North Slope Nearshore and Offshore Breakup Study Literature Search and Analysis of Conditions and Dates

FINAL REPORT

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The prime contractor was OASIS Environmental, Anchorage, with DF Dickins Associates, La Jolla, California providing technical expertise.

The study team comprised:

- David Dickins, DF Dickins Associates Ltd. as the primary author,
- Amy Peloza, OASIS Environmental, Inc. (OASIS) as the Anchorage project manager, providing client and industry liaison, data search and project coordination,
- Susan Ives, OASIS, provided Geographical Information System (GIS) mapping from the ice and bathymetric data, and
- Merion Kendall, OASIS, provided word processing and report layout.

SUMMARY

This study provides an analysis of ice conditions and the dates associated with seasonal transitions in the nearshore and offshore Beaufort Sea environments including the lagoon areas inside the barrier islands affected by major river overfloods. The geographic scope of the ice database includes the marine area from shore to beyond the northern boundaries of the existing offshore Federal leases in the March 30, 2005 Sale 195. The east/west extent of the study area spans the entire Alaskan North Coast from Point Barrow to the United States (US)/Canada border east of Kaktovik.

Alaska Department of Environmental Conservation (ADEC) will use this study of breakup dates and other ice conditions to assist in its determination of appropriate winter exploration drilling dates for sites falling within the fast ice zone. In addition, the geographic scope and detail of ice information presented in this study can be used to assess future development activities in deeper waters beyond the typical winter fast ice edge.

Realistic maximum response operating limitations (RMROL) that might be encountered at different locations are described in the Alaska Clean Seas (ACS) *Technical Manual*, Volume 1, Tactic L-7. Tactic L-7 analyzes the frequency and duration, expressed as a percentage of time, of limitations that would render mechanical response methods ineffective, as required by 18 AAC 75.425(e)(3)(D). The analysis considers weather, sea conditions, ice, daylight hours and other environmental conditions that might influence the efficiency of an oil spill response. Current ADEC policy is that winter exploration drilling must be completed in time for source control and cleanup to occur before RMROL conditions are reached.

The study was divided into two main tasks.

Task 1 Literature Search

Including satellite photo archives maintained by the United States Geological Survey (USGS) and National Aeronautics and Space Administration (NASA), industry and consultants reports, government-sponsored research programs, recent studies into the potential impacts of climate change on Arctic sea ice and conference papers.

Task 2 Ice Database Development and Interpretation

This task was broken into two components: (1) development of a database of sea ice conditions focusing on regional patterns in historical ice conditions; and (2) an interpretation of the ice database in terms of recommended time periods for on-ice operations covering issues such as ice bearing capacity and stability, shore access affected by river ice overflood, timing of first fracturing of fast ice and formation of new ice.

A detailed description of nearshore ice clearing patterns is supported by selected examples of Landsat and Moderate-resolution Imaging Spectroradiometer (MODIS) satellite images acquired through a search of web-based archives dating back to 1973. The primary component of the ice database is based on a set of ice atlas map products provided by the Canadian Ice Service (CIS) covering the period 1971 to 2000. The summary maps created for this study include weekly median values for ice concentration, the frequency of encountering ice and summaries of average breakup and freezeup dates over a 30-year period. The CIS files were integrated with a National Oceanic and Atmospheric Administration (NOAA) digital bathymetric chart to provide an underlay

of water depths (0-5, 5-10 and >15 m) on the ice maps. The full set of maps (weekly for three different areas covering the full study region) is provided in portable document format (PDF).

Tables of recommended on-ice operating windows are generated for seven subregions covering the full study area as

- Barrow to Drew Point,
- Drew Point to Cape Halkett,
- Cape Halkett to Oliktok Point,
- Oliktok Point to Bullen Point,
- Bullen Point to Brownlow Point,
- Brownlow Point to Kaktovik (Barter Island), and
- Kaktovik to US/Canada Border.

Each table contains the background data used to develop realistic estimates for recommended on-ice operating periods for each subregion and water depth range, freezeup, start and end of breakup, local timing of river overflood, etc. An example is provided here for the subregion spanning the existing Prudhoe Bay developments.

Example Table Showing Recommended Operating Periods (1 of 7)
Ice Cycle – Oliktok to Bullen Point

	Water Depth			
Ice Condition	**Shore to 2 m (Overflood areas)**	**2 to 5 m**	**5 to 10 m**	**10 to 15 m**
Median Freezeup	Oct 4	Oct 8	Oct 8	Oct 15
Ice 30 to 46 cm (+26 days)	Oct 30			
Ice 46 to 76 cm (+42 days)		Nov 15	Nov 15	Nov 22
Overflood (Kuparuk, Sag, Shaviovik)	May 27 (typ)	May 29	N/A	N/A
Start Breakup <10/10	Jun 12 (est.)	Jul 6	Jul 6	Jun 25
End Breakup <1/10	Jun 25	Jul 15	Jul 23	Jul 26 to Aug 29
Recommended On-ice Operating Season				
- From	Oct 30	Nov 15	Nov 15	Nov 22
- To	May 15	Jun 20	Jun 20	Jun 10
Days Open Water (<1/10) 1970-2000	102	86	81	47-85
Days Open Water (Dickins, 1984) <3/10 Ice Data 1971-83	No Data	84	77	56-77
Days Open Water (Dehn, 1981) US Ice Data 1953-75	No Data	72	54	36-42

The comparison made with older data sources in the example table would seem to indicate that the summer open water period has increased by 10 to 20 days from the 1960's to the 1990's. This may not be a real result. For example, the freezeup and breakup dates are comparable within a few days for the different sources. The difference could be a combination of the greatly improved quality of the ice reporting over the past few decades, and differences in interpretation of open water, or the distinction between ice free and open water (<1/10) ice can result in variable season lengths.

Recent reports and papers are reviewed to summarize a possible range of outcomes for the impact of Arctic climate change on the Beaufort Sea ice environment. Results are still inconclusive. There is wide degree of variation in projections possible in the available Global Climate Models, from almost no summer sea ice in the Arctic within 50 years to limited change from today's conditions. That said, there is no doubt that over the past five years, satellite sensors have mapped a dramatic reduction in summer ice extent, with 2002 and 2005 setting records for the broadest expanse of open water off the Alaskan coast ever observed in recorded history. The general consensus is that while summer ice conditions could change significantly over time scales of a few decades, mostly in terms of the distance from shore to pack ice edge, the general timing of freezeup and breakup, as well as the extent and thickness of the fast ice zone, are unlikely to change to a great extent.

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ACRONYMS AND ABBREVIATIONS

ACIA	Arctic Climate Impact Assessment
ACS	Alaska Clean Seas
ADEC	Alaska Department of Environmental Conservation
AEIDC	Alaska Environmental Information Data Center
AK	Alaska
AOGA	Alaska Oil and Gas Association
ASRC	Arctic Slope Regional Corporation
BLM	Bureau of Land Management
BPXA	British Petroleum Exploration (Alaska), Inc.
CIS	Canadian Ice Service
cm	centimeters
cm/sec	centimeters per second
DMSP	Defense Meteorological Satellite Program
EIS	Environmental Impact Statement
ESRI	Environmental Systems Research Institute, Inc
Fast Ice	Ice contiguous with shore without visible leads or openings (also known as Landfast Ice)
GCMs	Global Climate Models
GIS	EIS Arc Geographical Information System version 9.1
IPS	ice profiling sonar
JIP	joint industry studies
jpeg	Joint Photographic Experts Group
kg	kilograms
km	kilometers
km/day	kilometers per day
LS	Landsat Satellite
m	meters
MMS	Minerals Management Service
MODIS	Moderate-resolution Imaging Spectroradiometer
NASA	National Aeronautical and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NWT	Northwest Territories
pdf	portable document format
RMROL	Realistic Maximum Response Operating Limitations
SAIC	Science Applications International Corporation
Sag	Sagavanirktok
SAR	Synthetic Aperture Radar
SLIE	Seaward Landfast Ice Extension
UAF	University of Alaska Fairbanks

US	United States
USCG	United States Coast Guard
USGS	United States Geological Survey