay in the Chukchi Sea. Based on satellite telemetry data, males moving overland along the coast directly to the Chukchi Sea departed the breeding grounds earlier than those that lingered in the Beaufort Sea (Troy 2003). However, Petersen et al. (1999) reported that molt and fall migration occurred in offshore waters and found no evidence that spectacled eiders nesting on the ACP migrate over the coastal plain in the fall. Fischer et al. (2002) reported that spectacled eiders were generally uncommon in offshore surveys from Harrison Bay to Brownlow Point with small numbers occurring in July and August in Harrison Bay. During this time, Simpson Lagoon and Harrison Bay may be important staging areas for several weeks (TERA 1999; Petersen et al. 1999).

Successful females and young of the year begin to depart the breeding grounds in late July and movement continues until the end of August. Early departing females may be non-breeders or have had failed nesting attempts. Troy (2003) reported that female spectacled eiders use Beaufort Sea waters from east of the Sagavanirktok River west to Barrow and beyond to the Chukchi Sea. Spectacled eiders have been reported during migration in the offshore waters of the Beaufort Sea near the mouth of the Colville River, Harrison Bay, and Smith Bay, and near the coast in the area northwest of Teshekpuk Lake. Arrival onto molting areas, departure from molting areas to winter areas, and arrival onto wintering areas follow a similar pattern; males are followed by unsuccessful females which are followed by successfully breeding females (Petersen et al. 1999). More female than male spectacled eiders may migrate through the offshore marine waters of the Beaufort Sea because more open water exists in offshore areas when females depart than earlier in the year when males migrate which allows for more extensive use of marine habitats by later migrating birds. TERA (1999) reported that the average distance offshore for migrating males was 10.1 km compared to 21.8 km for migrating females.

Non-breeding season

Most of the spectacled eider world population winters in the Bering Sea south of St. Lawrence Island (Petersen et al. 1999). Based on counts and photography from aerial surveys, this population may number around 360-375,000 (Larned and Tiplady 1999). The birds congregate in this area to forage for invertebrates at depths of 45-70 m in areas of open leads. Petersen et al. (1998) reported that spectacled eider stomach samples from birds collected near St. Lawrence Island included snails, clams, barnacles, amphipods, and crabs. The samples were collected during May-June of 1987 and 1992 and the primary species group consumed was the clam *Macoma* sp. However, Lovvorn et al. (2003) reported that esophagi of spectacled eiders collected on the wintering grounds southwest of St. Lawrence Island contained only clams, mostly *Nuculana*, without a trace of *Macoma*. The difference in diet at the two locations likely reflects differences in prey availability. Global climate regime shifts have the potential to alter prey communities that could impact the spectacled eider population.

Factors affecting population status

The reasons behind declines in spectacled eider breeding populations are unknown. On the ACP, historical data are lacking and the extent of declines there, if any, are difficult to assess. On the Y-K delta, a number of potential factors that may have contributed to the spectacled eider population decline there have been identified but the relative importance of each has not been determined. Possible factors that may affect spectacled eider are discussed below. It is possible that a single factor alone may not be the cause of the spectacled eider population decline, and that the decline may have resulted from a combination of factors.

Lead shot ingestion. Extensive research has been conducted on the effects of ingestion of lead shot by foraging birds and lead poisoning has been confirmed to be a cause of mortality for spectacled eiders on the Y-K delta. The first reports of lead poisoning in spectacled eiders came from 4 birds found dead or moribund on the Yukon Delta National Wildlife Refuge from 1992 to 1994 (Franson et al. 1995). Ingested lead shot was found in the lower esophagus of one bird, and analyses revealed higher than normal lead concentrations in the livers of dead eiders. Subsequent studies examined lead-exposure rates of Y-K delta spectacled eiders (Flint et al. 1997). Ingested lead shot was detected in the gizzards of 11.6% of the birds sampled. During the brood-rearing period, 13.0% of the adult females and 6.6% of the adult males sampled had elevated blood lead levels, and during the brood-rearing period, 35.8% of the adult females and 12.2% of the ducklings had been exposed to lead. Flint and Grand (1997) also reported mortality of female spectacled eiders due to lead poisoning resulting from ingestion of lead shot and speculated that lower adult female survival during the breeding season may be contributing to the overall population decline. Franson et al. (1998) collected 342 blood samples from spectacled eiders in the Y-K delta and reported detectable lead in 58% of the samples. Detectable concentrations of lead occurred more frequently in females than in males upon arrival, and maximum lead concentrations in the blood of females was greater than that of males and ducklings. Grand et al. (1998) reported that female spectacled eiders on the Y-K delta exposed to lead prior to hatching their eggs survived at a much lower rate than females not exposed to lead before hatch. During a study of spectacled eider brood survival in the Y-K delta, Flint et al. (2000a) reported detectable concentrations of lead in 73.7% of the bones of depredated female spectacled eiders and 21.1% of the duckling bone samples. Flint (1998) established experimental plots to determine the settlement rates of lead shot in wetland types commonly used by foraging waterfowl. There was no change in the proportion of lead shot collected in the surface layer of the habitats sampled over a 3 year period suggesting that spent lead shot persists in waterfowl foraging habitat for many years.

Predation pressure. Tundra nesting birds are subjected to predation pressure from arctic (*Alopex lagopus*) and red (*Vulpes vulpes*) foxes, grizzly bears (*Urus arctos*), gulls, jaegers (*Stercorarius* sp.), common ravens (*Corvus corax*), and snowy owls (*Nyctea scandiaca*; Day 1998). Some predators, such as ravens, gulls, arctic fox, and bears may be attracted to areas of human activity where they find anthropogenic sources of food and denning or nesting sites (Eberhardt et al. 1982; Day 1998; Burgess 2000). The availability of anthropogenic food sources associated with villages or North Slope development, particularly during the winter, may increase winter survival of arctic foxes and contribute to increases in the arctic fox population. Anthropogenic sources of food at dumpsters and refuse sites may also help to increase populations of gulls and ravens above natural levels. Major negative impacts have occurred at the Howe Island goose colony in the Sagavanirktok River delta from predation by arctic fox and grizzly bears during some years (Johnson 2000), and arctic foxes and glaucous gulls (*Larus hyperboreus*) are predators of common eider and brant (*Branta bernicla*) eggs and young on the barrier islands (Noel et al. 2002). Increased levels of predation due to elevated numbers of predators could impact nesting and brood-rearing spectacled eiders.

Subsistence hunting. Subsistence harvest of eider eggs and adults occurs in coastal areas during the spring and fall. Subsistence harvest reports with information on spectacled eider harvest are available primarily for the Y-K delta, Bristol Bay, Alaska Peninsula (AMBCC 2006). Few data are available from the North Slope villages however, Braund (1993) reported 155 spectacled eiders taken at Wainwright during 1988-1989, and 2 reported from Barrow.

Contaminants. Exposure to contaminants, including petroleum-related compounds, organochlorinne compounds, and heavy metals, has also been proposed as a possible contributing factor in the decline of the spectacled eider population. Trust et al. (2000)

sampled male spectacled eiders from St. Lawrence Island and reported that a few contained trace concentrations of chlorinated organic compounds. However, levels of copper, cadmium, and selenium were elevated when compared to literature values for other marine birds. Other elements that could potentially impact eiders include mercury and zinc (Stout 1998; Stout et al. 2002). However, the birds sampled by Trust et al. (2000) appeared to be in good health and if the presence of contaminants is a factor involved in the spectacled eider population decline, it may act by reducing fecundity or survival of young rather than via direct health impacts on adults.

Effects of research activities. There has been speculation that researchers conducting studies on avian nest density and success may inadvertently affect the results by attracting predators to nests and broods (Bart 1977; Götmark 1992). Birds that are flushed from their nests during surveys may be more susceptible to nest predation than undisturbed birds. Ongoing activities by researchers could cause some mortality to spectacled eider eggs and chicks. The collection of birds for dietary or contaminant studies obviously impacts small numbers of spectacled eiders. Implantation of satellite transmitters has provided the best information available on spectacled eider movements and locations of molting and winter areas, but the invasive nature of the surgery may impact the survival of a small number of birds.

Other factors. Spectacled eider survival may also be affected by habitat loss and disturbance related to development, disease, parasites, potential changes in availability of prey related to global climate change, and the potential for fishing industry activities to impact benthic feeding areas in molting and/or wintering areas. The overall impact of the individual sources of take and their cumulative effects on spectacled eiders are unknown. Petersen and Douglas (2004) suggested that annual population estimates on the breeding grounds can be negatively affected by extended periods of dense sea-ice concentration and weather on the wintering grounds in the Bering Sea. However, their study did not support the hypothesis that changes in the benthic community in the wintering area had contributed to the decline or inhibited the recovery of the spectacled eider breeding population.

Critical habitat

The USFWS has established spectacled eider critical habitat for molting areas in Ledyard Bay and Norton Sound, for breeding areas in the Y-K Delta, and for wintering areas in the Bering Sea south of St. Lawrence Island (USFWS 2004). No critical habitat for spectacled eiders has been declared on the ACP.

Steller's Eider

Population status

Steller's eiders breed across coastal eastern Siberia and the ACP of Alaska. A smaller population also breeds in western Russia and winters in northern Europe (Fredrichson 2001). Steller's eiders were formerly common breeders in the Y-K delta but numbers there declined drastically and Kertell (1991) reported that Steller's eider was apparently extinct as a breeding species on the Y-K delta. However, Flint and Herzog

(1999) reported single Steller's eiders nests in the Y-K delta in 1994, 1996 and 1997, and 3 nests in 1998. Steller's eiders continue to nest in extremely low numbers in the Y-K delta (MMS 2006). Steller's eider density on the ACP is low and the largest population that may include over 128,000 birds is located in eastern Russia (Hodges and Eldridge 2001). Steller's eider was federally listed as a threatened species in 1997 (62 *FR* 31748-31757) due to a reduction in the number of breeding birds and suspected reduction in the breeding range in Alaska.

The historical range of Steller's eider on Alaska's ACP apparently extended from Wainwright east into the Canadian Northwest Territories (Johnson and Herter 1989, Quakenbush et al. 2002, and references therein). Steller's eiders are currently reported east at least to Prudhoe Bay where it is considered to be rare (TERA 1997) but no recent records have been reported east of the Sagavanirktok River (Quakenbush et al. 2002). Steller's eider has not been recorded nesting east of Cape Halkett other than one recent record inland near the Colville River (Quakenbush et al. 2002). Aerial surveys conducted by USFWS indicate that Steller's eiders are widely distributed across the ACP in low densities (0.01 birds/km^2 in 2006, Larned et al. in 2006) from Point Lay to the Sagavanirktok River with very few sightings east of the Colville River. The highest concentrations occur near Barrow (Quakenbush et al; 1995, 2002; Ritchie et al. 2006) although breeding there does not occur every year and may be related to predator/prey cycles (Quakenbush and Suydam 1999). During the 1990s, Steller's eider breeding at Barrow coincided with highs in the lemming population.

Mallek et al. (2006) reported lower than average population indices for Steller's eiders on the North Slope for the period 2000-2005 when the indices ranged from 0 to 563 birds. The long-term average for the index had been 968 birds for the period 1986-2001 (Mallek et al. 2003). However, Larned et al. (2006) reported an increasing growth rate for Steller's eiders during eider breeding pair surveys on the North Slope during the last 7 years (2000-2006). Differences in the two trends may be related to survey timing and variability within the surveys is high. However, based on comparisons of historical and recent data, Quakenbush et al. (2002) suggested that a reduction in both occurrence and breeding frequency of Steller's eiders had occurred on the ACP with the exception of the Barrow area. Larned (2005) also reported a declining trend during annual spring surveys for Steller's eiders in the Bristol Bay area.

Spring migration

In the spring the majority of the world population migrates along the Bristol Bay coast of the Alaska Peninsula, crosses Bristol Bay toward Cape Pierce, and continues northward along the Bering Sea coast (Larned 2005). Most of these birds migrate to breeding grounds in Siberia with small numbers moving to the Arctic Coastal Plain of Alaska. Small numbers of Steller's eiders may also breed in the Y-K delta.

Nesting

Steller's eiders arrive on the ACP in early June and evidence from the Barrow area suggests that nesting effort may vary from year to year (Quakenbush and Suydam 1999). At Barrow, Steller's eiders apparently nest during high lemming years when predators, such as snowy owl and pomarine jaeger (*Stercorarius pomarinus*) that feed on lemmings, are also nesting. Steller's eiders, as well as snowy owls and pomarine jaegers, may not nest at all during low lemming years. This cycle has been consistent since the initiation of intensive studies of Steller's eider nesting biology in the Barrow area in 1991 and has continued through 2006 (Quakenbush et al. 1995; Obritschkewitsch et al. 2001; Obritschkewitsch and Martin 2002 a, b; Rojek and Martin 2003; Rojek 2007). Theoretically, an ample supply of lemmings may divert potential predators away from eider eggs and chicks thus making it more advantageous for eiders to nest during years of high lemming populations. Some evidence also suggests that Steller's eiders may benefit by nesting close to nests of avian predators such as jaegers and snowy owls. These aggressive birds defend their own nests against other predators, and eider nests located nearby may benefit when potential predators are driven from the area. Other variables, such as weather and snow conditions did not explain the inter-annual variability of eider nesting. Although intensive studies of Steller's eider breeding biology have been conducted in the Barrow area, little information is available for other portions of the ACP where most information consists of scattered sightings during aerial surveys.

Steller's eiders nests are located on tundra habitats often associated with polygonal ground both near the coast and at inland locations. Emergent *Carex* and *Arctophila* provide import areas for feeding and cover. Males may remain on the breeding grounds for two weeks after the onset of the 24 day incubation period (Fredrichsen 2001). Clutch size ranges from 3 to 8, but averages 5 to 6 eggs. Nest success is variable and ranged from approximately 14 to 71% at Barrow in the 1990s (Quakenbush and Suydam 1999). Nest predators include jaegers, common ravens, glaucous gulls, and arctic foxes. Avian predators including snowy owls, and peregrine and gyrfalcons, have been the predominant natural cause of adult Steller's eider mortality. Steller's eider broods apparently are less mobile than those of spectacled eiders and remain in ponds with emergent *Carex* and *Arctophila* within a few hundred meters of the nest site.

Post-nesting period

Male departure from the breeding grounds begins in late June or early July. Most of the available information on migration comes from Barrow where birds disperse across the area from Admiralty Inlet to Wainwright and enter marine waters during the first week of July. They make use of coastal areas along the Chukchi Sea coast from Barrow to Cape Lisburne, and also use bays and lagoons of Chukotka (USDOI/BLM 2003). Females that fail in breeding attempts may remain in the Barrow area into late summer (USDOI/BLM 2003). Females and fledged young depart the breeding grounds in early to mid-September. Male and non- or failed breeding Steller's eiders concentrate in several lagoons on the Alaska Peninsula in August and September to molt (Flint et al. 2000b).

Non-breeding season

Steller's eiders spend most of the year in shallow marine habitats along the Alaska Peninsula and the eastern Aleutian Islands to lower Cook Inlet with stragglers south to British Columbia. In Eurasia they winter from Scandinavia and northern Siberia south to the Baltic Sea, southern Kamchatka, and the Commander and Kurile islands (Johnson and Herter 1989).

Factors affecting population status

Causes for the decline of the Steller's eider population in Alaska are unknown but may include increased predation pressure on the North Slope and Y-K delta breeding grounds, subsistence harvest, ingestion of lead shot, and contaminants (Henry et al. 1995). Bustnes and Systad (2001) also suggested that Steller's eiders may have specialized feeding behavior that may limit the availability of winter foraging habitat. Steller's eiders could be affected by global climate regime shifts that cause changes in prey communities.

Critical habitat

The USFWS has established Steller's eider critical habitat in the Y-K Delta nesting area, the Kuskokwim Shoals, and at the Seal Island, Nelson Lagoon, and Izembek Lagoon units on the Alaska Peninsula (USFWS 2004). No Steller's eider critical habitat has been established on the ACP.

4. AVENUES OF TAKE FOR LISTED EIDER SPECIES RESULTING FROM ACTIVITIES IN THE LIBERTY PROJECT AREA

Development activities on the North Slope have the potential to impact bird species in both positive and negative ways. Various types of development activities are discussed below in terms of their potential to impact spectacled and Steller's eiders. The focus of the discussion below is oriented toward spectacled eider which occurs regularly in low densities within the project area. Steller's eider is a rare species within the project area that is likely to occur only sporadically.

Habitat Loss

Habitat loss for tundra nesting birds during oil field development on the North Slope has resulted primarily from the placement of gravel during construction of infrastructure and from gravel mining. Tundra covered by gravel fill during the construction of roads and pads is lost as nesting habitat for tundra birds, and gravel mine sites that were once covered by tundra cannot be used for nesting by most bird species. Loss of nesting habitat through gravel placement and mining is permanent unless these areas are rehabilitated after abandonment of the field.

Gravel placement

After examining several onshore and offshore options for development of the Liberty reservoir, BP determined that the most practical development option would be to use extended-reach drilling from SDI to access the offshore reservoir. This option will require expansion of the existing pad at SDI from ~11 acres to 31 acres (working surface) which will require ~860,000 yd^3 of gravel fill. Gravel placement during the expansion of SDI will be confined to the waters surrounding SDI and will not impact tundra habitats. The placement of gravel for expansion should not have any impact on spectacled eider nesting habitat.

For the current construction option which calls for the use of sheet piling during the SDI expansion process, the footprint of the SDI expansion on the seabed will increase from ~20 acres to 40 acres. The SDI extension will be located in ~4-11 ft of water and could result in the loss of ~20 acres of potential feeding habitat for eiders or other diving waterfowl species. The abundance of mollusks and other invertebrates in this area that may be utilized as a food source by eiders is unknown. Due to the low densities of spectacled eiders in the general area, it is unlikely that many eiders would be impacted by this loss of feeding habitat. Due to their low density in the project area, few spectacled eiders would likely be affected by loss of feeding habitat. Eiders that may have used this area for feeding would be able to move to adjacent habitats.

Gravel mining

Gravel mining would have the potential to result in the loss of spectacled eider nesting habitat. BPXA has selected a site adjacent to the existing Duck Island Mine Site along the Endicott road (Fig. 3) as a gravel source for the Liberty project. Small numbers of spectacled eiders may nest in wetlands near this proposed gravel mine site. The site is located in the Sagavanirktok River delta along the Endicott road near locations where spectacled eiders have been reported during aerial surveys (TERA 1996). TERA (1996) reported spectacled eider density in this area ranging between 0.04 and 0.32 eiders/km^2. Larned et al. (2006) reported spectacled eider densities ranging from 0.01 to 0.61 birds/ km^2 in the same general area.

The proposed gravel mine site is located in upland habitats that are suitable for gravel mining and do not attract spectacled eiders. The proposed boundary area of the gravel mine site covers approximately 63 acres including the excavation area (18 acres), a viable soil overburden stockpile (3 acres), a non-viable overburden stockpile (8 acres), a safety berm (3 acres), and access roads (2 acres). Prior to development, a vegetation map will be prepared for the mine site and the site will be surveyed to determine its suitability as spectacled eider habitat. Based on the greater density of 0.6 birds/ km^2 reported by Larned et al. (2006), habitat for ~0.15 spectacled eiders would potentially be eliminated by the development of the 63 acres proposed for the gravel mine site. This figure assumes that the habitat value of the proposed mine site for spectacled eiders is the same as that of the general area. However, spectacled eiders are probably more likely to use wetland habitats associated with lakes or ponds than the upland habitat found at the mine site, and the number of eiders potentially affected by the mine site development will likely be reduced compared to the calculated figure based on eider density in the general area.

Damage to tundra from winter activities

In addition to permanent habitat loss associated with gravel placement and mining, temporary loss of habitat associated with gravel placement can occur on tundra adjacent to gravel structures. Accumulated snow from plowing activities or snow drifts can become compacted and cause delayed snow melt. Dust deposition can result in early green-up on tundra adjacent to roads and pads (Walker and Everett 1987; Auerbach et al. 1997). Rolligons and track vehicles used during seismic exploration leave tracks on tundra habitats that can affect vegetation, soil chemistry, soil invertebrates, soil thaw characteristics, and small-scale hydrologic changes (Kevan et al. 1995). For the Liberty Development Project, no new gravel roads will be constructed and the SDI pad expansion will be surrounded by water rather than tundra. Development-related impacts to tundra such as snow compaction will not be likely to affect tundra habitats beyond current levels. No land-based seismic activities are planned for the Liberty project and there will be no impacts to tundra habitats associated seismic activities.

Winter ice roads constructed for hauling gravel from the chosen mine site to SDI could cause compaction of vegetation (Walker 1996), which could temporarily affect the availability of cover for nesting eiders in the ice road footprint. BPXA is evaluating ice-road routes for the gravel haul along a channel of the Sagavanirtok River which would avoid traversing much of the tundra. Tundra affected by ice-road construction would likely recover within one to two years and any potential habitat alteration resulting from ice-road construction and use would be temporary.

Withdrawal of fresh water from lakes and ponds

Ice roads will be required to transport gravel from the chosen mine site to SDI. Construction of ice-roads involves water withdrawal from deep lakes in the areas adjacent to road locations. Bergman et al. (1977) reported that spectacled eiders at Point Storkerson used deep *Arctophila* lakes during pre-nesting, nesting, and post-nesting periods, and Derksen et al. (1981) reported that some spectacled eider brood-rearing occurred on deep open and deep *Arctophila* lakes in the NPR-A. Spectacled eider nests are often located within several feet of lake shorelines, and water withdrawal from lakes during ice-road construction that lowered the level of lakes could have the potential to affect spectacled eider nesting habitat. Changes in the surface levels of lakes as a result of water withdrawal would be dependent on the amount of water withdrawn, the size of the lake, and the recharge rate. The State of Alaska places restrictions on the amount of water that may be withdrawn from individual lakes and lakes must be permitted before being used as water-sources. Lake studies would be conducted prior to water withdrawal for ice road construction for any lakes that had not already been permitted as water sources. Most lakes would likely return to pre-withdrawal levels during spring flooding (Rovansek et al. 1996).

During winter water withdrawal operations, care should be taken to minimize or eliminate water withdrawal from deep open and deep *Arctophila* lakes that may be used by spectacled or Steller's eiders if other sources are available. Aerial and/or ground-based surveys of potential water withdrawal lakes conducted during the summer breeding and post-breeding season could identify lakes used by threatened eiders, and help to determine which lakes would be most suitable for water withdrawal activities to minimize potential impacts on threatened eiders. The existing Duck Island mine site located near the proposed mine sites contains fresh water and BPXA proposes to use this water for most of the onshore portion of the gravel-haul ice road. This should minimize water extraction from naturally occurring lakes as a water source during ice-road construction. However, water usage at all source lakes will be regulated by State issued Temporary Water Use Permits.

Disruption/alteration of hydrology

Impoundments created by gravel structures could cause temporary or permanent flooding on adjacent tundra. Impoundments could be ephemeral and dry up early during the summer, or they could become permanent water bodies that persist from year to year (Walker et al. 1987; Walker 1996). Tundra covered by impounded water may be lost as nesting habitat for some birds. However, impoundments could also create new feeding and brood-rearing habitat that would be beneficial to some bird species (Kertell 1993a,b; Noel et al. 1994). For the Liberty Project, no new roads or pads except a short access road to the mine site will be constructed on tundra habitats and the potential positive or negative effects of impoundments on spectacled eiders will not be relevant.

Disturbance

Activities that are typically related to oil development and production, such as vehicle, aircraft, pedestrian and boat traffic, routine maintenance activities, heavy equipment use, and oil-spill clean-up activities, could cause disturbances that adversely affect threatened eiders. These disturbances could result in decreased nest attendance or nest abandonment, and increased energy expenditures that could affect the physiological condition of birds and their rate of survival or reproduction. BPXA intends to use extended-reach drilling techniques from an existing pad to access the Liberty oil reservoir and some of the oilfield activities that typically are sources of disturbance for eiders or other tundra nesting birds will not be implemented for the Liberty project. The various sources of disturbance related to oil field development and their relevance to the Liberty project are discussed below.

Construction period (pads, pipelines and the Sag River Bridge)

Installation of pipelines and gravel placement for typical oil field infrastructure (e.g., roads, airstrips, and pads associated with wells, camps, staging areas, and processing facilities) has the potential to cause disturbance to eiders. No new roads or airstrips are proposed for the Liberty project. However, BPXA proposes to expand the existing SDI pad. Gravel placement during expansion of the SDI pad will occur during the winter months when eiders are on wintering grounds and construction activities at the gravel mine site and transport and placement of gravel at SDI would not have any disturbance effects on eiders.

At present the SDI design is based on sheet pile slope protection. The project schedule calls for installation of the sheet piles during winter of 2009. Installation of sheet piles will likely require the use of a vibratory and an impact pile driver. Eiders are absent from the North Slope during the winter months, therefore this activity will not have any effect on the birds.

No new pipelines will be constructed on tundra habitats however two new pipelines ~3 mi in length (a water injection pipeline and a high pressure gas pipeline) will be constructed along the Endicott causeway adjacent to existing pipelines from SDI to the Endicott processing facility. These pipelines will be elevated on industry standard vertical support members (VSMs) along the causeway at the same elevation as the existing adjacent pipelines. These pipelines are scheduled to be installed during winter of 2012 although there will be no seasonal constraints on pipeline construction. Winter construction of the pipelines would not cause any disturbance or other impacts to spectacled eiders.

BPXA is evaluating whether to upgrade the West Sag River Bridge or to construct a new bridge with up to two lanes upstream of the existing bridge. The bridge work will be done to accommodate increased traffic and vehicular loads. These winter construction activities would not cause disturbances that would impact spectacled eiders.

Pad activity

Various types of disturbances that are associated with oil and gas operations, such as vehicular traffic, machinery, facility noise, and pedestrian traffic may occur on the SDI pad during the construction period and after construction during the production phase of the project. Disturbance from facility noise and activity could affect activity and energy budgets of spectacled eiders.

Few studies have documented responses of spectacled eiders to oil field disturbances. Anderson et al. (1992) reported that during the nesting period, spectacled eiders near the GHX-1 facility in the Prudhoe Bay area appeared to adjust their use of the area to locations further from the facility in response to noise. TERA (1996) reported no conspicuous avoidance of facilities in the Prudhoe Bay oil field by brood-rearing spectacled eiders. Brood movement was extensive during the first few days after hatching, and broods often spent a portion of their time within 200 meters of facilities, including high-noise areas such as gathering centers and the Deadhorse airport. Spectacled eiders may be able to acclimate to periodic but regularly occurring disturbances related to oil field activities on roads and pads. A potentially more serious situation could develop if spectacled eiders nested near pads where little or no activity occurred early during the nesting period, but activity later in the summer causes nest failure or abandonment by eiders that had not become acclimated to oil field activities.

Some evidence suggests that pedestrian traffic may have a greater negative impact than vehicular traffic on some birds. Pedestrian traffic is likely to occur on well pads during well maintenance activities. During a study of the effects of disturbance related to the Lisburne Development in the Prudhoe Bay oil field, Murphy and Anderson (1993) reported that of the more common sources of disturbance, humans on foot elicited the strongest reactions from geese and swans. Ritchie (1987) reported that pedestrians caused greater disturbance to nesting raptors than other sources of disturbance.

Disturbances from oil field activities on the SDI pad would not affect nesting spectacled eiders because SDI is surrounded by water and removed from tundra nesting habitat. Spectacled eiders using the SDI shore for resting or nearby marine habitats for feeding would likely become acclimated to pad activities or move to adjacent habitats. Due to the low density of spectacled eiders in the general area of the SDI pad, the number of spectacled eiders likely to be affected by pad activities is low.

Aircraft

Disturbance from aircraft activity in support of oil field development and operation has the potential to impact birds by causing nest abandonment, or by disrupting normal activities that affect energy budgets (Ward and Stehn 1989; Derksen et al. 1992). After expansion of the SDI pad is completed, most drill rig and facility construction, maintenance, and operational activities will be supported using existing infrastructure along the Endicott Road system. Construction of new airstrips will not be required for support of the Liberty project and there will be no increase in aircraft traffic in the vicinity of the Liberty Development in support of construction, maintenance, and operation. There should not be any impacts to threatened eiders from aircraft traffic related to support for development of the Liberty project.

Year-round helicopter access to the Liberty project area is not planned, although there will be sufficient area for helicopter landings. In general, helicopter access to the Liberty Development will be used only for emergency evacuation of personnel. Helicopters will avoid direct overflights of Howe Island during the snow goose nesting and brood-rearing period. In addition, helicopters will fly at an altitude of at least 1500 ft except during landings and take-offs consistent with safe operation.

Like aircraft activity in support of oil field development, aircraft activity in support of research activities also has the potential to disturb spectacled eiders and other waterfowl. Aerial surveys using fixed-wing or helicopter aircraft are frequently used in support of wildlife monitoring studies. These studies sometimes result from development stipulations and may be required prior to or during development scenarios. No specific aerial surveys are expected to be required in support of the Liberty Development Project and there should be no impacts to threatened eiders related to aerial survey activity for research or monitoring purposes beyond those existing from current survey activity.

Roads

Spectacled eiders could be subjected to disturbances related to vehicular and pedestrian traffic and noise from equipment on roads. Increased vehicular traffic in support of the Liberty project, including large trucks hauling cranes and other equipment and road maintenance equipment could impact threatened eiders along the Endicott Road during summer activities. In the North Slope oilfields, these types of disturbances have been documented for brant, and Canada and white-fronted geese, and have been shown to have greater effects on geese feeding close to roads than on geese feeding further away (Murphy et al. 1988; Murphy and Anderson 1993). Disturbances occur most often during the pre-nesting period when these birds gather to feed in open areas near roads, and during brood-rearing and fall staging when some geese exhibit higher rates of disturbance (e.g., “heads up” behavior) in areas near roads than do birds in undisturbed areas. A small percentage of birds may walk, run, or fly to avoid vehicular disturbances (Murphy and Anderson 1993). Disturbance occurs most often within 50 meters of roads. However, some disturbance has been reported for birds as far as 150 to 210 meters from roads (Murphy and Anderson 1993).

The effects of disturbance to threatened eiders near roads would likely differ depending on the reproductive stage. Anderson et al. (2003) reported that pre-nesting pairs of spectacled eiders in the Kuparuk oil field were located nearer to roads than nesting females. However, both Anderson et al. (2003) and TERA (1996) reported locations of spectacled eider nests that were within a few hundred meters of oil field facilities. Anderson et al. (2003) also reported that there was no significant difference in the distance of failed vs. successful spectacled eider nests from oil field facilities.

There has been concern that the presence of gravel roads which are elevated structures 1 to 2 m above the tundra, may obstruct the movements of spectacled eiders. Gravel roads and pads could present some temporary obstructions during brood-rearing and molting periods when birds are flightless, particularly if traffic levels are high (Murphy and Anderson 1993). However, TERA (1996) reported that spectacled eider broods moved extensively averaging 0.53 km per day during the first week after hatch and that some of the longest movements occurred during the first day or two after hatch. Spectacled eider broods did not avoid facilities, and broods were known to cross roads repeatedly (TERA 1996).

No new roads would be constructed for the Liberty Development and there would be no increase in the physical presence of roads to obstruct the movements of spectacled eiders. Increased traffic on the road system between Deadhorse and SDI during summer construction and in support of drilling activities could increase the potential for obstruction of eider movements. Obstruction of movement may be most significant for eider broods which are flightless are known to walk across oil field roads. Reducing speed limits on oil field roads may help to reduce potential impacts to eider movement.

Watercraft based support

Barge traffic associated with the transportation of equipment during the construction period for the Liberty project could occur during the open-water season from mid-July to early October. A ***LoSal***™ enhanced oil recovery process plant and supporting facility are scheduled for fabrication during 2011 and 2012 and will be sealifted to the Endicott MPI. Barge routes may pass through shallow, nearshore habitats of the Beaufort Sea that are known to be used by spectacled eiders (TERA 1999; Fischer et al. 2002; Troy 2003). Failed nesting females and females with young would be the spectacled eider groups most likely to encounter vessel traffic. Most males would have departed the area by late June or early July before the onset of vessel traffic. Spectacled eiders are uncommon in the offshore waters of the Beaufort Sea but Fischer et al. (2002) reported that when spectacled eiders were sighted they occurred in relatively large flocks. The mean spectacled eider flock size during surveys in 1999 and 2000 was 21.1 eiders. Small numbers of Steller’s eiders could also occur in this area. Vessel traffic could cause temporary disturbance to feeding eiders if barges were to pass through eider feeding habitat. The disturbance would be short-term, and eiders would be able to swim or fly to avoid oncoming vessel traffic. The low number of barges involved would also minimize disturbance to eiders. Due to the low density of spectacled and Steller’s eiders in the offshore waters of the Beaufort Sea, barges would be likely to cause minimal disturbances to eiders.

Oil spill response training activities for the Liberty project using small boats will likely be conducted in the vicinity of SDI and the Endicott facilities. These activities would have the potential to disturb foraging or brood-rearing eiders in marine habitats adjacent to the Endicott causeway and SDI. We know of no studies that have addressed the potential impacts of boat disturbance on spectacled eiders, but boat activity can cause alerted postures, disruption of feeding behavior, and flight in other waterfowl, shorebirds, and raptors (Burger 1986; Belanger and Bedard 1989; Steidl and Anthony 2000). Rodgers and Smith (1995) and Rodgers and Schwikert (2001) determined set-back distances for boat activity for various bird groups to minimize the potential for boat disturbance, ranging from 100 meters for shorebirds to 180 meters for wading birds. Due to the small number of spectacled eiders expected to occur in the area where oil spill response training activities will occur, few eiders are likely to be affected.

Pipeline maintenance

The only new pipelines to be constructed for the Liberty development are a high pressure gas line and a water injection pipeline which will be located along the Endicott causeway between SDI and the Endicott production facility. The pipelines will be accessed and maintained from the causeway road and maintenance activities will not cause disturbance to eiders or other waterfowl on tundra habitats. If routine maintenance activities are required, spectacled eiders that may be using the causeway shore or adjacent marine habitats may be temporarily disturbed. Due to the small number of spectacled eiders expected to occur in the area, few spectacled eiders are likely to be affected. Spectacled eiders or other waterfowl that are disturbed by routine maintenance activities would likely move to adjacent habitats.

Tower maintenance

There has been concern that construction of towers for powerlines or cellular telephone towers associated with oil field development may negatively impact threatened eiders and other tundra nesting birds. Summer maintenance activities at powerline or cellular telephone towers could cause disturbances that impact nesting or brood-rearing eiders. No new powerlines or communication towers will be associated with the Liberty project and there should be no impacts to spectacled eiders related to powerlines or cellular telephone towers.

Gravel mining/transport

Gravel mining and transport during expansion of the expanded SDI pad would occur during the winter when threatened eiders are on wintering grounds. Gravel mining and transport would not cause disturbances that affect spectacled eiders.

Oil spill response activity

Should an oil spill occur, oil spill response and clean-up activities would be immediate and could not be planned to avoid disturbance to eiders. Clean-up activities would involve the use of vehicles, equipment, and ground personnel, and the disturbance effects of clean-up activities would be similar to those described for other activities associated with gravel roads and pads. Depending on the location and activity of eiders in relation to the spill, eider response could include anything from alert responses to abandonment of the area. Disturbance during oil spill response activities that caused spectacled eiders or other waterfowl to abandon the immediate area of the spill could help to reduce impacts of the spill on birds in the affected area. Although common and king eiders, long-tailed ducks, scoters, other waterfowl, and loons can sometimes be abundant in the marine habitats adjacent to the Endicott causeway, few spectacled eiders are likely to occur in this area. Impacts from disturbance related to oil spill response activities would depend on the timing, size and location of the spill which would affect the equipment used and the level of the response effort.

Collisions (Strikes)

Numerous authors have reported on bird mortality due to collisions with various types of man-made structures including powerlines, wind turbines, towers and associated guy wires, lighthouses, vessels, and buildings (e.g., Crawford 1981; Verheijen 1981; Day et al. 2002; Wiese et al. 2005). Day et al. (2005) reported collisions of 36 eiders (all common or king eiders) with facilities at Northstar Island or Endicott over a 4-year period. Gas flares and lights on some offshore oil platforms have also been reported to attract seabirds and passerines that sometimes result in bird mortality due to collision or incineration (Jones 1980; Wallis 1981; Wiese et al. 2005).

Structures and equipment associated with oil development and production for the Liberty project that could represent potential collision hazards to spectacled eiders include the drill rig, production and support facilities, pipelines, vehicles (trucks, heavy equipment), barges and other vessels, and bridges. TERA (1999) suggested that most spectacled eiders probably arrive on the breeding grounds using overland routes across the ACP. Good visibility associated with extended day length during the summer breeding season would minimize the potential for eider mortality due to collisions with any of these structures.

After arrival onto the breeding grounds most spectacled eiders remain primarily on tundra habitats. The greatest potential for eider collisions would occur during periods of reduced visibility such as rain or foggy conditions during fall migration. At this time flocks of low-flying eiders migrating during periods of darkness could be particularly susceptible to mortality due to collisions with man-made structures. However, based on relatively small number of spectacled eiders with satellite transmitters, TERA (1999) suggested that male and female spectacled eiders average 10 and 20 km, respectively, offshore during fall migration. If this is the case most spectacled eiders would be migrating well offshore of the Liberty facilities thus reducing the potential of collision with Liberty structures.

Drill rig

Quakenbush and Snyder-Conn (1993) reported that a Steller's eider was apparently killed by collision with a tower near Nanvak Bay. Day et al. (2002) concluded that the probability of collisions of migrating eiders with existing structures at Barrow was low, but this finding was influenced by the offshore route followed by most eiders during fall migration. The drill rig that will be used for Liberty will be larger than any other drill rig on the North Slope and will likely be one of the largest (if not the largest) drill rigs in the world. The base of the eastern side of the drill rig will be ~350 ft wide by ~44 ft high, and the top of the derrick will be ~230 ft above ground level (vs. 170-205 feet for other North Slope Drill rigs) (Figure 6). A trunk ~250 ft long by 29 ft high will extend north from the drilling rig toward the existing well house.

Day et al. (2005) reported that the mean elevation of migrating eiders (predominantly common and king eiders) near Northstar Island was 6 m above ground or sea level and ranged from 1-50 m. Although most eider flight paths near the drill rig at SDI would likely be near the pad and the lower portions of the drill rig, some eiders could fly in the vicinity of the upper portion of the rig and the tower. Eiders could collide with any portion of the drill rig. Collisions would be most likely to occur during fall for eiders migrating near shore, and during periods of poor visibility such as under foggy conditions and at night. Due to the low densities of spectacled and Steller's eiders in the project area, few threatened eiders would likely collide with the drill rig.

Production/support facilities

Surface facilities that will be located on SDI include a pipe rack and well tie-in piping, fuel-gas conditioning skid, booster pumps for high-salinity water injection, electrical transformer and switchgear, control room, transformer module for the electrical submersible pump, ***LoSal***™ pipeline pig launcher, and ***LoSal***™ EOR process injection pumps. Excluding the drill rig, these facilities relatively small in size compared to existing facilities on MPI. Threatened eiders would have the potential to collide with these production and support facilities. Human activity in the vicinity of facilities such as vehicle and pedestrian traffic could help to deter eiders from using habitats near this area. Due to the low density of threatened eiders in the project area, few spectacled or Steller's eiders would be likely to collide with production and support facilities. The potential for eider collisions with proposed facilities on SDI is likely reduced compared to that which may have resulted from the offshore development for the Liberty project as proposed in the 2002 FEIS (USDOI/MMS 2002).

Two new pipelines will be constructed from the SDI facilities for approximately 3 miles to the Endicott MPI facilities. One pipeline will be used to transport water for injection, and the other will be a high pressure gas line. The pipelines will be installed parallel to and west of the existing lines on the Endicott Road at the same elevation as the existing adjacent pipelines. Large pipelines such as those proposed for the Liberty Development Project are generally visible to waterfowl in flight. Eider collisions with elevated pipelines are probably infrequent but may be more likely to occur during periods of poor visibility such as at night or under foggy conditions. Since the proposed pipelines for the Liberty project will be constructed adjacent to the existing pipelines, the likelihood for eider collisions with the Liberty pipelines is probably no greater than the potential for collision with existing pipelines.

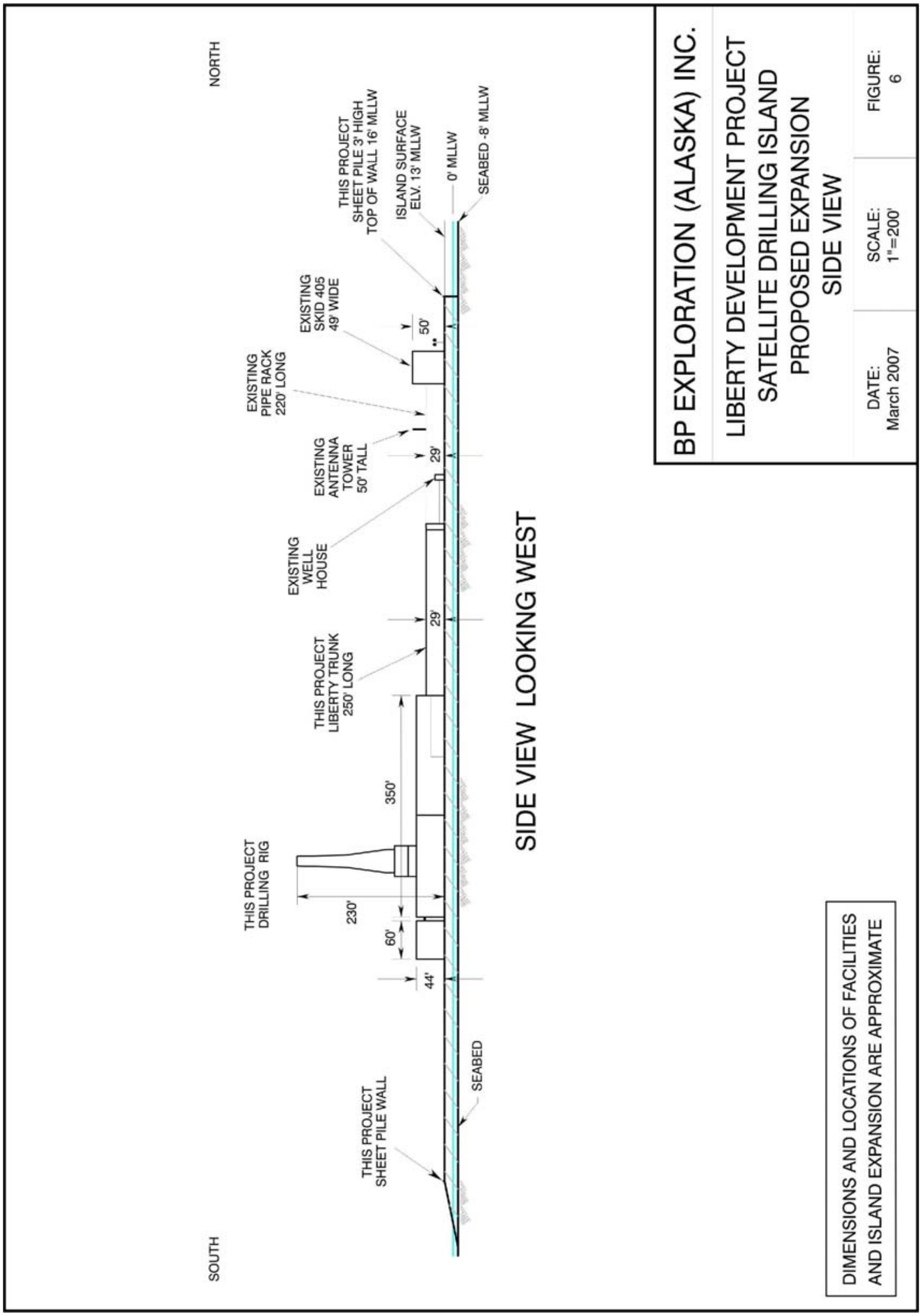

Figure 6. Configuration and dimensions of proposed Liberty project drill rig and facilities on SDI as viewed from the east.

Vehicles and equipment

Mortality to threatened eiders could result from collisions with vehicular traffic or equipment transiting the road system. This was the greatest source of bird mortality associated with the Trans Alaska Pipeline System, particularly along the Dalton Highway where dust shadows caused early green-up along the road that attracted birds (TAPSO 2001). The primary groups affected were grouse and passerines. Although the number of birds killed was not quantified, the level of mortality was probably low when compared to local populations. Dust deposition on tundra adjacent to gravel roads on the North Slope oil fields can cause early snow melt resulting in a snow-free band within 30 to 100 m of the road in early spring (Walker and Everett 1987). Waterfowl on the North Slope oil fields are known to congregate in these areas.

Levels of traffic (including vehicular traffic and machinery) are expected to be elevated during development of the Liberty project compared to that which has occurred in recent years. Since SDI is part of the existing oil field and connected to other oil field facilities and to Deadhorse by the road system, higher traffic levels are expected both during the winter and summer construction activities. Vehicular traffic during winter construction activities when eiders are not present on the North Slope would have no potential to result in collisions with eiders. Eiders could be susceptible to collisions with vehicles during the summer months, particularly during the early spring, if tundra habitats adjacent to roads become open earlier than habitats away from roads. Brood-rearing eiders with flightless young are known to cross North Slope oil field roads and could also be susceptible to vehicle collisions. Reduced speed limits along roads, particularly early in the season when eiders could be attracted to areas of early green-up near roads and pads, during periods of poor visibility, and during brood-rearing periods when flightless birds could cross gravel roads, would help to reduce the potential for eider collisions with vehicles.

Marine vessels

Since the SDI site is accessible by road there will be little need for marine traffic during development of the Liberty project. However, a sealift is scheduled for summer 2012 to transport the ***LoSal***™ process and power generation modules to the MPI dock. The sealift will transit the Chukchi and Beaufort seas where it may encounter spectacled eiders using open-water habitats after the breeding season. The sealift will avoid the critical habitat for spectacled eiders in Ledyard Bay.

There are few reports of collisions of eiders with marine vessel traffic. Lovvorn et al. (2003) salvaged 3 spectacled eiders that collided with a ship during predawn hours in the Bering Sea. Spectacled or Steller's eiders staging in the Beaufort and Chukchi seas along the route of the proposed sealift could potentially collide with vessel traffic during mid-July to September. Inexperienced young-of-the-year, which may be at higher risk for collisions with vessels, may occupy these marine habitats during August and September. However, good visibility associated with the long hours of daylight during much of this period could reduce the potential for eider collisions with vessel traffic. In addition, the number of barges transiting these offshore waters would be low.

West Sag River Bridge

BPXA plans an upgrade or construct a new bridge across the west channel of the Sagavanirktok River to accommodate increased traffic and vehicular loads. Threatened eiders and other waterfowl would have the potential to collide with the new or upgraded structure however the risk of collision would likely not be greater than any existing collision risk. Due to the low density of threatened eiders in the project area few spectacled or Steller's eiders would be likely to collide with the new or upgraded West Sag River Bridge.

Powerlines and communication towers

Some bird species have been victims of collisions with elevated power and communication lines or communication towers. Quakenbush and Snyder-Conn (1993) reported that a Steller's eider was apparently killed by collision with a tower near Nanvak Bay, and local residents on St. Lawrence Island have reported eider collisions with wires associated with the FAA tower (Day et al. 2003). Anderson and Murphy (1988) reported locating the remains of 15 and 16 birds in 1986 and 1987, respectively that had been killed as a result of collisions with the Lisburne Development powerline in the Prudhoe Bay area. None of the birds was identified as spectacled or Steller's eiders, although one unidentified eider was reported along with several other waterfowl species. No elevated power or communication lines, or communication towers will be constructed in support of the Liberty Development. There will be no additional risk to threatened eiders in relation to potential collisions with power or communication lines or towers.

Effects of light on bird movements

Numerous studies have attempted to determine how environmental and anthropogenic factors affect bird collisions with various types of structures. Lighting sources have been suggested as a possible mitigation tool to help reduce the risk of bird collisions with man-made structures, although there are a number of studies or observations of birds being attracted to lighting on various types of structures (e.g., Cochran 1958; Verheijen 1981; Jehl 1993). Birds are often attracted to lights and may collide with lighted man-made structures if they are blinded by the light and lose their ability to navigate. Strobe lights may affect birds differently than continuous light, and some evidence suggests that red lights may be more attractive to night-migrating birds than white lights.

Recently, Day et al. (2005) conducted a 4-yr radar and visual-based study of eiders and other waterfowl migrating in the fall past Northstar Island, located approximately 35 km northeast of SDI. Most of the birds recorded as eiders were likely common or king eiders although small numbers of spectacled, and possibly Steller's, eiders could have been in the area. Fourteen white strobe lights were mounted at ~14 m elevation on structures around the perimeter of the island to provide a visual deterrent to migrating birds during the fall. The lights were set to operate at a flash rate of 40/min and to fire asynchronously both with adjacent lights and with lights on other sides of the island. Visual and radar-based observations were made with the lighting system "on" and "off" to determine what effect the system might have on migrating eiders and other waterfowl.

Overall results of the Day et al. (2005) experiment were not conclusive however, eider flight velocity was significantly reduced during periods when the lights were on, which would allow eiders a better opportunity to avoid collisions with structures as they approached the island. The lighting system also appeared to result in a spatial redistribution of eiders away from the island during periods when sea ice was present around the island. However, the avoidance response was small and the lights explained only ~4% of the variation suggesting that other factors had a greater effect on the spatial distribution of migrating eiders than did the lighting. However, there appeared to be a weak attracting of non-eiders species toward the island during periods when the lights were on. It is noteworthy that a gas flaring event appeared to attract long-tailed ducks and glaucous gulls to the island resulting in some near collisions.

Day et al. (2005) reported information on 36 downed eiders (20 from Northstar Island and 16 from Endicott) that were discovered during the fall migration 2001-2004. There appeared to be a tendency for eiders to be downed during periods of a full or waxing moon, and during nights with a weakly changing barometer. All eiders about which information was available were downed on nights with foggy conditions. The sample size of downed eiders was small and no information appeared to be available to compare the numbers of collisions during period with the lights on vs. off.

The results of the Northstar study by Day et al. (2005) suggest that it may be possible to use anti-collision lighting system as a deterrent to migrating eiders. However, numerous studies and observations document collision mortality to birds attracted to lights near towers and buildings (Manville 2005). BPXA rig engineers will discuss lighting options with Fish and Wildlife Service biologists during rig design.

Increased Predation

There is evidence that some predators may be attracted to anthropogenic sources of food or denning/nesting sites associated with oilfield development (Eberhardt et al. 1982, 1983a, b; Garrott et al. 1983; Martin 1997; Day 1998; Burgess 2000). Increased predation pressure could impact threatened eiders and other tundra nesting birds. Potential predators of adult eiders and their eggs and young that could be attracted to anthropogenic sources of food or denning/nesting sites include arctic fox, red fox, grizzly bear, glaucous gull and common raven. Jaegers might also prey on eider eggs and young, but would probably not be attracted by human activities associated with development.

Major negative impacts have occurred at the Howe Island brant and snow goose (*Chen caerulescens*) colony in the Sagavanirktok River delta from predation by common ravens, arctic foxes, and grizzly bears (Johnson 2000). Arctic foxes and glaucous gulls are also predators of common eider and brant eggs and young on the barrier islands (Noel et al. 2002). Increased levels of predation due to elevated numbers of predators could impact nesting and brood-rearing spectacled and Steller’s eiders.

Increased food availability

The availability of anthropogenic food sources, particularly during the winter, could increase winter survival of arctic and red foxes and contribute to increases in the fox population. Anthropogenic sources of food at dumpsters and refuse sites could cause populations of foxes, gulls and ravens to increase above natural levels. In recent years, oil field operators have installed predator-proof dumpsters at camps and implemented new refuse handling techniques to minimize the attraction of predators to the North Slope Borough landfill and areas of oil field development. In addition, oil field workers undergo training designed in part to mitigate the effects of increased levels of predation by educating workers about the problems associated with feeding wildlife. The numbers of foxes and most avian predators at the existing Alpine development did not appear to increase during construction of the project with the exception of common ravens, which nested on buildings at the Alpine site (Johnson et al. 2003b). There was also no evidence that predation pressure on tundra nesting birds increased during construction and early operation of the Alpine development. Current oil field policy includes measures to help control the numbers of predators in the oil field by reducing attraction of predators to anthropogenic sources of food. If necessary these mitigation measures will be implemented at Liberty project facilities.

Increased den/nesting sites

Foxes in the Prudhoe Bay area have used spaces under buildings as dens sites, and common ravens that were uncommon visitors on the North Slope prior to development use buildings, towers, and other structures for nest sites (Johnson and Herter 1989; Johnson et al. 2003b). In addition, gyrfalcons have been reported nesting on pipelines (Ritchie 1991). Mitigation measures have been successful in preventing predator use of structures for denning sites, although it is difficult to deter common ravens use of structures for nest sites (Johnson et al. 2003b). Common ravens have also nested on the Endicott facilities and at the Alpine development. However, Johnson et al. (2003b) reported no increase in predation levels on tundra-nesting birds when comparing pre- and post-development nest success at Alpine. BPXA engineers will discuss methods to prevent raven nesting on the drilling rig with biologists from Fish and Wildlife Service during rig design.

Additional landfills

No additional landfill sites will be required for operation of the Liberty project. All garbage will be removed from development sites and transported to landfill sites currently in operation.

Increased anthropogenic perch/hunting sites

Building, towers, pipelines and other structures provide perching sites that may be used by avian predators such as raptors, jaegers, snowy owls, and glaucous gulls. These perches may have the potential to increase predator efficiency that could impact spectacled or Steller's eiders. The potential for impacts from anthropogenic sources of hunting perches for avian predators to affect eiders may be greatest during the brood-rearing period when hens with broods are moving across tundra habitats.

Oil Spills

Oil spills or leaks onto tundra or marine habitats could negatively impact spectacled or Steller's eiders in numerous ways. Oil can come in contact with and adhere to feathers, causing the feathers to lose their insulating capabilities resulting in hypothermia (Patten et al. 1991). The consequences would be most severe for aquatic habitats when feather integrity to maintain water repellency and buoyancy is lost due to contact with oil. Birds can suffer toxic effects from ingestion of oil by consuming food contaminated by an oil spill or by preening oiled feathers (Hansen 1981). Oil that comes in contact with bird eggs can cause toxic effects to embryos (Patten and Patten 1979; Stickel and Dieter 1979). Oil could come in contact with eggs directly as a result of a spill, or indirectly from the oiled feathers of incubating adults. Oil can also contaminate food sources. Oil spills can occur on terrestrial, river/delta, and offshore habitats.

Terrestrial

Oil spills or leaks from a pipeline located in terrestrial habitats would be confined by topographical features. Spilled oil could also enter a lake or pond and be contained by the banks of these water bodies. However, for a tapped lake or during spring flooding, an oil spill could spread to a much larger area depending on the amount of oil spilled, the surface topography, and the extent and duration of flooding. Oil entering a river or stream could spread into delta or coastal areas, where impacts to birds would likely be more severe. No new pipelines will be constructed to transport produced oil for the Liberty project and there would be no increase in the potential for a terrestrial oil spill to impact threatened eiders above that which currently exists.

Riverine/intertidal

A small spill entering a riverine or intertidal area would be diluted and would be unlikely to affect threatened eiders. Larger spills would have the potential to spread to intertidal or offshore areas where staging eiders could be affected. The greatest potential for impacts to eiders would occur during the fall staging period when eider flocks are molting. No new pipelines will be constructed to transport produced oil for the Liberty project and there would be no increase in the potential for an oil spill in river or intertidal habitats to impact threatened eiders above that which currently exists.

Offshore

Wind and currents in marine habitats could potentially spread an oil spill over a larger area than would be likely under most terrestrial scenarios. Therefore, birds residing in marine habitats could be particularly at risk for negative impacts from an oil spill. An oil spill occurring during the summer breeding and staging seasons would have a greater impact on threatened eiders than a spill occurring during the winter, when eiders are on wintering grounds. However, the lingering effects from a winter spill could impact returning birds during the following breeding season if clean-up activities did not adequately remove contaminants from bird habitats and food sources.

An oil spill that spread into offshore waters during the fall molting/staging period may have a greater potential to affect spectacled eiders than a nearshore spill (Fischer et al 2002). Stehn and Platte (2000) developed an oil spill scenario for the central Beaufort Sea based on a spill size of 5,912 barrels. When taking spectacled eider densities in the Beaufort Sea into consideration, the highest mean number of spectacled eiders exposed to oil was 2 birds. However, since there is some evidence that spectacled eiders may occur in flocks in offshore Beaufort Sea habitats (Fischer et al 2002), an offshore spill could potentially impact more birds than proposed in the analysis of Stehn and Platte (2000). The average flock size reported during aerial surveys in the offshore waters of Harrison Bay was 21.1 (Fischer et al 2002). An oil spill would be unlikely to contact eiders due to the low density of spectacled eiders in offshore waters, however, a spill that did contact spectacled eiders could impact 20 or more birds.

Based on a small number of spectacled eiders fitted with satellite transmitters, TERA (1999) reported that there appeared to be little spectacled eider use of the Beaufort Sea offshore habitats east of Spy and Pingok islands located offshore of Oliktok Point, approximately 60 km west of SDI. No other information is available on spectacled eider use of marine habitats east of Pingok Island or the marine habitats offshore of SDI. The Liberty project is located near the eastern edge of the breeding range of spectacled eider where densities are relative low, and few spectacled eiders would be likely to be affected by an offshore spill from the Liberty project unless a massive spill spread to the west of SDI.

Toxics

Organic pollutants and metals can be found in various types of environments throughout the world. The availability of these contaminants and their effects on waterfowl are becoming popular topics of study for researchers (e.g., Franson et al. 1995; Henry et al. 1995; Stout 1998; Trust et al. 2000; Stout et al. 2002; Grand et al. 2002). Contaminants are sometimes spilled during oil and gas exploration and development activities. Some types of contaminants include drilling mud, waste water, used crankcase oil, dust-control chemicals, reserve pit fluids, diesel fuel, glycol, crude oil, and salt water (Walker 1996). Current policies in North Slope oil fields require that any spills of toxic materials, including small quantities of material, be reported and cleaned up as soon as possible. In addition, current and future development practices have eliminated hazardous reserve pits that may have been a source of contaminants for threatened eiders in the past.

5. POSSIBLE MITIGATION OPTIONS AND SUGGESTED STIPULATIONS

The types of activities generally associated with oil field development on the North Slope and the potential impacts that may result from those activities are expected to be reduced or eliminated for the Liberty SDI alternative compared to other options that had been proposed for the Liberty development. Loss of tundra habitat resulting from the Liberty Development Project will be limited to the footprint of the mine site development along the Endicott road. No new gravel roads (except a short access road to the mine site), pads or airstrips will be constructed for the Liberty Development. Although temporary disturbance to tundra habitats along the route of the ice road may occur, impacts are expected to be short term and effects are not likely to persist beyond 1 or 2 growing seasons. Further, BPXA plans to maximize use of a channel of the Sagavanirktok River for the onshore portion of the ice road.

Disturbance activities that typically occur on gravel infrastructure, such as vehicular, pedestrian, and aircraft traffic, and noise resulting from construction, production, and maintenance activities will also be reduced compared to that which often occurs at new development sites. The SDI is not located near potential nesting habitat for spectacled eiders, and pad activities would not be expected to affect nesting eiders. However, increased vehicular traffic along the Endicott road during the construction period could have the potential to affect spectacled eiders during the pre-nesting, nesting, and brood-rearing periods. Traffic along the Endicott road would likely return to pre-construction levels during the production phase of the development and road disturbance would likely be no greater than that which currently exists.

Many types of mitigation that are required for North Slope oil field development will not be necessary for development of the Liberty Development Project. However, mitigation will be relevant for several aspects of the project including mine-site development, ice-road construction and use, and potential disturbance along the road system during the construction period. Potential mitigation for these aspects of the Liberty development are discussed below. In addition, standard North Slope practices established to reduce the availability of anthropogenic sources of food to predators must be continued for the Liberty development.

Mitigation Options

Mine-site Development

A vegetation map of the mine site will be prepared prior to development of the mine to aid in the identification of potential eider habitats. A ground-based survey to determine the suitability of the mine site as potential spectacled eider nesting habitat will be conducted during the pre-nesting period to determine the level of use of the site by spectacled eiders.

The DPP contains details of a rehabilitation plan developed by BP for the mine site. The goal for the mine site preparation, operation, and subsequent closure and rehabilitation is to minimize tundra disturbance. The rehabilitation plan describes methods and procedures for rehabilitating the Liberty mine site and is subject to confirmation based on a biological assessment of the site prior to mining operations. The plan may be amended when more site-specific information is available and as the rehabilitation progresses over time.

The excavated area will be prepared for restoration when it is no longer required for the Liberty Project Development (i.e., after the second winter season). Inorganic overburden will be placed over the stepped benches in the excavated area side walls and allowed to form side slopes with the natural angle of repose expected to be between 2:1 and 3:1 H:V. These side slopes would be consistent with those at the nearby Duck Island Mine Site. The inorganic material, except for a flood protection berm, will be replaced in the excavated area to moderate the side slopes. The harvested organic material stockpile will be used to encourage natural species revegetation on the flood protection berm.

Excess organic material that is not used on the fold protection berm will remain stockpiled for potential use elsewhere to be done in consultation with regulatory agencies.

The goal after mining is completed is to replace the stockpiled overburden back into the excavated area to create shallow sloping excavated side walls to the extent practicable. In response to comments on the Mining and Rehabilitation Plan, BPXA has agreed to provide a breech to the excavated area to connect to the ephemeral Duck Island Creek after closure of the mine site. The excavated area will be allowed to fold gradually over time from locally occurring run-off waters.

In consultation with the U.S. Army Corp of Engineers, BPXA has established a practice of defining clear goals, objectives, and performance standards as part of their current approach to rehabilitation. The quantitative measures associated with BS's rehabilitation goals, objectives, and performance standards typically focus on percent vascular cover, species composition, and available nutrients. Additional quantitative measures often include monitoring the site for wildlife activity, and significant areas of subsidence or thermokarst. Specific time frames for completion of various stages of the rehabilitation process for the Liberty mine site and BPXA's reporting schedule are included in Attachment D to the DPP.

Ice-road Construction and Use

Ice roads have the potential to crush tundra vegetation causing temporary disturbance to the vegetation that may affect nesting eiders. Thickened areas of ice may linger into the nesting season reducing the availability of tundra habitats to spectacled eiders. Potential impacts to spectacled eiders from ice-roads may be reduced by avoiding routes near known eider nesting locations, and by routing ice roads over habitats not preferred by eiders (such as river channels). Such routing is currently being investigated by the project team to maximize use if feasible of a channel of the Sagavanirktok River.

Road Disturbance

Reduced speed limits along the road system, particularly during the pre-nesting period when eiders and other waterfowl may be attracted to areas of open tundra near roads may help to reduce the potential for collisions of spectacled eiders with vehicles or equipment. Reduced speed limits during the brood-rearing period would reduce any negative impacts associated with potential obstruction of eider movements or bird collisions with vehicles during the brood-rearing period. Reduced speed limits were used as mitigation to minimize impacts to snow geese in brood-rearing areas adjacent to the Endicott road during the mid-1980s.

Suggested Stipulations

BPXA has an active long-term environmental studies program designed to understand the impacts of its operations and develop appropriate environmental mitigation. In support of this program BPXA recently began production of an annual, long-term monitoring report which highlights the results of ongoing ecological studies on the North Slope and the long-term status of various environmental factors. Some chapters in the long-term monitoring report summarize information gathered over many years, while others present information on recently launched efforts. The intent of the report is to add data to the report sections each year and to increase the scope of the report over time. At this time the report discusses a number of topics including but not limited to weather, plant communities, tundra-nesting birds, fox denning activity, polar bear and seal sightings, and nearshore fish.

Possible topics for inclusion in future editions of the report include studies that have been conducted intermittently in the Liberty project area but that could be resumed on an annual basis. Common eiders are known to use nest sites located on the Endicott causeway and on the man-made Duck Island located south of SDI. Common eider nesting activity has been monitored on the Endicott causeway during some years beginning a few years after construction of the causeway when eiders were first observed nesting in the area. However common eider nesting along the causeway has been monitored only sporadically since 1992. Monitoring of common eider nesting activity along the Endicott causeway and Duck Island that would continue for the life of the project could be continued on an annual basis as a permitting stipulation for the Liberty development with reporting to be included in BP's annual long-term monitoring report. Other studies that could be initiated in the general area of the Liberty project include monitoring of long-tailed duck use of the lagoon formed by the Endicott causeway, monitoring of raven nesting in the Endicott/Liberty area, and monitoring of bird mortality that may result from collision with structures at the Liberty development site. Results of these monitoring efforts could also be included in the long-term monitoring report through the life of the Liberty project.

The potential stipulations for the proposed Liberty development which could be conducted for the life of the project include:

- monitoring of common eiders along the Endicott causeway and the man-made Duck Island south of SDI,
- monitoring of long-tailed duck (and other waterbird) use of the Endicott lagoon, and
- monitoring of collision mortality at the Liberty facilities.
- BPXA consultation with the USFWS during design of the drilling rig and SDI facilities with respect to raven nesting and facility lighting

6. CUMULATIVE EFFECTS ON SPECTACLED AND STELLER'S EIDERS

Cumulative effects are defined in 50 CFR 402.02 (Interagency Cooperation on the Endangered Species Act of 1973, as amended) as "…those effects of future State or private activities not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation." The cumulative effects described in this section relate to potential effects to spectacled and Steller's eiders that may result from State or private actions reasonably certain to occur within or near the Liberty Project area. These actions relate primarily to future oil development.

Continued Oil Field Development

The initial development work for the Prudhoe Bay oil fields began around 1968. Since then the number of production pads increased from 16 in 1973 to 115 in 2001 (NRC 2003). The number of miles of gravel road increased from 100 in 1973 to 400 in 2001. The developed area, which was originally confined to the Prudhoe Bay area, currently extends from the Colville to the Sagavanirktok River. In addition, production facilities for the Badami Unit, located about 30 miles east of the Sagavainrktok River, are connected to the Endicott development by a pipeline, and further oil field expansion is planned west of the Colville River into the National Petroleum Reserve—Alaska.

Recent and future negotiations between the State of Alaska and various industry groups regarding development of a gas pipeline from Prudhoe Bay to Canadian and U.S. markets could result in future development of the Point Thomson Unit located about 50 miles east of Prudhoe Bay. Other exploratory activities which could lead to future development are proposed for offshore areas east of the Liberty Project area during 2007. Recent and future seismic exploration in the Chukchi Sea could also result in future development that would have the potential to affect spectacled and Steller's eiders. The types of impacts that could result from future development would be similar to those discussed above in Chapter 4 including potential impacts resulting from habitat loss, effects of disturbance and increased predation, and oil spills.

The need for developers and wildlife managers to address all of the issues related to the potential impacts of future oil field development will continue. Many stipulations and required operating procedures which have helped mitigate the effects of North Slope oil field development are included in various permitting and EIS documents. Continued oversight of North Slope development will help to insure that the impacts of future development on spectacled and Steller's eiders and other wildlife are minimized.

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RD

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

MAY 25 2007

Memorandum

To: Regional Director, FWS, Region 7

From: Regional Director

Subject: Endangered Species Act Section 7 Consultation Request for Proposed Liberty Development and Production Plan

The Minerals Management Service (MMS), in cooperation with the U.S. Army Corps of Engineers, is completing a draft Environmental Assessment for the proposed Liberty Development and Production Plan in the Beaufort Sea. The Steller's and spectacled eider, both threatened species, occur in the project area. The Kittlitz's murrelet, a candidate species, may also occur there as well.

Section 402.08 of the Endangered Species Act (ESA) states that a Federal agency may designate a non-Federal representative to conduct informal consultation or prepare a biological assessment (BA) by giving written notice to the Director of the U.S. Fish and Wildlife Service (FWS) of such designation. The MMS notified the FWS that it had designated British Petroleum Exploration (Alaska) Inc. (BPXA) as the non-Federal representative on February 17, 2006, and BPXA submitted a BA to MMS on May 8, 2007. The BPXA BA was prepared by LGL, Alaska Research Associates, Inc. (Attachment 1). The ultimate responsibility for Section 7 consultation under the ESA, however, remains with the MMS. Section 402.08 of the ESA requires MMS to independently review and evaluate the scope and contents of the BPXA BA.

The MMS has completed its review of the BPXA BA (Attachment 2). This review supersedes conclusions in the BPXA BA. We believe the MMS review and BA satisfy the information requirements specified in 50 CFR 402.12 and 402.14 and consequently constitute a complete consultation package for your review and preparation of a biological opinion. The MMS determined that the proposed Liberty Development and Production Plan activities would likely have the following level of effects on Steller's and spectacled eiders and Kittlitz's murrelets:

- Listed and Candidate Species
  - The Liberty Development and Production Plan activities *are likely to adversely affect* spectacled eiders.
  - The Liberty Development and Production Plan activities *are not likely to adversely affect* Steller's eiders.

  - The Liberty Development and Production Plan activities *are not likely to adversely affect* Kittlitz's murrelets.

- Critical Habitat Area
  - The Liberty Development and Production Plan activities are *not likely to adversely modify* the Ledyard Bay Critical Habitat Unit.

We request your concurrence on these findings. If you determine a jeopardy situation may exist for all or any part of the proposed action, we ask that you notify us as early as possible, according to 50 CFR 402.14(g)(5), to allow the MMS and FWS staff time to jointly discuss the findings. We believe that such discussions will facilitate the consultation and ensure protection of listed species. These discussions will also ensure that any proposed alternatives are within our authority to control and implement, and are feasible, prudent, and effective. To facilitate timely completion of this consultation, we are sending a copy of this memorandum to the Fish and Wildlife Service, Field Office in Fairbanks, Alaska.

The BPXA is also designated the non-federal representative to evaluate potential project impacts on the polar bear, a species proposed for listing as threatened under the ESA. Although it does not appear that the Liberty Development and Production Plan activities are likely to jeopardize the continued existence of the polar bear, the MMS would like to conference on this species. We request the conference be conducted in accordance with the procedures for formal consultation in 50 CFR 402.14 so that the conference opinion may be adopted as a biological opinion if the polar bear is listed. BPXA has agreed to prepare a BA, which MMS will use as the basis for the conference. We intend to initiate conferencing when the BA is complete. We prefer to keep the conference separate from the Section 7 consultation process on ESA-listed birds.

If you have any questions on these consultations or require additional information, please contact Mr. Mark Schroeder (907-334-5247) or Mr. Casey Buechler (907-334-5265).

Attachments

cc: (w / attachments)

Supervisor, Fairbanks Fish and Wildlife Field Office
Cash Fay, BPXA

bcc: Official File (1001-03a)
RD Chron
RSLE Chron
EAS Chron
Author (Schroeder) MTS

MAY 25 2007

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Field Office Supervisor
U.S. Fish and Wildlife Service
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
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Cash Fay
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United States Department of the Interior
U.S. FISH AND WILDLIFE SERVICE
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701
June 20, 2007

Memorandum

To: Regional Director, MMS – Alaska OCS Region

From: Fairbanks Fish and Wildlife Field Office Supervisor Terry Bright

Subject: BP Alaska's Liberty Project: Endangered Species Act Section 7 Consultation

We received a Biological Assessment and cover memo requesting initiation of section 7 consultation under the Endangered Species Act (Act) for BP Exploration (Alaska) Inc.'s (BP Alaska) proposed Liberty Development and Production Plan on May 31, 2007. The consultation concerns the possible effects of the proposed action on spectacled (*Somateria fischeri*) and Alaska-breeding Steller's *(Polysticta stelleri*) eiders, which are listed as threatened under the Act and the candidate species Kittlitz's murrelet (*Brachyramphus brevirostris*). We understand that MMS intends to request a separate conference opinion on the potential effects of the project on Polar Bears (*Ursus maritimus*), which are proposed for listing.

After reviewing the BA we have determined that the proposed action may adversely affect listed species and will therefore require formal consultation. All the information required to initiate formal consultation was either included in the BE, or is otherwise accessible for our consideration and reference. However, it is likely that we will identify additional information needs, or require clarification on aspects of the proposed action as consultation progresses.

As a reminder, section 7 allows the Fish and Wildlife Service (Service) 90 calendar days to conclude formal consultation with your agency and an additional 45 calendar days to prepare our biological opinion (unless we mutually agree upon an extension).

This consultation will be conducted by the Endangered Species Branch of the Fairbanks Field Office. In order to expedite communication please address future documents or requests concerning this consultation to Ted Swem, Branch Chief, Fairbanks Fish & Wildlife Field Office, 101 12th Ave, Room 110, Fairbanks, AK 99701.

United States Department of the Interior
U.S. FISH AND WILDLIFE SERVICE
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701
October 3, 2007

RECEIVED
OCT 11 2007
REGIONAL DIRECTOR, ALASKA OCS
MINERALS MANAGEMENT SERVICE
ANCHORAGE, ALASKA

Memorandum

To: Regional Director, MMS – Alaska OCS Region

From: Fairbanks Fish & Wildlife Field Supervisor D. Roy

Subject: BP Alaska's Liberty Development Project: Endangered Species Act Section 7 Consultation

This document transmits the U.S. Fish and Wildlife Service's (Service's) Final Biological Opinion (BO) based on our review of the Mineral Management Service's (MMS's) Biological Assessment (BA) and supplemental materials on BP Alaska Inc.'s proposed Liberty Development Project. The BO documents effects of the action on threatened spectacled (*Somateria fischeri*), and Alaska-breeding Steller's (*Polysticta stelleri)* eiders, and the candidate species Kittlitz's murrelets (*Brachyramphus brevirostris*) in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 et seq.). A separate conference opinion is being prepared for the proposed species polar bear (*Ursus maritimus*).

The Liberty field is located offshore in the Beaufort Sea Outer Continental Shelf (OCS) region. Originally BP Alaska intended to develop the field from a stand-alone offshore island with a subsea pipeline. However, the current proposal would expand the Endicott Satellite Drilling Island to house ultra extended reach wells to extract oil from this field. Products from the Liberty field will move through existing Endicott pipelines and production infrastructure. This new design, use of state-of-the-art technology, and co-location with existing infrastructure, significantly reduces the environmental impacts of the project and the Service commends BP Alaska for this new approach.

After reviewing the information provided, the status of the species, the environmental baseline, and cumulative effects, the Service concludes the proposed activities will not violate section 7(a)(2) of the Act by jeopardizing the continued existence of any listed species or adversely modify designated critical habitat. Adverse effects to listed species are, however, predicted to occur. The incidental take statement for this non-jeopardy BO includes reasonable and prudent measures, and terms and conditions that are non-discretionary for MMS and their agents, BP Alaska, to implement.

A complete administrative record of this consultation is on file at the Fairbanks Fish and Wildlife Field Office, 101 12th Ave., Room 110, Fairbanks, Alaska 99701, and a chronology of the consultation history is provided in Appendix 1.

We look forward to working collaboratively with the MMS and BP Alaska to implement the terms and conditions of the BO. If you have any comments or concerns regarding this BO, please contact Ted Swem, Endangered Species Branch Chief, at (907) 456-0441.

CC: Mr. Cash Fay, Permits Coordinator, BP Exploration (Alaska) Inc., P.O. Box 196612, Anchorage, AK 99519-6612