
4C DIRECT AND INDIRECT IMPACTS – ALTERNATIVE C 1

4C.1 INTRODUCTION..... 1

4C.2 PHYSICAL CHARACTERISTICS 1

 4C.2.1 Terrestrial Environment..... 1

 4C.2.1.1 Physiography 1

 4C.2.1.2 Geology 2

 4C.2.1.3 Soils and Permafrost..... 3

 4C.2.1.4 Sand and Gravel 4

 4C.2.1.5 Paleontological Resources 5

 4C.2.2 Aquatic Environment..... 5

 4C.2.2.1 Water Resources 5

 4C.2.2.2 Surface Water Quality 16

 4C.2.3 Atmospheric Environment..... 17

 4C.2.3.1 Climate and Meteorology 17

 4C.2.3.2 Air Quality..... 17

 4C.2.3.3 Noise..... 18

4C.3 BIOLOGICAL RESOURCES..... 1

 4C.3.1 Terrestrial Vegetation and Wetlands 1

 4C.3.1.1 Alternative C – CPAI Development Plan Impacts on
Terrestrial Vegetation and Wetlands 1

 4C.3.1.2 Alternative C – FFD Plan Impacts on Terrestrial Vegetation and Wetlands 7

 4C.3.1.3 Alternative C – Summary of Impacts (CPAI and FFD) on
Terrestrial Vegetation and Wetlands 13

 4C.3.1.4 Alternative C – Potential Mitigation Measures (CPAI and FFD)
for Terrestrial Vegetation and Wetlands..... 13

 4C.3.2 Fish 13

 4C.3.2.1 Alternative C – CPAI Development Plan Impacts on Fish..... 13

 4C.3.2.2 Alternative C – Full-Field Development Impacts on Fish..... 17

 4C.3.2.3 Alternative C – Summary of Impacts (CPAI and FFD) on Fish..... 18

 4C.3.2.4 Alternative C – Potential Mitigation Measures (CPAI and FFD)
for Fish 19

 4C.3.3 Birds 20

 4C.3.3.1 Alternative C – CPAI Development Plan Impacts on Birds 20

 4C.3.3.2 Alternative C – Full-Field Development Plan Impacts on Birds 30

 4C.3.3.3 Alternative C – Summary of Impacts (CPAI and FFD) on Birds 32

 4C.3.3.4 Alternative C – Potential Mitigation Measures (CPAI and FFD)
for Birds..... 32

 4C.3.4 Mammals 34

 4C.3.4.1 Terrestrial Mammals..... 34

 4C.3.4.2 Marine Mammals..... 40

4C.3.5	Threatened and Endangered Species	42
4C.3.5.1	Bowhead Whale	42
4C.3.5.2	Spectacled Eider	42
4C.3.5.3	Steller’s Eider	47
4C.4	SOCIAL SYSTEMS	1
4C.4.1	Socio-Cultural Characteristics.....	1
4C.4.1.1	Alternative C – CPAI Development Plan Impacts on Socio-Cultural Characteristics	1
4C.4.1.2	Alternative C – FFD Plan Impacts on Socio-Cultural Characteristics.....	1
4C.4.1.3	Alternative C – Summary of Impacts (CPAI and FFD) on Socio-Cultural Characteristics	1
4C.4.1.4	Alternative C – Potential Mitigation Measures (CPAI and FFD) on Socio-Cultural Characteristics	1
4C.4.2	Regional Economy	1
4C.4.2.1	Alternative C – CPAI Development Plan Impacts on Regional Economy	1
4C.4.2.2	Alternative C – FFD Plan Impacts on Regional Economy	2
4C.4.2.3	Alternative C – Summary of Impacts (CPAI and FFD) on Regional Economy	2
4C.4.2.4	Alternative C – Potential Mitigation Measures (CPAI and FFD) for Regional Economy.....	2
4C.4.3	Subsistence.....	2
4C.4.3.1	Alternative C – CPAI Development Plan Impacts on Subsistence.....	2
4C.4.3.2	Alternative C – Full Field Development Plan Impacts on Subsistence	3
4C.4.3.3	Alternative C – Summary of Impacts (CPAI and FFD) on Subsistence.....	4
4C.4.3.4	Alternative C – Potential Mitigation Measures (CPAI and FFD) for Subsistence	4
4C.4.4	Environmental Justice	5
4C.4.4.1	Introduction	5
4C.4.4.2	Alternative C – Disproportionate Impacts (CPAI and FFD) on Environmental Justice	5
4C.4.4.3	Alternative C – Potential Mitigation Measures (CPAI and FFD) for Environmental Justice	5
4C.4.5	Cultural Resources	5
4C.4.5.1	Alternative C – CPAI Development Plan Impacts on Cultural Resources	5
4C.4.5.2	Alternative C – FFD Plan Impacts on Cultural Resources	5
4C.4.5.3	Alternative C – Summary of Impacts (CPAI and FFD) on Cultural Resources	5
4C.4.5.4	Alternative C – Potential Mitigation Measures (CPAI and FFD) on Cultural Resources.....	5
4C.4.6	Land Uses and Coastal Management	6
4C.4.6.1	Alternative C – CPAI Development Plan Impacts on Land Uses and Coastal Management	6

4C.4.6.2	Alternative C – FFD Plan Impacts on Land Uses and Coastal Management	9
4C.4.6.3	Alternative C – Summary of Impacts (CPAI and FFD) on Land Uses and Coastal Management.....	11
4C.4.6.4	Alternative C – Potential Mitigation Measures (CPAI and FFD) for Land Uses and Coastal Management	11
4C.4.7	Recreation Resources	12
4C.4.7.1	Alternative C – CPAI Development Plan Impacts on Recreation Resources	12
4C.4.7.2	Alternative C – FFD Plan Impacts on Recreation Resources	12
4C.4.7.3	Alternative C – Summary of Impacts (CPAI and FFD) on Recreation Resources.....	12
4C.4.7.4	Alternative C – Potential Mitigation Measures (CPAI and FFD) on Recreation Resources	12
4C.4.8	Visual Resources	12
4C.4.8.1	Alternative C – CPAI Development Plan Impacts on Visual Resources.....	12
4C.4.8.2	Alternative C – FFD Plan Impacts on Visual Resources	13
4C.4.8.3	Alternative C – Summary of Impacts (CPAI and FFD) on Visual Resources....	13
4C.4.8.4	Alternative C – Potential Mitigation Measures (CPAI and FFD) on Visual Resources.....	13
4C.4.9	Transportation	13
4C.4.9.1	Alternative C – CPAI Development Plan Impacts on Transportation	13
4C.4.9.2	Alternative C – FFD Plan Impacts on Transportation	14
4C.4.9.3	Alternative C – Summary of Impacts (CPAI and FFD) on Transportation	14
4C.4.9.4	Alternative C – Potential Mitigation Measures (CPAI and FFD) for Transportation.....	15

4C DIRECT AND INDIRECT IMPACTS – ALTERNATIVE C

4C.1 INTRODUCTION

This section provides an analysis of the environmental consequences that would result from implementation of Alternative C, CPAI Development Plan and FFD.

Alternative C differs from Alternative A principally by including a more southern bridge location over the Nigliq Channel, a road connection to Nuiqsut, a southerly road and pipeline route to CD-6 and CD-7, and road connections to all production pads, including those in the lower Colville River Delta. This alternative also contrasts with Alternative A by requiring a minimum pipeline height of 7 feet and placing power lines on separate poles rather than on VSMs. There would be no 2-inch products pipelines to production pads. Exceptions to the same Northeast NPR-A IAP/EIS stipulations as in Alternative A would be required. Use of roads on BLM lands would be unrestricted. Industry and local residents would have access to other roads.

In the FFD scenario for Alternative C, roads would link all pads to processing facilities, CD-1, and Nuiqsut. Roads in the Colville River Delta also would be constructed.

4C.2 PHYSICAL CHARACTERISTICS

4C.2.3 Terrestrial Environment

4C.2.3.1 Physiography

Alternative C – CPAI Development Plan Impacts on Physiography

Construction Period

The effects on physiography would result from changes to landforms by construction of roads, pads, and gravel mines. The impacts are therefore similar to those discussed in Section 4A.2.1.1 for Alternative A.

Areas that would experience direct physiographic effects from gravel mining operations include approximately 86 acres (refer to Section 4C.2.1.4) of gravel mine sites. Areas that would experience direct physiographic impacts from placement of gravel on tundra include 379 acres (refer to Tables 2.2.4.3-2 and 2.4.3-3).

Operation Period

Impacts during the operation period would be similar to those for Alternative A.

Alternative C – FFD Plan Impacts on Physiography

Areas where gravel mining operations would directly affect the physiography include approximately 365 acres. Areas that would experience direct physiographic impacts from placement of gravel on the tundra include 1,544 acres.

Alternative C – Summary of Impacts (CPAI and FFD) on Physiography

Impacts to physiography occur primarily during the construction phase and result from changes to landforms by construction of roads, pads, airstrips, and mine sites. If not properly designed and constructed, these landform changes can adversely affect thermal stability of the tundra and hydrology through thermokarsting and increased ponding.

Alternative C – Recommended Mitigation Measures (CPAI and FFD) for Physiography

No measures have been identified to mitigate impacts to physiography under Alternative C or Alternative C FFD.

4C.2.3.2 Geology

The following discussion of impacts to geological resources is limited to lithified, inorganic materials and their associated petroleum resources. Effects on unconsolidated material are discussed in Sections 4C.2.1.3, Soils and Permafrost, and 4C.2.1.4, Sand and Gravel.

Alternative C – CPAI Development Plan Impacts on Geology

Construction Period

Direct Effects

The only surface bedrock identified in the ASDP Area outcrops at the bend in the lower Colville River upstream of Ocean Point (Mayfield et al. 1988). Alternative C does not propose excavation activities in this area and would, therefore, not directly affect surface bedrock.

Indirect Effects

No indirect effects are recognized for the construction period.

Operation Period

Direct Effects

Drilling oil production wells at the five pad locations would directly affect the target and overlying lithologies. Annular disposal or Class II reinjection of drilling wastes would directly affect the receiving lithologies. The volume of rock affected by drilling and drilling waste disposal is insignificant compared to the volume of lithified resources present within the Plan Area. For this reason, direct impacts to ASDP Area lithology are considered negligible.

The CPAI Development Plan would produce hydrocarbons from subsurface reservoirs, thereby depleting the *in situ* petroleum reserves. Although hydrocarbon production constitutes an unavoidable and permanent impact that would not recover to its pre-impact state within the scale of human longevity, the effect is confined to the geological environment, and economic gains would likely outweigh adverse effects on petroleum resources.

Indirect Effects

No indirect effects are recognized for the operation period.

Alternative C – FFD Plan Impacts on Geology

Direct and indirect impacts incurred during construction and operation of Alternative C FFD would be similar to those presented above, but would be experienced over greater spatial and temporal extents. The volume of rock affected by drilling and drilling waste disposal under FFD is also considered insignificant when compared to the volume of lithified resources present within the Plan Area. Surface bedrock is not expected to be affected under the FFD scenario. FFD would further deplete Plan Area petroleum reserves; however, the hypothetical nature of FFD precludes quantification of petroleum resource reduction.

Alternative C – Summary of Impacts (CPAI and FFD) on Geology

Reduction of petroleum resources in the ASDP Area is inevitable. Because these resources are essentially non-renewable, effects would be permanent and unresponsive to mitigation. Impacts to lithified resources in the ASDP Area under Alternative C and Alternative C FFD would produce no measurable effect.

Alternative C – Potential Mitigation Measures (CPAI and FFD) for Geology

No measures have been identified to mitigate effects to geologic resources under Alternative C or Alternative C FFD.

4C.2.3.3 Soils and Permafrost

Alternative C – CPAI Development Plan Impacts on Soils and Permafrost

Direct and indirect effects on soils and permafrost would be of the same type and caused by the same activities as under Alternative A. However, because of the different footprint and gravel requirements, the total amount of soils and permafrost disturbed or covered would be greater. Development of new gravel mine sites would require excavation of approximately 86 acres of overburden. Fill material placed in conjunction with Alternative C would overlie approximately 379 acres of native soil. The total surface area of ice roads constructed over six seasons would overlie approximately 1,236 acres of native soil during the winter months. Approximately 3,948 VSMs would be embedded within the pipeline corridors delineated for Alternative C.

Alternative C – FFD Plan Impacts on Soils and Permafrost

The types of impacts and associated effects of FFD are similar to those presented in Section 4C.2.1.3, the CPAI Development Plan Alternative C, but would be experienced over greater spatial and temporal extents. Additional gravel mine sites would be developed to provide the volume of construction material necessary for FFD. Based upon the condition and depth experience from 1999–2000 excavation at the ASRC mine, FFD could disturb surface soils and permafrost of approximately 365 acres.

Colville River Delta Facility Group

Fill material placed in conjunction with Alternative C FFD would overlie approximately 351 acres of native soil in the Colville River Delta area. The total surface area of ice roads constructed over 20 seasons would overlie approximately 397 acres of native soil during the winter months. Approximately 3,645 VSMs would be embedded and six additional oil well clusters would be drilled in the Colville River Delta area.

Fish-Judy Creeks Facility Group

Fill material placed in conjunction with Alternative C FFD would overlie approximately 755 acres of native soil in the Fish-Judy creeks area. The total surface area of ice roads constructed over 20 seasons would overlie approximately 548 acres of native soil during the winter months. Approximately 9,113 VSMs would be embedded and a minimum of 10 additional oil well clusters would be drilled in the Fish-Judy Creeks Facility Group.

Kalikpik-Kogru Rivers Facility Group

Fill material placed in conjunction with Alternative C FFD would overlie approximately 437 acres of native soil in the Kalikpik and Kogru rivers area. The total surface area of ice roads constructed over 20 seasons would overlie approximately 243 acres of native soil during the winter months. Approximately 5,468 VSMs would be embedded and a minimum of three additional oil well clusters would be part of the Kalikpik-Kogru Rivers Facility Group.

Alternative C – Summary of Impacts (CPAI and FFD) on Soils and Permafrost

Most impacts on soil and permafrost under the CPAI Development Plan Alternative C and Alternative C FFD would be sustained during construction. Effects on the environments are unavoidable and semi-permanent but affect less than 1 percent of the total soil and permafrost system surface area within the Plan Area. Soil and permafrost systems could recover to their pre-impact state, but not without appropriate mitigation.

Alternative C – Potential Mitigation Measures (CPAI and FFD) for Soils and Permafrost

Potential mitigation measures would be the same as those identified for Alternative A (Section 4A.2.1.3).

4C.2.3.4 Sand and Gravel

Alternative C – CPAI Development Plan Impacts on Sand and Gravel

Alternative C would produce impacts similar to those discussed in Alternative A (Section 4A.2.1.4). The estimated quantities of sand and gravel and mine site areas would be different, as discussed in the following sections.

Construction Period

The estimated gravel volume for Alternative C from Table 2.4.3.1-2 is 2.1 million cubic yards. Using the same relationship between volumes and surface area detailed in Section 4A.2.1.4, Alternative C would affect approximately 86 acres of the surface and subsurface materials to extract gravel. This is about 0.010 percent of the total Plan Area.

Operation Period

During the operation period, relatively small amounts of gravel are expected to be extracted from existing permitted mine sites for repair of road or pad embankments.

Alternative C – FFD Plan Impacts on Sand and Gravel

Alternative C FFD would use and build off of the same road network that would be constructed under the Alternative C CPAI Development Plan. Alternative C FFD, depicted in Figure 2.4.3.2-1, is estimated to need 12.8 million cy (Table 2.4.3-2) of gravel. Outside of the Clover, where this gravel would come from has not yet been determined. Using the same relationship between volumes and surface area detailed in Section 4A.2.1.4, construction of Alternative C FFD would affect approximately 365 acres of the surface to extract subsurface gravel materials. This is about 0.041 percent of the total Plan Area.

Alternative C – Summary of Impacts (CPAI and FFD) on Sand and Gravel

Once used, sand and gravel resources for construction of roads, pads, or airstrips could only be available for reuse upon abandonment. Removal of gravel fill is not currently a scheduled phase of abandonment.

Alternative C – Potential Mitigation Measures (CPAI and FFD) for Sand and Gravel

No measures have been identified to mitigate effects on sand and gravel resources under Alternative C or Alternative C FFD.

4C.2.3.5 Paleontological Resources

Alternative C – CPAI Development Plan Impacts on Paleontological Resources

Construction Period

Under Alternative C, the impacts to paleontological resources could be greater than under Alternatives A and B because road segments between the proposed pads would be generally longer, and an additional road segment would be constructed to connect CD-3 to CD-1 at the Alpine Development. Excavation of sand and gravel material at the ASRC mine site and the Clover Potential gravel source could affect paleontological resources under approximately 86 acres. As in Alternative A, drilling; placement of gravel pads, VSMs, and power line poles; and construction of bridges are very unlikely to impact paleontological resources, though under this alternative there would be more VSMS, power line poles, and bridges.

Alternative C – FFD Plan Impacts on Paleontological Resources

Under the Alternative C scenario for FFD, the mechanisms associated with effects on paleontological resources would remain the same as those described under Alternative C for the ASDP, except the intensity of the actions would increase as a result of the greater extent of the development. The primary potential cause of impacts would be excavation of gravel on approximately 365 acres. Approximately three gravel mine sites would be developed to provide the volume of construction material necessary for FFD. The location of the gravel mine sites for FFD is yet unknown, but could be in locations that would affect paleontological resources. It is likely that the additional sand and gravel mine sites would be situated in the vicinity of the Fish-Judy Creeks facility group and/or the Kalikpik-Kogru Rivers facility group. In addition, approximately 1,540 acres could be covered by gravel in the construction of pads, roads, and airstrips.

Alternative C – Summary of Impacts (CPAI and FFD) on Paleontological Resources

Surface activities such as construction of pad, road, and airfield embankments are not likely to affect paleontological resources. Impacts could result from those activities involving subsurface disturbance such as production well drilling, sand and gravel mining, and installation of VSMs, power poles, and bridge piles. Excavation of sand and gravel under approximately 86 acres for CPAI'S project and 365 acres for FFD constitute the greatest risk to paleontological resources.

Alternative C – Potential Mitigation Measures (CPAI and FFD) for Paleontological Resources

No potential measures have been identified to mitigate impacts to paleontological resources under Alternative C or Alternative C FFD.

4C.2.4 Aquatic Environment

4C.2.4.1 Water Resources

Alternative C – CPAI Development Plan on Water Resources

Alternative C provides alternative road routes as compared to Alternative A. More specifically, a southern bridge would be located over the Nigliq Channel, a southern road route would link to Nuiqsut, a road in the Colville River Delta would link CD-1 and CD-3, and roads instead of airstrips would be connected to all production pads, including those in the lower Colville River Delta. (Figure 2.4.3.1-1). In general, Alternative C would affect the same water resources (i.e., subsurface waters, lakes, creeks, rivers, and the nearshore environment) and to a similar extent as Alternative A. Tables 4C.2.2.1-1 and 4C.2.2.1-2 provide summaries of potential construction and operation impacts to water resources under Alternative C.

Because the Delta is subject to flooding during the spring break-up as well as seasonal flooding induced by rain in the Brooks Range, a road to CD-3 could have adverse effects on the peak water surface elevations that were used to design existing CD-1 and CD-2 facilities. In addition, a year-round road to CD-3 would require more embankment material than the typical North Slope road to account for these floodwaters and could be affected by storm surges that could cause the delta to back up from elevated sea levels from offshore. Several vehicle bridges would be required for a year-round road between CD-1 and CD-3.

Alternative C – FFD Plan on Water Resources

In the FFD scenario for Alternative C, roads link all pads to processing facilities and to CD-1 (and Nuiqsut). The alignment of the interconnecting road through the hypothetical development area has been modified from the five-pad Alternative C alignment. The spine road continues west from the Nuiqsut junction to APF-2, rather than curving north to CD-6. Roads in the Colville River Delta have also been included.

Table 4C.2.2.1-3 provides summaries of potential construction and operation impacts to water resources under the FFD for Alternative C. Compared to Alternative A, the overall impacts to water resources under the FFD for Alternative C would be more extensive to stream and creeks for road and pipeline crossings because of the proposed expansion of the gravel road system. However, the overall impacts to lakes (i.e. from water supply) would be less because the lengths of ice roads that would need to be constructed would be lower for this alternative than with Alternative A.

Alternative C – Summary of Impacts (CPAI and FFD) on Water Resources

Alternative C would have reduced impact on water resources than Alternative A due to fewer ice road needs, but greater potential for impacts associated with ice flows and storm surge (scour, erosion, washout) due to the roads in the delta region and somewhat greater extent of roads elsewhere.

Alternative C – Potential Mitigation Measures (CPAI and FFD) for Water Resources

No measures have been identified to mitigation impacts to water resources under Alternative C or Alternative C FFD.

TABLE 4C.2.2-1 ALTERNATIVE C – POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES

Alternative C – CPAI Development Plan														
	GROUNDWATER			LAKES			MAJOR & MINOR STREAM CROSSINGS						ESTUARIES & NEARSHORE ENVIRONMENT	
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Ulmniglaq Channel	Tamayaglaaq Channel	Sakoonaq Channel	Colville River	Minor Streams	Colville River Delta	Harrison Bay			
CD-3														
Gravel Road Segment: CD-1 to CD-3	8?	NI	5	5	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	NI	3,4,5,6,7	7	NI			
Pipeline Segment: CD-1 - CD-3	NI	NI	NI	NI	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	NI	3,4,5,6,7	6?	NI			
Production Pad	8	NI	NI	8	2,3	2,3	2,3	2,3	2,3	6?	NI			
Underground injection	NI	9	NI	NI	NI	NI	NI	NI	NI	NI	NI			
Chemical/Petroleum Tank Storage	9	NI	9	9	NI	NI	NI	NI	NI	9	9			
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI			
CD-4														
Gravel Road Seg. CD-1 to CD-4	8	NI	NI	NI	2,3,4,5,6			2,3,4,5,6		NI				
Pipeline Segment: CD-1 - CD-4	NI	NI	NI	NI	2,3,4,5,6			2,3,4,5,6		NI				
Production Pad	8		8	NI	NI			2,3,4,5,6		NI				
Underground injection	NI	9	NI	NI	NI			NI		NI				
Chemical/Petroleum Tank Storage	9	NI	9	NI	9			9		9				
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI			NI		NI				

TABLE 4C.2.2-1 ALTERNATIVE C – POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES (CON'T)

Alternative C – CPAI Development Plan										
	GROUNDWATER			LAKES			MAJOR & MINOR STREAM CROSSINGS			ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Minor Streams				
CD-5										
Gravel Road Segment: From CD-4 to Intersection with CD-5; CD-5 to intersection between w/CD-6 & 7	8	NI	NI	NI	2,4,5,6	2,4,5,6	2,4,5,6	NI	NI	Harrison Bay
Pipeline Segment: same as gravel road segment	NI	NI	NI	NI	2,4,5,6	2,4,5,6	2,4,5,6	NI	NI	
Production Pad	8	NI	8	NI	NI	NI	NI	NI	NI	
Bridges/Culverts	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	NI	NI	
Underground injection	NI	9	NI	NI	NI	NI	NI	NI	NI	
Chemical/Petroleum Tank Storage	9	NI	9	NI	NI	9	9	9	9	
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	
CD-6										
Gravel Road Segment: CD-5 - CD-6	8	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	NI	
Pipeline Segment: CD-5 - CD-6	NI	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	NI	
Production Pad	8	NI		NI	NI	NI	NI	NI	NI	
Bridges/Culverts	NI	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	NI	
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	9	9	9	9	
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	

TABLE 4C.2.2-1 ALTERNATIVE C – POTENTIAL CONSTRUCTION IMPACTS TO WATER RESOURCES (CON'T)

Alternative C – CPAI Development Plan									
	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS			ESTUARIES & NEARSHORE ENVIRONMENT	
	Shallow	Deep	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creek Basin	Ublutuch River Basin	Minor Streams		Harrison Bay
CD-7									
Gravel Road Segment: CD-6 - CD-7	8	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7		NI
Pipeline Segment: CD-6 - CD-7	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7		NI
Production Pad	8	NI	8	NI	NI	NI	NI		NI
Bridges/Culverts	NI	9	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7		NI
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	9	NI		9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI		NI

Notes:

- 1 = Shoreline Disturbance & Thermokarsting
- 2 = Blockage of Natural Channel Drainage
- 3 = Increased stages & velocities of floodwater
- 4 = Increased channel scour
- 5 = Increased Bank Erosion
- 6 = Increased Sedimentation
- 7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)
- 8 = Removal of surface soils/gravel and changes in recharge potential
- 9 = Chemical & Petroleum Spills & Cleanup
- 10 = Water Supply Demand
- NI = No Impact

TABLE 4C.2.2-2 ALTERNATIVE C – POTENTIAL OPERATIONAL IMPACTS TO WATER RESOURCES

Alternative C – CPAI Development Plan														
COLVILLE RIVER SUB-AREA		GROUNDWATER			LAKES			MAJOR & MINOR STREAM CROSSINGS					ESTUARIES & NEARSHORE ENVIRONMENT	
		Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Uiamniglaq Channel	Tamayaglaaq Channel	Sakoonang Channel	Colville River	Minor Streams	Colville River Delta	Harrison Bay		
CD-3														
Gravel Road Segment: CD-1 to CD-3	8	NI	NI	NI	5	NI	NI	NI	NI	NI	7	NI		
Pipeline Segment: CD-1 - CD-3	NI	NI	NI	NI	NI	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	NI	3,4,5,6,7	6	NI		
Production Pad	8	NI	NI	NI	8	2,3	2,3	2,3	2,3	2,3	6	NI		
Underground injection	NI	9	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI		
Chemical/Petroleum Tank Storage	9	NI	NI	9	9	NI	NI	NI	NI	NI	9	9		
Surfacewater extraction for potable and construction use	NI	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI		
CD-4														
Gravel Road Seg. CD-1 to CD-4	8	NI	NI	NI	NI	NI	NI	NI	2,3,4,5,6	NI	NI	NI		
Pipeline Segment: CD-1 - CD-4	NI	NI	NI	NI	NI	NI	NI	NI	2,3,4,5,6	NI	NI	NI		
Production Pad	8	NI	NI	8	NI	NI	NI	NI	2,3,4,5,6	NI	NI	NI		
Underground injection	NI	9	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI		
Chemical/Petroleum Tank Storage	9	NI	NI	9	NI	9	9	9	9	9	9	9		
Surfacewater extraction for potable and construction use	NI	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI		

TABLE 4C.2.2-2 ALTERNATIVE C – POTENTIAL OPERATIONAL IMPACTS TO WATER RESOURCES

Alternative C – CPAI Development Plan									
	GROUNDWATER			LAKES			MAJOR & MINOR STREAM CROSSINGS		ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Niglitq Channel	Minor Streams			
CD-5 Area									
Gravel Road Segment: From CD-4 to Intersection with CD-5; CD-5 to intersection between w/CD-6 & 7	8	NI	NI	NI	2,4,5,6	2,4,5,6	2,4,5,6	NI	Harrison Bay
Pipeline Segment: CD-2 - CD-5	NI	NI	NI	NI	NI	6	6	NI	NI
Production Pad	8	NI	8	NI	NI	NI	NI	NI	NI
Bridges/Culverts	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	NI	NI
Underground injection	NI	9	NI	NI	NI	NI	NI	NI	NI
Chemical/Petroleum Tank Storage	9	NI	9	NI	NI	9	9	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI
CD-6									
Gravel Road Segment: CD-5 - CD-6	8	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI	NI
Pipeline Segment: CD-5 - CD-6	NI	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI	NI
Production Pad	8	NI	8	NI	NI	NI	NI	NI	NI
Bridges/Culverts	NI	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI	NI
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	9	9	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI

TABLE 4C.2.2-2 ALTERNATIVE C – POTENTIAL OPERATIONAL IMPACTS TO WATER RESOURCES

Alternative C – CPAI Development Plan									
	GROUNDWATER		LAKES			MAJOR & MINOR STREAM CROSSINGS		ESTUARIES & NEARSHORE ENVIRONMENT	
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish-Judy Creek Basin	Minor Streams	Harrison Bay		
CD-7									
Gravel Road Segment: CD-6 - CD-7	8	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI		
Pipeline Segment: CD-6 - CD-7	NI	NI	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI		
Production Pad	8	NI	8	NI	NI	NI	NI		
Bridges/Culverts	NI	9	NI	NI	2,3,4,5,6,7	2,3,4,5,6,7	NI		
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	NI	9		
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI		

Notes:

- 1 = Shoreline Disturbance & Thermokarsting
- 2 = Blockage of Natural Channel Drainage
- 3 = Increased stages & velocities of floodwater
- 4 = Increased channel scour
- 5 = Increased Bank Erosion
- 6 = Increased Sedimentation
- 7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)
- 8 = Removal of surface soils/gravel and changes in recharge potential
- 9 = Chemical & Petroleum Spills & Cleanup
- 10 = Water Supply Demand
- NI = No Impact

TABLE 4C.2.2-3 ALTERNATIVE C – POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES

ALTERNATIVE C - FULL FIELD DEVELOPMENT														
	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS								ESTUARIES & NEARSHORE ENVIRONMENT	
	Shallow Groundwater	Deep Ground-water	Small Shallow Lakes and Ponds	Large Deep Lakes	Nigliq Channel	Sakonang Channel	Tamayagiqaq Channel	Uamngiaq Channel	Elaktoveach Channel	Kupigruak Channel	Colville River	Minor Streams	Colville River Delta	Harrison Bay
Hypothetical production pads CD-11, 12, 14, 15, 19, 20, and 21.														
COLVILLE RIVER FACILITY GROUP	8	NI	NI	NI	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	1,2,3,4,5,6,7	NI
	NI	NI	10	10	NI	3	3	3	3	3	3	3	1,2,3,4,5	NI
	NI	NI	NI	NI	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	3,4,5,6,7	1,2,3,4,5,6,7	NI
Production Pads: All Proposed and Hypothetical Satellite Locations														
Airstrips: CD-3, 14, 19, 20, and 21														
Underground Injection Chemical/Petroleum Tank Storage	NI	9	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI

TABLE 4C.2.2-3 ALTERNATIVE C – POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES (cont'd)

ALTERNATIVE C - FULL FIELD DEVELOPMENT										
	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS					ESTUARIES & NEARSHORE ENVIRONMENT
	Shallow groundwater	Deep Ground-water	Small Shallow Lakes and Ponds	Large Deep Lakes	Fish Creek Basin	Ingok Creek Basin	Judy Creek Basin	Ublutuoch River Basin	Minor Streams	
Hypothetical processing facility APF-2, and hypothetical production pads CD-8, 9, 10, 13, 16, 17, 18, 22, 23, 24, and 26.										
Gravel Road Segments: CD-7 to CD-9; CD-10 to CD-6/5; CD-13 to CD-5/6 ; CD-13 to CD-16; CD-17 to CD-7/9 ; CD-16 to CD-18; CD-6 to CD-22; APF-2 to CD23; CD-23 to CD-24; CD-24 to CD-26	8	NI	3,5,6,7	3,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	NI
Pipeline Segment: CD-8 to CD-6/5; CD-7 to CD-9; CD-10 to CD-6/5; CD-13 to CD-5/6 ; CD-13 to CD-16; CD-17 to CD-7/9 ; CD-16 to CD-18; CD-6 to CD-22; APF-2 to CD23; CD-23 to CD-24; CD-24 to CD-26	NI	NI	3,5,6,7	3,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	2,3,4,5,6,7	NI
Production Pads: All Proposed and Hypothetical Satellite Locations and Hypothetical Processing Facility	8	NI	8	NI	2,3	2,3	2,3	2,3	2,3	NI
Underground Injection	NI	9	NI	NI	NI	NI	NI	NI	NI	NI
Processing Facility: APF-2	8	NI	NI	NI	NI	NI	2,3,4,5,6	NI	NI	NI
Chemical/Petroleum Tank Storage	9	NI	9	9	9	9	9	9	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI	NI

TABLE 4C.2.2-3 ALTERNATIVE C – POTENTIAL CONSTRUCTION AND OPERATIONAL IMPACTS TO WATER RESOURCES (cont'd)

ALTERNATIVE C - FULL FIELD DEVELOPMENT									
KALIKPIK-KOGRU RIVER FACILITY GROUP	GROUNDWATER		LAKES		MAJOR & MINOR STREAM CROSSINGS			ESTUARIES & NEARSHORE ENVIRONMENT	
	Shallow Groundwater	Deep Groundwater	Small Shallow Lakes & Ponds	Large Deep Lakes	Kalikpik River Drainage	Kogru River	Minor Streams		
Hypothetical processing facility APF-3 and hypothetical production pads CD-25, 27, 28, and 29									
Gravel Road Segments: CD-25 to APF-2; CD-27 to APF-3/CD-25 road; CD-28 to APF-3; CD-28 to CD-29, CD-29 road to airstrip; APF-3 to CD-25; APF-3 road to airstrip	8	NI	3, 5, 6	3, 5, 6	2, 3, 4, 5, 6	NI	2, 3, 4, 5, 6	NI	NI
Ice Roads: CD-29	NI	NI	10	10	NI	3, 4, 5, 6,	3, 4, 5, 6,	3, 4, 5, 6,	3, 4, 5, 6,
Pipeline Segment: CD-25 to APF-2; CD-27 to APF-3/CD-25 road; CD-28 to APF-3; CD-29 to CD-28; APF-3 to CD-25	NI	NI	NI	NI	2, 3, 4, 5, 6	2, 3, 4, 5, 6	2, 3, 4, 5, 6	2, 3, 4, 5, 6	NI
Production Pads: All hypothetical Satellite Locations and hypothetical processing facility	8	NI	NI	NI	2, 3, 4, 5, 6	2, 3, 4, 5, 6	2, 3, 4, 5, 6	2, 3, 4, 5, 6	NI
Airstrips: CD-29, APF-3	8	NI	NI	NI	3, 4, 5, 6	3, 4, 5, 6, 7	3, 4, 5, 6, 7	3, 4, 5, 6, 7	NI
Underground Injection	NI	9	NI	NI	NI	NI	NI	NI	NI
Processing Facility: CD-1 (existing)	8	NI	NI	NI	3, 4, 5, 6	NI	NI	NI	NI
Chemical/Petroleum Tank Storage	9	NI	9	NI	9	9	9	9	9
Surfacewater extraction for potable and construction use	NI	NI	10	10	NI	NI	NI	NI	NI

Notes:

IMPACTS

- 1 = Shoreline Disturbance & Thermokarsting
- 3 = Increased stages & velocities of floodwater
- 5 = Increased Bank Erosion
- 7 = Increased potential for over banking (due to inundation or wind-generated wave run-up)
- 9 = Chemical & Petroleum Spills & Cleanup
- 2 = Blockage of Natural Channel Drainage
- 4 = Increased channel scour
- 6 = Increased Sedimentation
- 8 = Removal of surface soils/gravel and changes in recharge potential
- 10 = Water Supply Demand NI =No Impact

4C.2.4.2 Surface Water Quality

Alternative C – CPAI Development Plan Impacts on Surface Water Quality

Construction Period

Water withdrawal volumes required for ice road construction would be approximately the same as Alternative A during the construction phase of the project because ice roads would be built to the same locations. The lengths of ice roads to be constructed in later phases of the project would be lower for this alternative compared with Alternative A because gravel roads would be used for drill rig access to lower Colville Delta pads after initial construction activities were completed. There would be a decreased chance that ice roads would be routed across lakes, likely leading to lower incidences of reductions in dissolved oxygen concentrations (as described for Alternative A).

The increase in total gravel placed in the planning area for this alternative would increase the potential impacts to water quality from increased turbidity caused by erosion and sedimentation. Alternative C would have approximately 386 acres covered with gravel for the proposed project. This represents a 43 percent increase in the gravel coverage estimated for Alternative A.

Operation Period

Dust fallout from roads would be expected to be higher for this alternative compared to Alternative A for two reasons. First, this alternative allows the broadest range of users on the roads. This would increase the number of vehicles traveling on the roads, although probably not by a measurable percentage. Second, this alternative would include construction of 41 miles of gravel roads for the applicant's proposed project, which represents an increase from Alternative A of 59 percent. This increase in the miles of gravel road constructed, combined with the fact that roads in the Colville Delta would be subject to the potential for impacts from upslope impoundments, increases potential for water quality impacts.

Alternative C – FFD Plan Impacts on Surface Water Quality

Ice road construction for the FFD scenario would require up to approximately 230 acre-feet of water to be withdrawn from lakes. The lengths of ice roads to be constructed in later phases of the project would be lower for this alternative compared with Alternative A because gravel roads would be used for drill rig access to pads after initial construction activities were completed. Because the miles of ice roads constructed in this alternative for the FFD scenario would be approximately 23 percent lower, there would be a decreased chance that ice roads would be routed across lakes, likely leading to lower incidences of reductions in dissolved oxygen concentrations (as described for Alternative A).

The increase in total gravel placed in the planning area for this alternative would increase the potential impacts to water quality from increased turbidity caused by erosion and sedimentation. Alternative C would have approximately 1,544 acres covered with gravel for the FFD scenario. This represents 10 percent increase from the gravel coverage estimated for Alternative A. The area of tundra potentially affected by thermokarst erosion would be equivalent to twice the area directly covered by gravel or approximately 3,088 acres for the FFD scenario.

Dust fallout from roads would be expected to be higher for this alternative compared to Alternative A for the same two reasons as cited in describing the impacts of CPAI's proposal—greater access to use of the road and construction of more roads than in Alternative A. The increase in the miles of gravel road constructed, combined with the fact that roads in the Colville Delta would be subject to the potential for impacts from upslope impoundments, increases potential for water quality impacts.

Alternative C – Summary of Impacts (CPAI and FFD) on Surface Water Quality

Alternative C proposes constructing roads in alternate locations, including a road connection to Nuiqsut and roads to all production pads in the Colville Delta. No new airstrips would be constructed except at the processing facilities for the FFD scenario. In comparison with Alternative A, this alternative would have more sources of potential impacts to surface water quality because of the increased gravel placement for road construction.

- Decreased miles of ice roads to be built compared to Alternative A, lowering the chance that ice roads would be routed across lakes, and potentially affecting dissolved oxygen concentrations
- Increased area potentially affected by thermokarst erosion compared to Alternative A, leading to increased impacts to water quality from increased turbidity caused by erosion and sedimentation
- Increased potential for dust fallout and upslope impoundments compared to Alternative A, resulting in a higher potential for impacts to turbidity.

Alternative C – Potential Mitigation Measures (CPAI and FFD) for Surface Water Quality

No mitigation measures identified for Alternative C or Alternative C FFD.

4C.2.3 Atmospheric Environment

4C.2.3.1 Climate and Meteorology

Alternative C – CPAI Development Plan Impacts on Climate and Meteorology

Construction Period

The impacts to climate and meteorology are the same as those for Alternative A.

Operation Period

Impacts from GHG would be similar to those stated for Alternative A.

Alternative C – FFD Plan Impacts on Climate and Meteorology

The impacts to climate and meteorology are the same as those discussed for the FFD of Alternative A, except there would be no airstrips in the lower Colville Delta. This would not change the overall impact from GHG.

Alternative C – Summary of Impacts (CPAI and FFD) on Climate and Meteorology

The impacts are the same as for Alternative A.

Alternative C – Potential Mitigation Measures (CPAI and FFD) for Climate and Meteorology

No mitigation measures have been identified.

4C.2.3.2 Air Quality

Alternative C – CPAI Development Plan Impacts on Air Quality

Construction Period

The amount of fugitive dust could increase over that for Alternative A because of the construction of more miles of roads.

Operation Period

The air quality environmental consequences would be about the same for this alternative as for alternative A, except emissions would be from vehicles instead of aircraft to CD-3.

Alternative C – FFD Plan Impacts on Air Quality

Air impacts would be similar to those stated for Alternative A, though impacts from aircraft would be reduced and those from road vehicles would be increased.

Alternative C – Summary of Impacts (CPAI and FFD) on Air Quality

The impacts would be roughly the same as Alternative A.

Alternative C – Potential Mitigation Measures (CPAI and FFD) for Air Quality

Air quality impacts from Alternative C would be limited through the permitting process, which ensures that no significant new air pollution sources contribute to deterioration of the ambient air quality. No additional measures have been identified.

4C.2.3.3 Noise

Alternative C – CPAI Development Plan Impacts on Noise

Construction Period

The noise quality environmental consequences are about the same for this Alternative as for Alternative A.

Operation Period

The noise quality from the operation period of Alternative C are about the same for this Alternative as for Alternative A, except there would be noise from vehicles instead of aircraft flights at CD-3.

Alternative C – FFD Plan Impacts on Noise

The noise impacts would be similar to those described for the FFD Plan under Alternative A, except there would be noise from aircraft flights at only two new airstrips, and none of these would be in the Lower Colville River Delta. Instead, roads would access all pads, and road vehicle noise would replace aircraft noise to and from most lower delta pads.

Alternative C – Summary of Impacts (CPAI and FFD) on Noise

The impacts from the CPAI Development Plan and FFD would be similar to the impacts under Alternative A. The major difference would be the reduction in aircraft noise and the increase in vehicle noise in the lower Colville Delta.

Alternative C – Potential Mitigation Measures (CPAI and FFD) for Noise

No potential mitigation measures have been identified for Alternative C or Alternative C FFD.