TABLE 5.3-1
SEDIMENT CHARACTERISTICS FROM OFFSHORE BORINGS
IN THE PROJECT AREA

Approximate Age	Data Source	Number of Borings	Approx. Unit Thickness (feet)	Predominant Grain Size Classification[1]	Ice Bonded?	% Fines (Passing #200)
INSHORE OF BARRIER ISLANDS						
Holocene	Miller (1996)	12	13.5 - 27.5	SM/ML	Mixed	4.3 - 88.5
	McClelland (1985)	2	5 - 13	SP/SM	Mixed	--
	Benton (1970)	1	6.6 - 25.6	--	--	--
Pleistocene	Miller (1996)	5	34+	GP/SP-SM	Mixed	4 - 6.7
	McClelland (1985)	2	31.5+	SP	Mixed	--
	Benton (1970)	1	33.4+	--	--	--
BARRIER ISLANDS (Approximately 1,000 Feet Offshore)						
Holocene	Miller (1996)	7	24 - 42.5	SM/SP/ML	Yes	4.8 - 84.6
	McClelland (1985)	11	11 - 34	SP-SM/ML	Mixed	--
	Benton (1970)	1	30	--	--	--
Pleistocene	Miller (1996)	2	31+	GP/SP	Mixed	0.8
	McClelland (1985)	11	24+	GP/SP	Mixed	--
OFFSHORE OF BARRIER ISLANDS						
Holocene	Miller (1996)	10	15 - 30.5	SP/SM/ML	No	1.4 - 8.7
	McClelland (1985)	3	8.5 - 17	--	No	--
	Woodward-Clyde Consultants (1981)	9	3.5 - 23	SM/SP	No	--
	Benton (1970)	2	6.6 - 9.2	--	--	--
Pleistocene	Miller (1996)	4	72+	GP	No	0.1 - 7.6
	McClelland (1985)	3	26.5+	--	No	--
	Woodward-Clyde Consultants (1981)	8	59+	GP	No	--

Note: Location of borings shown on Figure 5.3-6.

-- = Not analyzed or not applicable
1 = ASTM, 1995:207-217
Benton = Benton Engineering as cited in Miller, 1995:2-5
Miller = Miller, 1996:Pl.B1-B19
McClelland = McClelland-EBA, Inc., 1985:Pl.3-19
Pleistocene = More than 11,000 years before present
Woodward-Clyde Consultants = WCC, 1981:Figs. 3-7

% = Percent
SM = Silty sand
ML = Silt
GP = Poorly graded gravel
SP = Poorly graded sand
Holocene = Less than 11,000 years before present

Source: This was compiled and prepared by Dames & Moore using listed references.

TABLE 5.3-2
MARINE SEDIMENT CHEMISTRY RESULTS IN THE PROJECT AREA

		VOCs (EPA 8260A)		SVOCs (EPA 8270)				Metals (EPA 6010; Mercury 7471)					
Sample No.	DRO (EPA 8100M) (mg/kg)	Methylene chloride (mg/kg)	Toluene (mg/kg)	Bis (2-ethylhexyl) phthalate (mg/kg)	Di-n-butyl phthalate (mg/kg)	TCLP Barium (EPA 1311.6010) (mg/L)	Soluble Barium[3] at pH 5 by TCLP (mg/L)	Barium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Zinc (mg/kg)
95NS-S001	ND(16)	22 B	ND(1.7)	0.93	ND(0.29)	--	--	90	ND(0.46)	18	11	ND(0.16)	77
95NS-S003	ND(10)	NA	NA	ND(0.18)	ND(0.18)	--	--	9.6	ND(0.27)	0.6	2	0.14	4.3
95NS-S005	ND(12)	12 B	ND(1.2)	ND(0.21)	0.18 J	--	--	71	ND(0.31)	6.5	2.9	ND(0.12)	30
95NS-S006	ND(15)	11 B	ND(1.5)	0.20 J	0.21 J	--	--	160	ND(0.38)	17	12	ND(0.15)	63
95NS-S013	ND(16)	17 B	2.4	ND(0.29)	ND(0.29)	--	--	93	ND(0.46)	17	8.5	ND(0.17)	64
95NS-S018	ND(15)	17 B	ND(1.7)	ND(0.28)	ND(0.28)	--	--	86	ND(2.2)	18	9.2	ND(0.16)	73
95NS-S019[1]	ND(16)	30 B	ND(1.7)	ND(0.29)	ND(0.29)	--	--	91	ND(2.1)	20	12	ND(0.17)	85
95NS-S023	ND(13)	4 J,B	ND(1.3)	0.16 J	ND(0.21)	--	--	74	ND(0.66)	4.5	2.7	ND(0.13)	21
95NS-S024	ND(13)	3 J,B	ND(1.3)	0.69	ND(0.22)	--	--	110	ND(1.7)	8.2	4.6	ND(0.13)	35
95NS-S025	ND(12)	ND(6.8)	ND(1.4)	ND(0.23)	ND(0.23)	--	--	62	ND(0.71)	5.5	3.2	ND(0.14)	25
95NS-S029	ND(14)	4.1 J,B	ND(1.4)	ND(0.23)	ND(0.23)	--	--	48	ND(0.69)	8.6	4.6	ND(0.13)	32
95NS-S034	ND(16)	7.1 J,B	6.1 J	ND(0.27)	ND(0.27)	0.26	5.2	99	ND(2.2)	15	6.6	ND(0.16)	57
95NS-S035	ND(14)	9.1 B	ND(1.6)	ND(0.27)	ND(0.27)	0.19	3.8	59	ND(0.83)	13	5.5	ND(0.16)	47
95NS-S036[2]	ND(14)	13 B	ND(1.6)	ND(0.27)	ND(0.27)	0.20	4.0	74	ND(0.80)	14	5.8	ND(0.15)	54
95NS-S037	ND(13)	13 B	ND(1.2)	ND(0.20)	ND(0.20)	0.15	3.0	20	ND(0.66)	4.7	ND(2.0)	ND(0.11)	19
95NS-S038	ND(12)	14 B	7	ND(0.19)	ND(0.19)	0.23	4.6	37	ND(0.59)	3.8	2.6	ND(0.11)	21

Notes:
-- = Not applicable
1 = Sample No. 95NS-S019 is a field duplicate of 95NS-S018.
2 = Sample No. 95NS-S036 is a field duplicate of 95NS-S035.
3 = Soluble barium is determined to be 20 times greater than the TCLP Barium value due to a dilution in the TCLP method.
B = Analyte is found in the associated blank as well as the sample.
J = Estimated value (Measured concentration below the estimated limit but above the method detection limit)
DRO = Diesel range organics
EPA = U.S. Environmental Protection Agency
mg/kg = Milligrams per kilogram
mg/L = Milligrams per liter
NA = Not analyzed due to physical characteristics of matrix (rocks)
ND( ) = Not detected (reporting limit)
SVOCs = Semi-volatile organic compounds
TCLP = Toxicity Characteristic Leaching Procedure
VOCs = Volatile organic compounds

Source: WCC, 1996:Table 3

TABLE 5.3-3
FLOW DATA FOR THE KUPARUK AND PUTULIGAYUK RIVERS

River	Distance from Mouth (miles)	Approx. Years of Record	October				November				December				January			
			Range[1]		Average[2] (cfs)	STD[3] (cfs)	Range[1]		Average[2] (cfs)	STD[3] (cfs)	Range[1]		Average[2] (cfs)	STD[3] (cfs)	Range[1]		Average[2] (cfs)	STD[3] (cfs)
			Min. (cfs)	Max. (cfs)			Min. (cfs)	Max. (cfs)			Min. (cfs)	Max. (cfs)			Min. (cfs)	Max. (cfs)		
Kuparuk	10	1971-1996	10	692	212	∀ 167	0	174	19	∀ 36	0	24	3	∀ 6	0	10	2	∀ 3
Putuligayuk	7.3	1970-1986	0	15	2	∀ 4	0	0	0	∀ 0	0	0	0	∀ 0	0	0	0	∀ 0

River	Distance from Mouth (miles)	Approx. years of Record	February				March				April				May			
			Range[1]		Average[2] (cfs)	STD[3] (cfs)	Range[1]		Average[2] (cfs)	STD[3] (cfs)	Range[1]		Average[2] (cfs)	STD[3] (cfs)	Range[1]		Average[2] (cfs)	STD[3] (cfs)
			Min. (cfs)	Max. (cfs)			Min. (cfs)	Max. (cfs)			Min. (cfs)	Max. (cfs)			Min. (cfs)	Max. (cfs)		
Kuparuk	10	1971-1996	0	10	2	∀ 3	0	10	2	∀ 3	0	10	2	∀ 3	0	6,572	1,098	∀ 1,624
Putuligayuk	7.3	1970-1986	0	0	0	∀ 0	0	0	0	∀ 0	0	0	0	∀ 0	0	54	4	∀ 14

River	Distance from Mouth (miles)	Approx. years of Record	June				July				August				September			
			Range[1]		Average[2] (cfs)	STD[3] (cfs)	Range[1]		Average[2] (cfs)	STD[3] (cfs)	Range[1]		Average[2] (cfs)	STD[3] (cfs)	Range[1]		Average[2] (cfs)	STD[3] (cfs)
			Min. (cfs)	Max. (cfs)			Min. (cfs)	Max. (cfs)			Min. (cfs)	Max. (cfs)			Min. (cfs)	Max. (cfs)		
Kuparuk	10	1971-1996	726	26,360	11,056	∀ 5,459	310	2,439	977	∀ 593	127	5,095	1,526	∀ 1,400	193	3,607	1,368	∀ 1,005
Putuligayuk	7.3	1970-1986	163	694	451	∀ 158	3	64	21	∀ 17	0.1	49	9	∀ 13	0.4	62	15	∀ 20

Notes: 1 = Range of monthly means for period of record
2 = Average of monthly means for period of record
3 = Standard Deviation
cfs = Cubic feet per second
Max. = Maximum
Min. = Minimum

Sources: Kuparuk River: USDOI, GS, 1996
Putuligayuk River: USDOI, GS, 1970; 1971; 1972; 1973; 1974; 1975; 1976; 1977; 1978; 1979; 1982; 1983; 1984; 1985; 1986.

TABLE 5.3-4
RANGE OF WATER QUALITY CONSTITUENTS, KUPARUK AND PUTULIGAYUK RIVERS

Chemical Constituent	Kuparuk River						Putuligayuk River					
	Minimum Concentration			Maximum Concentration			Minimum Concentration			Maximum Concentration		
	Concentration	Date	Discharge (cfs)	Concentration	Date	Discharge (cfs)	Concentration	Date	Discharge (cfs)	Concentration	Date	Discharge (cfs)
Turbidity (NTU/JCU)	0.00	6/19/77	308	33	6/11/86	29,400	1	6/23/72	200	20	7/18/74	12
pH	6.3	8/7/84	6,580	8.2	11/20/70	N/A	7.4	6/9/70	1,220	8.3	9/5/70	0.6
Dissolved Oxygen (mg/L)	1.4	4/29/75	N/A	14.6	6/9/75	748	11.0	9/5/70	0.6	14.9	10/15/71	N/A
Phosphate[1] (mg/L)	0.00	3/18/72	N/A	0.18	9/18/83	2,620	0.0	Multiple Years	N/A	0.31	6/14/75	1,870
Nitrogen[2] (mg/L)	0.05	6/25/77	7,300	0.92	6/7/80	35,700	0.20	6/23/72	200	0.91	9/20/75	6.3
Nitrate[3] (mg/L)	0.00	8/13/71	654	0.42	2/6/76	0.00	0.00	8.00	2.00	0.66	6.00	157.00
Nitrite[3] (mg/L)	ND	Multiple Years	N/A	0.01	6/16/81	5,720	N/A	N/A	N/A	N/A	N/A	N/A

Notes: 1 = Phosphate reported as orthophosphate, dissolved
2 = Nitrogen reported as total organic
3 = Reported as dissolved
cfs = Cubic feet/second
NTU = Nephelometric Turbidity Unit, for Kuparuk data
JCU = Jackson Candle Unit, for Putuligayuk data
mg/L = Milligrams per liter
N/A = Not applicable or not available
ND = Not detected

Sources: Kuparuk River: USDOI, GS, 1996
Putuligayuk River: USDOI, GS, 1970; 1971; 1972; 1973; 1974; 1975; 1976; 1977; 1978; 1979; 1982; 1983; 1984; 1985; 1986.

TABLE 5.3-5
SEDIMENT DISCHARGE DATA,
KUPARUK AND PUTULIGAYUK RIVERS

River	Number of Measurements	Period of Record	Suspended Sediment Discharge (Tons/Day)			
			Minimum	Maximum	Average	Standard Deviation
Kuparuk	61	1971-1986	0.00	55,600	2,951	± 9,027
Putuligayuk	13	1970-1976	0.04	825	115	± 229

Source: USDOI, GS, 1996:Table 1

TABLE 5.3-6
IMPACTS OF ALTERNATIVES 2, 3, 4, AND 5 ON GEOLOGY AND HYDROLOGY

Action/Event	Frequency	Duration	Scope	Direct Impacts	Indirect Impacts
Ice Roads - Construction	Once	All winter	Freshwater required for ice roads ranges from 13 to 14.9 million gal (49.2 to 56.4 million liters).	None - To soil or sediment would be expected. Minor - To lake water level and water quality which would total 15% of permitted usage from Kuparuk Deadarm mine site.	None anticipated.
Ice Roads - Operations	Annually	All winter	Freshwater required for ice roads is approximately 5.9 to 7.8 million gal (22.3 to 29.5 million liters) to connect West Dock to Seal Island.	None - To soil or sediment would be expected. Minor - To lake water which would total less than 15% of permitted usage from Kuparuk Deadarm mine site.	None anticipated.
Island – Construction	Once	3 Months	700,000 to 800,000 yds^3 (535,185 to 611,647 m^3) gravel moved and emplaced.	Negligible – To sediment from construction dewatering discharge. Minor – To sediment from direct covering and suspension and redeposition; to sediments due to plume from regrading island slope and berm before installation of concrete mat(s).	None anticipated.
Island – Operation/ Maintenance	Annually	15 years	Seal Island and immediate vicinity. Minor amounts of gravel moved. 23 wells would be drilled. Injection of 120 million barrels waste. Withdrawal of 158 million barrels oil.	Negligible - To sediment from island discharges or settling of suspended material; to geological environment and ground subsidence from removal of oil. Negligible to Minor - From drilling or injection of wastes, and island maintenance and repair. Minor - To subsurface geological environment and shallow sediment quality from injection of wastes; to island facilities from permafrost thaw settlement; to operations from potential shallow gas accumulations.	None anticipated.

TABLE 5.3-6 (Cont.)

IMPACTS OF ALTERNATIVES 2, 3, 4, AND 5 ON GEOLOGY AND HYDROLOGY

Action/Event	Frequency	Duration	Scope	Direct Impacts	Indirect Impacts
Offshore Pipeline – Construction	Once	3 Months (Winter)	Lengths vary from 6 to 9 miles (9.7 to 14.5 km).	Negligible – To sediment chemical quality from trenching and pipeline covering activities. Minor - To sediment settling of suspended sediment along trench margins and spoils disposal; to sediment from West Dock causeway widening for Alternative 5.	None anticipated.
Offshore Pipeline - Operation/ Maintenance	Rare	15 years	Pipeline lengths vary from 6 to 9 miles (9.7 to 14.5 km). Repair scenarios would vary with season and magnitude of problem.	Negligible - To pipeline from extension of barrier islands by natural processes; to pipeline stability from vibration. Minor – Localized, to sediment if a repair were required; to subsea pipeline from permafrost settlement (possible exception: Alt. 5); to Alts. 2, 3, and 4 shore approach facilities from coastal erosion; to subsea pipeline from scour and storm channeling.	None anticipated.
Onshore Pipeline – Construction	Once	6 Months (Winter)	Total lengths range from 11.9 to 15.6 miles (19.1 to 25.2 km). Lengths of undisturbed tundra crossing range from 3.1 to 9.6 miles (5 to 15.5 km).	Negligible - To surface water resources, including the Putuligayuk River. Minor - To soils along the pipeline route; onshore soils at the shore landing and valve pad.	None anticipated.
Onshore Pipeline - Operation/ Maintenance	Weekly	15 years	Lengths vary from 11.9 to 15.6 miles (19.1 to 25.2 km).	None– To river hydrology. Negligible to Minor – To pipeline from coastal erosion. Negligible to Minor - To permafrost and surface water resources; to physical hydraulic processes; to onshore soil from inspection, operation, and maintenance activities.	None anticipated.

TABLE 5.3-6 (Cont.)

IMPACTS OF ALTERNATIVES 2, 3, 4, AND 5 ON GEOLOGY AND HYDROLOGY

Action/Event	Frequency	Duration	Scope	Direct Impacts	Indirect Impacts
Gravel Mining	Once Occasionally	3 Months (Winter) Unknown	35 acres (14 hectares) for Alternatives 2, 3, and 4. Additional gravel needed for Alternative 5 causeway widening.	Minor - To onshore geology and hydrology.	None anticipated.
Large Oil Spill	Rare	Unknown	Area contacted by oil - up to 200 miles (322 km) of coastline.	Significant - Contamination (sheens or free product) of soils, sediment, and surface water bodies from direct oiling and deposition of tarballs, potentially last for 5 to 10 years.	Minor - Thawing or disturbance of permafrost for the area (few hundred square yards) of vegetation damaged or removal during spill response.
Abandonment	Once	3 to 6 Months	Seal Island and pipeline route, depending on abandonment method.	Negligible to Minor - To soil from pipeline removal; sediment from island and pipeline removal.	Negligible to Minor – If pipelines remained in place.

Notes:
< = Less than
Alt. = Alternative
ft = Feet
gal = Gallons
km = Kilometer
m = Meters
m^3 = Cubic meters
yd^3 = Cubic yards

TABLE 5.4-10
AIR QUALITY IMPACTS FOR ON-ISLAND CONSTRUCTION ACTIVITIES

Pollutant	Averaging Period	Worst Case Year	NAAQS ($\mu g/m^3$)	Maximum Concentration [a] ($\mu g/m^3$)	Background Concentration [b] ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)
CO	1-Hour	1991	40,000	1969.0	NA	1,969.0
	8-Hour	1988	10,000	580.2	NA	580.2
NO_2 [c]	Annual	1987	100	90.2	7.0	97.2
PM_{10}	24-Hour	1989	150	121.2	6.3	127.5
	Annual	1987	50	10.8	0.1	10.9
SO_2	3-Hour	1988	1,300	157.0	3.8	160.8
	24-Hour	1989	365	71.0	3.8	74.8
	Annual	1987	80	5.2	0.1	5.3

Note:
a = Highest second highest concentration requested for the short-term averaging periods, except for construction PM_{10} impacts (highest-sixth-highest). There is no 1.6 kilometer exclusion zone and impacts are considered at island edge.
b = Background concentrations include global background values (SECOR, 1995a:Table 3-4); NO_2 background also includes inventory modeling results from nearby point sources. (See location and sources in Table 5.4-6.)
c = Concentration adjusted using the Ozone Limiting Method (Wilson, 1997:1 and 2 - Copy provided in Appendix D).
CO = Carbon monoxide
$\mu g/m^3$ = Micrograms per cubic meter
NA = Not available
NAAQS = National Ambient Air Quality Standards
NO_2 = Nitrogen dioxide
PM_{10} = Particulate matter less than 10 microns in diameter
SO_2 = Sulfur dioxide

Source: RILLC, 1998:Table 5-4

TABLE 5.4-11
PROPOSED BACT CONTROLS - DRILLING AND OPERATION ACTIVITIES

Pollutant	Sources	Proposed Control Technology
NO_X	Turbines	Dry Low NO_X
	Boilers/Heaters	Good Operating Practices
	Internal Combustion Engines (natural gas fueled)	Low Emission Combustion
	Internal Combustion Engines (diesel) - Cummins	Fuel Injection Timing Retard
	Internal Combustion Engines (diesel)	Good Operating Practices
	Incinerator	Good Operating Practices
CO	Turbines	Good Operating Practices
	Boilers/Heaters	Good Operating Practices
	Internal Combustion Engines (natural gas fueled)	Catalytic Oxidation
	Internal Combustion Engines (diesel fueled)	Good Operating Practices
	Incinerator	Good Operating Practices
PM_{10}	Turbines (natural gas fuel)	Good Operating Practices
	Boilers	Good Operating Practices
	Internal Combustion Engines	Good Operating Practices
	Incinerator	Good Operating Practices
	Flares	Smokeless Tip Design
VOCs	Turbines	Good Operating Practices
	Boilers/Heaters	Good Operating Practices
	Internal Combustion Engines (natural gas fueled)	Catalytic Oxidation
	Internal Combustion Engines (diesel fueled)	Good Operating Practices
	Incinerator	Good Operating Practices
	Tanks	None
SO_2	Turbines	Low Sulfur Fuel
	Boilers/Heaters	Low Sulfur Fuel
	Internal Combustion Engines	Low Sulfur Fuel
	Incinerator	Low Sulfur Fuel

Notes: BACT = Best Available Control Technology
CO = Carbon monoxide
NO_X = Oxides of nitrogen
PM_{10} = Particulate matter less than 10 microns in diameter
SO_2 = Sulfur dioxide
VOCs = Volatile organic compounds

Source: RILLC, 1998:Section 4.6.1

TABLE 5.4-12
SUMMARY OF POTENTIAL OFFSHORE AIR EMISSIONS FOR LONG-TERM DRILLING AND OPERATION ACTIVITIES

Source	Fuel	Number	Maximum Rating	Tons Per Year				
				CO	NO_X	PM_{10}	SO_2	VOCs
LM 2500 Turbines	Gas	2	32,715 hp each	155.58	255.44	31.54	19.34	21.02
Mars 90 Turbines	Gas	3	11,892 kw each	217.57	249.12	61.76	13.51	62.26
Glycol Reboiler	Gas	1	5 MMBtu/hr	0.50	2.38	0.29	0.20	0.13
Glycol Heaters	Gas	1	1.05 MMBtu/hr	0.10	0.50	0.06	0.04	0.03
	Diesel	1	1.05 MMBtu/hr	0.02	0.08	0.01	0.08	0.00
Space Heaters	Gas	4	2.685 MMBtu/hr (total)	0.27	1.28	0.16	0.11	0.08
HP Flare [a]	Gas	1	0.079 MMscfd	4.91	0.90	0.19	0.12	1.86
LP Flare [b]	Gas	1	0.454 MMscfd	3.58	0.66	0.14	0.08	1.35
Camp Generator								
Prime Mode [c]	Diesel	2	2,362 kW each	7.55	38.74	1.17	2.53	0.75
Standby Mode [d]	Diesel	2	2,717 kW each	9.62	43.73	1.18	2.83	0.85
Storage Tanks	NA	NA	NA	NA	NA	NA	NA	0.25
Fire Water Pump	Diesel	1	755 hp	0.11	0.85	0.01	0.04	0.02
Incinerator	Gas/Waste	1	1.6 MMBtu/hr and 100 lb/hr	6.95	1.30	5.59	0.82	0.41
Cold Start Unit	Diesel	1	314 hp	0.07	1.34	0.01	0.09	0.14
Rig Boilers	Gas	2	6.3 MMBtu/hr each	1.26	6.00	0.72	0.51	0.32
	Diesel	2	6.3 MMBtu/hr each	0.23	0.92	0.09	0.98	0.01
Heaters	Gas	3	7.7 MMBtu/hr total	1.12	5.33	0.64	0.45	0.29
	Diesel	3	7.7 MMBtu/hr total	0.21	0.82	0.08	0.87	0.01
Portable Equipment	Diesel	Various	Variable	12.06	55.73	4.03	3.94	4.30
Totals				421.71	665.12	107.67	46.54	94.08

Notes:
CO = Carbon monoxide
hp = Horsepower
kW = Kilowatts
lb/hr = Pounds per hour
MMBtu/hr = Million British thermal units per hour
MMscfd = Million standard cubic feet per day
NA = Not applicable
NO_X = Oxides of nitrogen
PM_{10} = Particulate matter less than 10 microns in Diameter
SO_2 = Sulfur dioxide
VOCs = Volatile organic compounds
a = HP flare handles primary separators and gas turbine fuel
b = LP flare handles blanketing and fuel gas system.
c = Prime mode assumes electrical power provided by turbines.
d = 4 hours per day of operation.

Source: RILLC, 1998:Appendix A; BPXA, 1998

TABLE 5.4-1
AVERAGE CLIMATIC CONDITIONS FOR BARROW, PRUDHOE BAY, AND BARTER ISLAND, ALASKA

Parameter (Dates)	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Average
Barrow													
Monthly Average Temp (°F)	-14.7	-18.6	-15.2	-0.9	19.1	33.0	38.7	37.6	30.3	15.3	-0.5	-12.3	9.3
Mean Wind Dir (1951-1963)	ESE	E	ENE	NE	E	ENE	E	E	E	E	E	E	NA
Mean Wind Speed (mph) (1951-1963)	11.3	10.9	11.2	11.5	11.6	11.4	11.5	12.4	13.1	13.3	12.6	11.2	11.8
Precipitation (inches) (1951-1980)	0.21	0.17	0.17	0.21	0.16	0.37	0.86	0.98	0.59	0.55	0.30	0.18	0.40
Prudhoe Bay (Deadhorse Airport)													
Hourly Mean Temp (°F)[1] (1996)	-16.6	-16.1	-11.4	1.3	23.3	36.6	46.4	43.1	31.6	16.0	-8.7	-13.7	11.0
Mean Wind Dir[2] (1969-1988)	ENE	WSW	WSW	ENE	ENE	E	ENE	ENE	ENE	ENE	ENE	WSW	NA
Mean Wind Speed[3] (mph) (1969-1988)	14.7	13.7	13.3	12.4	13.7	13.3	12.9	11.9	13.1	13.6	13.8	13.2	13.3
Precipitation (inches) (1983-1993)	0.55	0.35	0.47	0.44	0.55	0.46	0.66	1.07	0.72	0.75	0.50	0.51	0.59
Barter Island													
Monthly Average Temp (°F) (1951-1980)	-15	-20.5	-16.3	-0.9	20.9	34	40	39.9	31.4	15.2	0	-13	9.6
Mean Wind Direction	W	W	W	W	E	ENE	ENE	E	E	E	E	E	NA
Mean Wind Speed (mph)	13	12	12	10	11	10	10	11	12	13	14	13	11.8
Precipitation (inches) (1951-1980)	0.50	0.27	0.24	0.22	0.35	0.56	1.03	1.08	0.80	0.81	0.40	0.23	0.54

Notes:
1 = Monthly Average temperature from Well Pad A, Prudhoe Bay
2 = Mean wind direction taken at Deadhorse Airport (SECOR, 1995b:5)
3 = Mean wind speed taken at Deadhorse Airport (SECOR, 1995b:5)
°F = Degrees Fahrenheit
mph = Miles per hour
NA = Not applicable

N = North
S = South
E = East
W = West

Sources: USDOI, NOAA and Ruffner, 1985:20-29; GRI, 1992:25-28; SECOR, 1995a:Table 2-1, Figures 2-1 through 2-5; SECOR, 1995b:5; BPXA, 1996:4-2.

TABLE 5.4-13
COMPARISON OF DRILLING AND OPERATION PHASE MODELING ANALYSIS RESULTS TO NAAQS

Pollutant	Averaging Period	Worst Case Year[a]	NAAQS ($\mu g/m^3$)	Maximum Concentration[b] ($\mu g/m^3$)	Background Concentration[c] ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)
NO_2	Annual	1988	100	22.8[d]	7.8	30.6
PM_{10}	24-Hour	1989	150	21.6	7.0	28.6
	Annual	1988	50	4.5	0.1	4.6
SO_2	3-Hour	1988	1,300	179.1	6.8	185.9
	24-Hour	1988	365	85.6	4.8	90.4
	Annual	1988	80	4.2	0.1	4.3
CO	1-Hour	1991	40,000	213.7	NA	213.7
	8-Hour	1988	10,000	105.3	NA	105.3

Notes:
a = Year of meteorological data which produced highest air quality impacts.
b = Highest second highest concentration reported for the short-term averaging periods.
c = Background concentrations from SECOR (1995a:Table 3-4) NO_2 background includes existing sources in area.
d = Value adjusted using the Ambient Radio Method
CO = Carbon monoxide
NA = Not available
NAAQS = National Ambient Air Quality Standards
NO_2 = Nitrogen dioxide
PM_{10} = Particulate matter less than 10 microns diameter
SO_2 = Sulfur dioxide
$\mu g/m^3$ = Micrograms per cubic meter

Source: RILLC, 1998:Table 5
BPXA, 1998:Attachment E

TABLE 5.4-14
NORTHSTAR PROJECT DRILLING AND OPERATION
PSD CLASS II INCREMENT ANALYSIS

Pollutant	Averaging Period	Worst Case Year [a]	PSD Class II Increments Level ($\mu g/m^3$)	Maximum Concentration ($\mu g/m^3$)
NO_2	Annual	1988	25	24.7
PM_{10}	24-Hour	1989	30	21.6
	Annual	1988	17	4.5
SO_2	3-Hour	1988	512	179.1
	24-Hour	1988	91	85.6
	Annual	1988	20	4.2

Notes: a = Year of meteorological data which produced highest air quality impacts.
b = Value adjusted using the Ambient Ratio Method. These impacts include NO_2 PSD Class II increment consumption from other PSD sources in the project area (see Table 5.4-6), as well as the proposed project.
NO_2 = Nitrogen dioxide
PSD = Prevention of Significant Deterioration
PM_{10} = Particulate matter less than 10 microns
SO_2 = Sulfur dioxide
$\mu g/m^3$ = Micrograms per cubic meter

Source: RILLC, 1998:Table 5-3
BPXA, 1988:Attachment D

TABLE 5.4-15
NORTHSTAR PROJECT DRILLING AND OPERATION PSD CLASS II INCREMENT ANALYSIS FOR ANWR, KAKTOVIK, AND NUIQSUT

Pollutant	Averaging Period	PSD Class II Increment Level ($\mu g/m^3$)	Maximum Concentration ($\mu g/m^3$) [a]		
			ANWR	Kaktovik	Nuiqsut
NO_2	Annual	25	0.02	0.01	0.06
PM_{10}	24-Hour	30	0.07	0.03	0.14
	Annual	17	0.002	0.001	0.01
SO_2	3-Hour	512	0.35	0.21	0.38
	24-Hour	91	0.04	0.02	0.09
	Annual	20	0.001	0.001	0.004

Notes: a = Highest second-highest concentration reported for the short-term averaging periods.
ANWR = Arctic National Wildlife Refuge
NO_2 = Nitrogen dioxide
PSD = Prevention of Significant Deterioration
PM_{10} = Particulate matter less than 10 microns
SO_2 = Sulfur dioxide
$\mu g/m^3$ = Micrograms per cubic meter

Source: RILLC, 1998:Table 5-5

TABLE 5.4-16
AIR EMISSIONS INVENTORY FOR THREE ONSHORE PROCESS FACILITIES

Source	Tons Per Year				
	CO	**NO_2**	**PM_{10}**	**SO_2**	**VOCs**
Shore Crossing					
Thermoelectric Generator	0.01	0.03	0.04	0.03	0.02
Central Compressor Plant Tie-In					
Compressor	25.67	35.43	8.21	1.91	7.35
Generator	9.44	8.81	1.01	0.22	1.26
Total	35.11	44.24	9.22	2.13	8.61
Pump Station No. 1					
Indirect-Fired Heater	2.34	11.15	1.34	9.40	0.59
Space Heater	0.11	0.51	0.06	0.43	0.03
Total	2.45	11.66	1.40	9.83	0.62

Note: CO = Carbon monoxide
NO_2 = Nitrogen dioxide
PM_{10} = Particulate matter less than 10 microns diameter
SO_2 = Sulfur dioxide
VOCs = Volatile organic compounds

Sources: BPXA:1998:Table A-1
RILLC: 1998: Appendix F

TABLE 5.4-2
NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Average Period	Primary Standard	Secondary Standard
CO	8 hour	9 ppm (10 mg/m^3)	Same as primary
	1 hour	35 ppm (40 mg/m^3)	Same as primary
SO_2	Annual arithmetic mean	0.03 ppm (80 $\mu g/m^3$)	Same as primary
	24 hour maximum	0.14 ppm (365 $\mu g/m^3$)	Same as primary
	3 hour maximum	no standard	0.5 ppm (1,300 $\mu g/m^3$)
PM_{10}	24 hour average	150 $\mu g/m^3$	Same as primary
	Annual arithmetic mean	50 $\mu g/m^3$	Same as primary
$PM_{2.5}$	24 hour average	65 ($\mu g/m^3$)	Same as primary
	Annual arithmetic mean	15 ($\mu g/m^3$)	Same as primary
NO_X	Annual arithmetic mean	0.053 ppm (100 $\mu g/m^3$)	Same as primary
Ozone	1 hour maximum	0.12 ppm (235 $\mu g/m^3$)	Same as primary
	8 hour maximum	0.08 ppm (157 $\mu g/m^3$)	Same as primary
Lead	Quarterly maximum arithmetic mean	1.5 $\mu g/m^3$	Same as primary

Note:
CO	=	Carbon monoxide
SO_2	=	Sulfur dioxide
PM_{10}	=	Particulate matter greater than 10 microns diameter
$PM_{2.5}$	=	Particulate matter greater than 2.5 microns diameter
NO_X	=	Oxides of nitrogen
mg/m^3	=	Milligrams per cubic meter
$\mu g/m^3$	=	Micrograms per cubic meter
ppm	=	Parts per million

Source: 40 CFR, Part 50.1 through 50.9

TABLE 5.4-3
PSD SIGNIFICANCE LEVELS

Air Pollutant	Significant Emission Rate (tpy)
Criteria Pollutants:	
Carbon Monoxide	100
Nitrogen Oxides	40
Ozone (VOC)	40
Sulfur Dioxide	40
Particulate Matter less than 10microns	15
Total Particulate Matter	25
Hazardous Air Pollutants:	
Asbestos	0.007
Beryllium	0.0004
Fluoride [a]	3
Hydrogen Sulfide	10
Lead	0.6
Mercury	0.1
Vinyl Chloride	1.0
Other Air Pollutants:	
Sulfuric Acid Mist	7
Reduced Sulfur Compounds [b]	10
Total Reduced Sulfur [b]	10

Notes: a = As hydrogen fluoride
b = Includes hydrogen sulfide emissions
PSD = Prevention of Significant Deterioration
tpy = Tons per year
VOC = Volatile organic compounds

Source: 40 CFR Part 52.21(b)(23)(i)

TABLE 5.4-4
PSD CLASS I AND II INCREMENTS

Pollutant/Averaging Period	Class I Increment ($\mu g/m^3$)	Class II Increment ($\mu g/m^3$)
NO_2		
Annual Mean	2.5	25
SO_2		
Annual Mean	2	20
24-Hour Maximum	5	91
3-Hour Maximum	25	512
PM_{10}		
Annual Mean	4	17
24-Hour Maximum	8	30

Notes: NO_2 = Oxides of nitrogen
PM_{10} = Particulate matter greater than 10 microns diameter
PSD = Prevention of Significant Deterioration
SO_2 = Sulfur dioxide
$\mu g/m^3$ = Micrograms per cubic meter

Source: 40 CFR Part 52.21(c)

TABLE 5.4-5
SUMMARY OF NORTH SLOPE OIL FIELD AIR MONITORING PROGRAMS, 1990 - 1996

Facility	Year	Criteria in Micrograms per Cubic Meter					
		NO_2 Annual Mean	O_3 Max. 1-hour	SO_2			PM_{10} Maximum 24-hour Measurement
				Max. 3-hour	Max. 24-hour	Annual Mean	
Kuparuk Sites							
CPF-1	1990/91	16.0	90.2	44.5	26.2	4.4	--
	1991/92	13.2	115.6	28.8	15.7	5.2	--
DS1F	1990/92	4.9	92.1	55.0	13.1	2.6	--
	1991/92	3.8	100.0	13.1	5.2	2.6	--
Prudhoe Bay Sites							
CCP	1992/93	18.6	94.1	13.1	10.5	2.6	16.5
	1993/94	16.2	111.7	10.5	7.9	2.6	29.3
	1994/95	17.7	82.3	13.1	10.5	2.6	28.4
	1995/96	26.3	115.8	13.1	10.5	2.6	11.6
WPA	1992/93	9.4	152.9	--	--	--	--
	1993/94	11.9	180.3	--	--	--	--
	1994/95	8.1	103.9	--	--	--	--
	1995/96	9.4	106.0	--	--	--	--
GC1	1992/93	15.5	98.0	34.1	13.1	3.5	155.0
	1993/94	20.2	105.8	101.4	39.0	2.6	54.7
	1994/95	16.0	80.4	21.0	7.9	2.6	64.3
	1995/96	18.8	94.2	44.5	15.7	2.6	--
Current (1997) State of Alaska or NAAQS Standards		**100**	**235**	**1,300**	**365**	**80**	**150**

Notes:
-- = No data collected
CCP = Central Compressor Plant
CPF-1 = Central Processing Facility, Location 1
DS1F = Drill Site 1F
GC1 = Gathering Center 1
Max. = Maximum
NAAQS = National Ambient Air Quality Standards
NO_2 = Nitrogen dioxide
O_3 = Ozone
PM_{10} = Particulate matter greater than 10 microns in diameter
SO_2 = Sulfur dioxide
WPA = Well Pad A

Source: ENSR, 1996:ii

TABLE 5.4-6
TOTAL ALLOWABLE EMISSION RATES FOR ONSHORE OPERATING SOURCES (KUPARUK, PRUDHOE BAY, AND ENDICOTT)

Unit Name	Tons Per Year (Grams Per Second)			
	NO_2	SO_2	CO	PM_{10}
Prudhoe Bay	59,448 (1,710.1)	720 (20.7)	10,300 (296.3)	827 (23.8)
Kuparuk	7,763 (223.3)	643 (18.5)	1,846 (53.1)	393 (11.3)
Endicott (Duck Island)	3,202 (92.1)	24 (0.7)	674 (19.4)	28 (0.8)
Total	**70,413 (2,025.5)**	**1387 (39.9)**	**12,820 (368.8)**	**1,248 (35.9)**

Notes: Milne Point sources are not included. (NO_2 = 30.1 g/sec, SO_2 = 3.2 g/sec, CO = 12.4 g/sec, and PM_{10} = 1.7 g/sec)

The Lisburne and Deadhorse Power Plant allowable emission rates were included in the modeling of impacts for the Northstar Unit Development. Milne Point, Badami, and Pump Station No. 1 sources were not included in the modeling analysis.

CO = Carbon monoxide
g/sec = Grams per second
NO_2 = Nitrogen dioxide
PM_{10} = Particulate matter greater than 10 microns in diameter
SO_2 = Sulfur dioxide

Source: SECOR, 1995a:3-4

TABLE 5.4-7
ACTUAL EMISSIONS FROM BPXA AND ARCO OPERATED FACILITIES [1]
July 1, 1994 - June 30, 1995

Emission	BPXA Operations						ARCO Operations								
	PBU Western Operating Area[2]				Milne[2]	Endicott[2]	PBU Eastern Operating Area[2]								Lisburne[2]
	GC1	GC2	GC3	CPS			CCP	CGF	FS1	FS2	FS3	SIP (east)	STP	COTU	LPC
NO_X	5,905	2,875	2,314	5,515	1,046	2,986	12,528	9,611	2,490	2,693	3,729	1,912	450	23	2,350
CO	1,179	610	491	1165	285	856	1,307	2,116	1,426	842	810	369	101	3	701
SO_X	57	51.5	45	91	21	183	132	531	153	27	18	60	79	0.1	22
PM_{10}	150	75.2	61	150	28	96	4,708	271	72	422	36	24	16	1	89
VOCs	237	128.5	102	184	55	30	501	456	290	237	262	19	21	9	116

Notes: 1 = As reported to the Alaska Department of Environmental Conservation; provides actual emissions data based on stock measurements and/or actual throughputs, fuel use, etc.
2 = Units are in short tons (2,000 pounds) per year
ARCO = ARCO Alaska, Inc.
BPXA = BP Exploration (Alaska) Inc.
CCP = Central Compressor Plant
CGF = Central Gas Facility
CO = Carbon monoxide
COTU = Crude Oil Topping Unit
CPS = Central Power Station
FS1 = Flow Station 1
FS2 = Flow Station 2
FS3 = Flow Station 3
GC1 = Gathering Center 1
GC2 = Gathering Center 2
GC3 = Gathering Center 3
LPC = Lisburne Processing Center
NO_X = Oxides of nitrogen
PBU = Prudhoe Bay Unit
PM_{10} = Particulate matter greater than 10 microns in diameter
SIP = Seawater Injection Plant
SO_2 = Sulfur dioxide
STP = Seawater Treatment Plant
VOCs = Volatile organic compounds

Source: ARCO, 1994:3-6; BPXA, 1994:3

TABLE 5.4-8
IMPACTS OF ALTERNATIVES 2, 3, 4, AND 5 ON AIR QUALITY

Action/Event	Frequency	Duration	Scope [1]	Direct Impacts	Indirect Impacts
Ice Roads – Construction	Once	All winter	Along primary construction routes associated with each alternative.	Minor – Temporary and localized emissions from trucks and other mobile equipment.	None anticipated.
Ice Roads – Operations	Annually	All winter	Along primary construction routes associated with each alternative.	Minor – Temporary and localized emissions from trucks and other mobile equipment.	None anticipated.
Island – Construction	Once	3 Months	Along primary construction routes. Conventional equipment for concrete batch plant. Results of air quality modeling for on-island construction activities	Minor – Temporary and localized emissions from trucks and other mobile equipment, as well as fugitive dust. Minor – Temporary and localized emissions. Minor – Temporary and localized emissions from internal combustion engines and heaters, modeling results show compliance with NAAQS.	None anticipated.
Island – Operation/ Maintenance	Annually	15 years	Flare operating processing equipment, generators, boilers, storage tanks, drilling equipment, etc. at Seal Island.	Negligible - Temporary emissions from mobile equipment during maintenance, as well as fugitive dust. Minor – Long-term emissions of air pollutants associated with facility operations (including drilling) and support vehicles would occur, but would not result in the exceedance of any air quality standard. Modeling results show compliance with NAAQS; to ANWR, Kaktovik, and Nuiqsut from operations emissions; short-term, emergency release of air pollutants from flaring activities.	None anticipated.
Offshore Pipeline – Construction	Once	3 Months (Winter)	Along primary construction routes associated with each alternative.	Minor - Temporary and localized emissions from buses, trucks, other mobile, and some stationary sources.	None anticipated.

TABLE 5.4-8 (Cont.)
IMPACTS OF ALTERNATIVES 2, 3, 4, AND 5 ON AIR QUALITY

Action/Event	Frequency	Duration	Scope [1]	Direct Impacts	Indirect Impacts
Offshore Pipeline - Operation/ Maintenance	Rare	15 years	Depends on maintenance or repair required. Along primary construction routes associated with each alternative.	Negligible - Temporary and localized short-term emissions from trucks, trenching equipment, and other mobile sources.	None anticipated.
Onshore Pipeline – Construction	Once	6 Months (Winter)	Along primary construction routes associated with each alternative.	Minor - Temporary and localized emissions from buses, trucks, and other mobile sources.	None anticipated.
Onshore Pipeline - Operation/ Maintenance	Weekly	15 years	Along primary construction routes associated with each alternative.	Negligible - Temporary and localized short-term emissions from bus trips and helicopter overflights; and pigging operations. Minor – Long-term emissions of air pollutants associated with sources at the shore-crossing, CCP tie-in location, and PS1.	None anticipated.
Gravel Mining Construction Operation	Once Occasionally	3 Months (Winter) Unknown	Immediate vicinity of the gravel mine.	Minor - Temporary and localized emissions from trucks, mining equipment, other mobile sources, and fugitive dust.	None anticipated.
Large Oil Spill	Rare	Unknown	Air quality above the surface of the oil slick for first few days following the spill.	Minor - Release of volatile organic compounds to the air from the evaporation of 25% to 35% of the spilled oil.	Minor - Emission of criteria pollutants from machinery exhaust and/or in situ burning, temporarily reducing air quality for up to a few miles from the burn.
Abandonment	Once	3 to 6 Months	Seal Island and pipeline route, depending on abandonment method.	Negligible - Temporary and localized emissions from trucks and other mobile sources.	None anticipated.

Notes: 1 = Numbers do not include caribou crossings, infrastructure, process facilities, drilling, logistics, or island maintenance.
CCP = Central Compressor Plant
N/A = Not applicable
NAAQS = National Ambient Air Quality Standards
% = Percent
PS1 = Pump Station 1

TABLE 5.4-9
AIR EMISSIONS FOR ON-ISLAND CONSTRUCTION ACTIVITIES

Source	Fuel	Tons Per Year				
		CO	**NO_2**	**PM_{10}**	**SO_2**	**VOCs**
Non-Civil	Diesel	48.00	222.59	15.83	7.87	17.67
Civil	Diesel	97.23	450.00	32.20	15.73	35.33
Construction Reserve Pool	Diesel	13.22	60.90	4.42	2.07	4.65
Total		158.45	733.49	52.45	25.67	57.65

Note: CO = Carbon monoxide
NO_2 = Nitrogen dioxide
PM_{10} = Particulate matter less than 10 microns in diameter
SO_2 = Sulfur dioxide
VOCs = Volatile organic compounds

Source: RILLC, 1998:Appendix A

TABLE 5.5-1
PREDICTED WAVES FOR POINT STORKERSEN SHORE

Wave Parameters	Return Period - Years				
	1	10	20	50	100
Westerly Storm					
Height (feet)	1	--	--	--	4.4
Period (seconds)	2	--	--	--	4.8
Easterly Storm					
Height (feet)	1	--	--	--	2.8
Period (seconds)	2	--	--	--	3.0

Note: -- = Not Available

Source: INTEC, 1996:3-39

TABLE 5.5-2
EXTREME WAVE PREDICTIONS AT SEAL ISLAND

Extreme Wave Prediction	Return Period - Years					
	1	5	10	25	50	100
Westerly Storm Events						
Height (feet)	7.1	8.3	10.8	14.6	18.4	19.9
Period (seconds)	6.8	7.8	8.3	5.1	9.9	10.9
Easterly Storm Events						
Height (feet)	7.6	8.3	9.7	11.1	11.8	12.8
Period (seconds)	7.0	7.5	7.8	9.9	10.7	12.3

Source: Offshore and Coastal Technologies, Inc. (1996) as cited in BPXA, 1997:Table 2.1-3

TABLE 5.5-3
IMPACTS OF ALTERNATIVES 2, 3, 4, AND 5 ON OCEANOGRAPHY AND MARINE WATER QUALITY

Action/Event	Frequency	Duration	Scope	Direct Impacts	Indirect Impacts
Ice Roads - Construction	Once	All winter	Up to 200 ft (61 m) wide ice platform with thicknesses of up to approximately 8 ft (2.4 m); segments of road over sea ice constructed from West Dock to mouth of Kuparuk River and then to Seal Island.	None anticipated.	None anticipated.
Ice Roads - Operations	Annually	All winter	Similar route to construction ice road.	None anticipated.	None anticipated.
Island - Construction	Once	3 Months	Small island footprint increase from additional 700,000 to 800,000 yds^3 (535,191 to 611,647 m^3) of gravel; dewatering discharge of 1 to 2 million gallons (3.7 to 7.6 million liters) per day for 2 to 4 weeks adjacent to Seal Island.	Negligible – To bathymetry from slight island footprint increase including the addition of a 50- to 100-ft (15.2 to 30.5 m) wide gravel berm; to marine water quality from short-term increases in turbidity during gravel placement. Minor – To marine water quality from short-term elevated suspended sediment loading and turbidity from dewatering discharge and island grading.	None anticipated.
Island - Operation/ Maintenance	Annually	15 years	Operational support vessel operations between Seal Island and the West Dock area; permitted discharges of continuous system flush, sanitary/domestic waste, desalination brine, and annual fire suppression test.	Negligible – To local oceanography from slight alteration of current direction and velocity due to the island; to marine water quality from support vessel operations, slope protection repairs, and permitted discharges. Minor – To marine water quality from berm replenishment activities.	None anticipated.
Offshore Pipeline - Construction	Once	3 Months (Winter)	Length of offshore portion of pipeline varies by route: Alternatives 2 & 3 - 6 mi (9.6 km) Alternative 4 - 9 mi (14.5 km) Alternative 5 - 8.9 mi (14.3 km)	None - In nearshore bottomfast ice areas. Negligible – To marine water quality in offshore areas from short-term increases in suspended sediment and turbidity. Negligible to Minor – To marine water quality and bathymetry from release of excess spoil material.	None anticipated.

TABLE 5.5-3 (Cont.)
IMPACTS OF ALTERNATIVES 2, 3, 4, AND 5 ON OCEANOGRAPHY AND MARINE WATER QUALITY

Action/Event	Frequency	Duration	Scope	Direct Impacts	Indirect Impacts
Offshore Pipeline - Operation/ Maintenance	Rare	15 years	Length of offshore portion of pipeline varies by route: Alternatives 2 & 3 - 6 mi (9.6 km) Alternative 4 - 9 mi (14.5 km) Alternative 5 - 8.9 mi (14.3 km)	Minor – To offshore marine water quality from short-term, limited increases in suspended sediment and turbidity; to pipeline at West Dock scour.	None anticipated.
Onshore Pipeline - Construction	Once	6 Months (Winter)	N/A	None anticipated.	None anticipated.
Onshore Pipeline - Operation/ Maintenance	Weekly	15 years	N/A	None anticipated.	None anticipated.
Gravel Mining Construction Operation	 Once Occasionally	 3 Months (Winter) Unknown	N/A	None anticipated.	None anticipated.
Large Oil Spill	Rare	Unknown	Marine waters contacted by oil - up to 200 miles (322 km) from the release site.	Minor – Dissolution and dispersion of hydrocarbons in water column (concentration depends on ice cover and time since release); State of Alaska water quality (chronic) criteria may be temporarily exceeded in close locale of spill plume.	Minor - Dissolution and dispersion of hydrocarbons contained in/on ice into the water column following spring breakup.
Abandonment	Once	3 to 6 Months	Seal Island and pipeline route, depending on abandonment method	Minor – To marine water quality from short-term increased suspended sediment and turbidity if pipeline and/or island slope protection is removed.	None anticipated.

Notes:
ft = Feet
km = Kilometers
m = Meters
m^3 = Cubic meters
mg/L = Milligrams per liter
mi = Miles
N/A = Not applicable
STP = Seawater Treatment Plant
yds^3 = Cubic yards

TABLE 5.6-1
ANNUAL ICE CYCLE IN NEARSHORE AREAS
OF THE ALASKAN BEAUFORT SEA

Timing	Event
Late September to early October	New ice begins to form in open water, forming first adjacent to rivers and in coastal lagoons.
Mid to late October	A continuous landfast ice sheet is formed. Ice outside of the bays and barrier islands is unstable.
November to February	The landfast ice area is extended from shore and is modified. Landfast ice becomes stable inside the 50 ft isobath by December. The general sequence of events includes: 1) a seaward progression of the ice edge, 2) ridging of successive ice edges, 3) incursions of older pack ice, and 4) grounding of ice masses either in situ or as they are driven ashore.
March to May	Ice is generally stable inside the 100-foot isobath, depending on location and time of year.
Late May to early June	River breakup results in flooding of nearshore ice.
Early June	Melt ponds begin to form on the ice; water ultimately drains through cracks and holes in the ice.
June	Ice begins to melt and weaken. Open water usually first occurs along the coast and around the barrier islands.
June to August	Breakup of the ice sheet continues.
August to September	Some open water is present nearshore in favorable years. Some thick older ice and ridge fragments may remain in the nearshore areas.

Source: Barnes et al., 1977

TABLE 5.6-2
IMPACTS OF ALTERNATIVES 2, 3, 4, AND 5 ON SEA ICE

Action/Event	Frequency	Duration	Scope	Direct Impacts	Indirect Impacts
Ice Roads - Construction	Once	All winter	Routes over sea ice from West Dock to mouth of Kuparuk River to Seal Island.	Negligible - to sea ice from ice thickening and from vertical ice movement due to vehicular traffic.	None anticipated.
Ice Roads - Operations	Annually	All winter	Routes over sea ice from West Dock to mouth of Kuparuk River to Seal Island.	Negligible - To sea ice from ice thickening vehicular traffic.	None anticipated.
Island - Construction	Once	3 Months	50 to 100-ft (15.2 t 30.5 m) wide subsurface berm at Seal Island for wave/ice protection.	Negligible - To sea ice from ice thickening and vertical ice movement from vehicular traffic; to island slopes from summer storm-surge induced ice floe strikes; to construction activities from vertical ice movements and seasonal ice formation/breakup.	Possible ice override.
Island - Operation/ Maintenance	Annually Rare	15 years	Island slope protection; subsurface berm; annual maintenance of berm material.	Negligible - To sea ice from island maintenance and repair activities; to operation and maintenance activities from vertical or horizontal ice movements. Minor - To island from normal ice loading and override, rubble collar, and summer storm-surge induced ice floe strikes.	Possible island facilities damage from an extreme ice override event at Seal Island.
Offshore Pipeline – Construction	Once	3 Months (Winter)	Along route and varies by route: Alternatives 2 & 3 - 6 mi (9.6 km) Alternative 4 - 9 mi (14.5 km) Alternative 5 - 8.9 mi (14.3 km)	None to Negligible - To sea ice from ice slotting, ice thickening, and vertical ice movement from vehicular traffic; to construction activities from vertical ice movement, flooding over the ice due to storms, and seasonal ice formation/breakup.	None anticipated.

TABLE 5.6-2 (Cont.)
IMPACTS OF ALTERNATIVES 2, 3, 4, AND 5 ON SEA ICE

Action/Event	Frequency	Duration	Scope	Direct Impacts	Indirect Impacts
Offshore Pipeline - Operation/ Maintenance	Rare	15 years	Along route and varies by route: Alternatives 2 & 3 - 6 mi (9.6 km) Alternative 4 - 9 mi (14.5 km) Alternative 5 - 8.9 mi (14.3 km)	Negligible - To sea ice from ice thickening and vertical ice movement from vehicular traffic; to pipeline maintenance and repair activities from vertical or horizontal ice movement. Minor - To pipeline from ice gouging or strudel scour; to landfall facilities from Alternatives 2, 3, and 4 from ice pile-up.	None anticipated.
Onshore Pipeline - Construction	Once	6 Months (Winter)	N/A	None anticipated.	None anticipated.
Onshore Pipeline - Operation/ Maintenance	Weekly	15 years	N/A	None anticipated.	None anticipated.
Gravel Mining Construction Operation	 Once Occasionally	 3 Months (Winter) Unknown	N/A	Negligible – To sea ice from ice thickening and vertical ice movement from vehicular traffic due to gravel hauling activities.	None anticipated.
Large Oil Spill	Rare	Unknown	Area contacted by oil - up to 200 miles (322 km) from the release site.	Minor - Reduction of mechanical integrity from melting or oil incursion into the ice and from ice scraping or drilling during spill response.	None anticipated.
Abandonment	Once	3 to 6 Months	Seal Island and pipeline route, depending on abandonment method	Negligible - To sea ice from ice slotting if pipeline is removed.	None anticipated.

Notes:
ft = Foot
km = Kilometers
m = Meter
m^3 = Cubic meters
mi = Miles
N/A = Not applicable