
APPENDIX E
AQUATIC SITE ASSESSMENT AND CREDIT-DEBIT CALCULATION

***Willow Master Development Plan
Wetlands Compensatory Mitigation Plan***

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WILLOW MASTER DEVELOPMENT PLAN
POA-2018-00190 HARRISON BAY
AQUATIC SITE ASSESSMENT
AND
CREDIT-DEBIT CALCULATION

North Slope, Alaska

for



**ConocoPhillips Alaska, Inc.
700 G Street
Anchorage, AK 99510**

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Attachment A: North Slope Rapid Assessment Method Data Sheets

Acronyms and Abbreviations

Abbreviation	Definition
Δ	Change
BLM	Bureau of Land Management
BT	Bear Tooth
CPAI	ConocoPhillips Alaska, Inc.
CRSA	Colville River Special Area
EIS	Environmental Impact Statement
FCI	functional capacity index
GIS	geographic information system
GMT2/MT7	Greater Mooses Tooth 2/Mooses Tooth 7
HGM	hydrogeomorphic
IAP	Integrated Activity Plan
KRU	Kuparuk River Unit
NPR-A	National Petroleum Reserve-Alaska
PAF	preservation adjustment factor
ROD	Record of Decision
TLSA	Teshkepuk Lake Special Area
USACE	U.S. Army Corps of Engineers
WAA	Wetland Assessment Area
WCF	Willow Central Processing Facility
Willow Project	Willow Master Development Plan
WOUS	water of the U.S.

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1.0 INTRODUCTION

ConocoPhillips Alaska, Inc. (CPAI) is seeking a Department of the Army (DA) permit authorization from the U.S. Army Corps of Engineers (USACE) to construct the Willow Master Development Plan (Willow Project). The Willow Project consists of five gravel drillsites in the Bear Tooth Unit (BTU) (Bear Tooth [BT]1 through BT5), a processing facility, an operations center, gravel access roads, bridges, pipelines, material sites, a constructed fresh water reservoir, an airstrip, and other ancillary facilities to support development of petroleum reserves within the BTU.

The Willow Project will result in 481.1 acres of permanent fill placement in waters of the U.S. (WOUS) and will be constructed in two phases. Phase 1 consists of construction of drillsites BT1 through BT3, the processing facility, and support infrastructure necessary to support Willow Project drilling and production. Phase 2 consists of drillsites BT4 and BT5 and their associated access roads and pipelines. Phase 1 will include 356.4 acres of fill placement in WOUS. Phase 2 will result in an additional 124.7 acres of fill placement in WOUS. The Willow Project also includes conversion of 135.8 acres of WOUS from excavation. This plan describes the compensatory mitigation for the full project (Phase 1 and 2).

To support permit evaluation, CPAI has prepared this aquatic site assessment and credit-debit calculation to assess wetlands proposed to be impacted by the Willow Project (debit areas) as well as wetlands and waterbodies that would receive functional uplift as a result of three compensatory mitigation projects proposed by CPAI and under evaluation by the USACE (credit areas).

2.0 METHODOLOGY

This Aquatic Site Assessment and debit calculation followed the methodologies found in the *Operational Draft Regional Guidebook for the Rapid Assessment of Wetlands in the North Slope Region of Alaska* (NS Assessment Method) (Berkowitz et al., 2017) and Alaska District: Credit Debit Methodology, Version 1.0 (USACE, 2016). Additionally, CPAI applied information from the Willow Master Development Plan Final Environmental Impact Statement (Final EIS; BLM 2020) and past precedent to evaluate debits from indirect impacts (Section 2.5, Indirect Impact Debits).

2.1 Debit and Credit Evaluation Areas

At the direction of the USACE and per the USACE's Alaska District Compensatory Mitigation Thought Process (USACE 2018), CPAI evaluated the following Willow Project impact areas for debit calculations:

- Willow Project footprint (fill and excavation) in wetlands or waterbodies within 500 feet of anadromous fish-bearing waterbodies¹
- Willow Project footprint (fill and excavation) in wetlands or waterbodies within the Colville River Special Area (CRSA) defined by the Bureau of Land Management (BLM) in the 2013 Record of Decision (ROD) to the 2012 Integrated Activity Plan (IAP) Final (EIS) for the NPR-A

¹ Willow impact areas within 500-feet of anadromous fish-bearing waters were identified using riverine polygons from the Willow Final EIS Integrated Terrain Unit Mapping (ABR, Inc.), which were then identified as anadromous using the ADF&G Catalog of Waters. Anadromous riverine polygons were then buffered by 500 feet and evaluated for overlap with the Willow Project footprint.

- Willow Project footprint (fill and excavation) in wetlands or waterbodies within the Teshekpuk Lake Special Area (TLSA) BLM in the 2013 ROD to the 2012 IAP Final EIS for the NPR-A

A wetland delineation for these areas was provided as Attachment E of CPAI's Department of the Army Permit application.

Where Willow Project footprints fall into more than one category (i.e., Willow Project footprints in wetlands or waterbodies within 500 feet of anadromous fish-bearing waterbodies and within the TLSA), footprints were evaluated within the anadromous fish-bearing waterbodies areas and subtracted from the other category to avoid double counting. The total of the three direct impact debit areas is 122.8 acres. Finally, CPAI has identified impacts as occurring in two project phases over a total construction phase of approximately 10 years. A single Aquatic Site Assessment was conducted for the debit areas for the project as a whole; however, debits are also identified by project phase in Section 4.0.

CPAI also evaluated two areas for two enhancement projects being evaluated as compensatory mitigation to offset unavoidable impacts of the proposed Willow Project on WOUS. The two projects are described further in CPAI's Wetlands Compensatory Mitigation Plan. The two areas evaluated include: the Nuiqsut Subsistence Trail Tundra Rehabilitation (Nuiqsut Subsistence Trail) credit area and the Nuiqsut Culvert Repair (Culvert Repair) credit area. The two enhancement credit areas total 120.8 acres.

The Nuiqsut Subsistence Trail credit area is defined as the area of existing trail damage including lateral web effect that would be rehabilitated through placement of geogrid. Along the eastern portion of the trail, the credit area was delineated based on aerial interpretation of the area of disturbance. Along the western portion of the trail, the area of disturbance was estimated based on an averaged width of disturbance as measured at several locations along the trail. That area is defined as 75 feet to either side of the trail centerline (150 feet wide total). CPAI acknowledges that in some areas, the area of disturbance may be smaller while in other areas it is larger but believes that the disturbance width is an appropriate estimate of the overall area that would receive functional uplift from the mitigation project.

The Culvert Repair credit area is defined as the aerial signature of disturbance and estimated ordinary high water and loss of channel morphology to the drainage leading to the Nigliq Channel. Since initial assessment, CPAI determined that the Culvert Repair project was impractical for compensatory mitigation. However, CPAI is supporting the project on a voluntary basis and assessment and credit generation information is provided below.

In addition to the enhancement projects, CPAI is also proposing preservation of 800 acres at either the mouth of Fish Creek or at Cape Halkett. Section 3.2.3, Fish Creek or Cape Halkett Preservation, provides additional detail on the evaluation of credit areas for preservation.

2.2 Wetland Assessment Areas

A Wetland Assessment Area (WAA) represents a unique wetland habitat in a proposed project area. According to the NS Assessment Method, more than one WAA can be defined within a project area. WAAs are defined by hydrogeomorphic (HGM) class (Brinson 1993) and the relative disturbance regime (undisturbed, disturbed within 80 meters, or disturbed within 800 meters) within the project impact zone and the credit area for mitigation projects. Once a WAA is evaluated, the resulting data can be extrapolated over similar HGM classes and disturbance regimes across the entire project.

Each of the direct impact debit and credit evaluation areas were broken into WAAs based on HGM class and disturbance class as shown in Table 2-1 below. Following WAA identification, representative data points were selected to evaluate the conditions within each WAA following the NS Assessment Method (Figure 1).

Table 2-1. Wetland Assessment Areas

Area Type	Area	Disturbance Class ^a	HGM Class	Representative Point	Acres
Willow Project Direct Impact Debit Areas					
Phase 1 Willow Project Direct Impacts Area					
Project Impact	Fish-Bearing Waters	Undisturbed	Flat	FBWAA2	7.0
Project Impact	Fish-Bearing Waters	Undisturbed	Depression	FBWAA1	1.7
Project Impact	Fish-Bearing Waters	Undisturbed	Riverine	FBWAA5	0.6
Project Impact	Fish-Bearing Waters	Disturbed >80m but <800m	Flat	FBWAA9	2.6
Project Impact	Fish-Bearing Waters	Disturbed >80m but <800m	Riverine	Extrapolated from FBWAA9	0.2
Project Impact	Fish-Bearing Waters	Disturbed >80m but <800m	Lacustrine Fringe	Extrapolated from FBWAA9	<0.1
Project Impact	Fish-Bearing Waters	Disturbed >80m but <800m	Slope	Extrapolated from FBWAA9	<0.1
Project Impact	Fish-Bearing Waters	Disturbed >80m but <800m	Flat	FBWAA10	1.1
Project Impact	Colville River SA	Undisturbed	Flat	CRSAWAA1	7.3
Project Impact	Colville River SA	Disturbed >80m but <800m	Flat	CRSAWAA2	0.8
Project Impact	Teshekpuk Lake SA	Undisturbed	Flat	TLSAWAA1	18.5
Project Impact	Teshekpuk Lake SA	Undisturbed	Depression	TLSAWAA2	13.6
Project Impact	Teshekpuk Lake SA	Undisturbed	Riverine	Extrapolated from TLSAWAA1	<0.1
Project Impact	Teshekpuk Lake SA	Undisturbed	Slope	TLSAWAA3	0.1
<i>Phase 1 Willow Project Direct Impact Debit Area Subtotal^P</i>					53.5
Phase 2 Willow Project Direct Impacts Area					
Project Impact	Fish-Bearing Waters	Undisturbed	Flat	FBWAA2	1.3
Project Impact	Fish-Bearing Waters	Undisturbed	Depression	FBWAA1	<0.1
Project Impact	Fish-Bearing Waters	Undisturbed	Riverine	FBWAA5	0.4
Project Impact	Teshekpuk Lake SA	Undisturbed	Flat	TLSAWAA1	54.7

Table 2-1. Wetland Assessment Areas

Area Type	Area	Disturbance Class ^a	HGM Class	Representative Point	Acres
Project Impact	Teshekpuk Lake SA	Undisturbed	Depression	TLSAWAA2	12.3
Project Impact	Teshekpuk Lake SA	Undisturbed	Riverine	Extrapolated from TLSAWAA1	0.1
Project Impact	Teshekpuk Lake SA	Undisturbed	Slope	TLSAWAA3	0.5
<i>Phase 2 Willow Project Direct Impact Debit Area Subtotal^b</i>					69.3
Phase 1 and Phase 2 Willow Project Direct Impact Debit Area Total^b					122.8
Enhancement Mitigation Project Areas					
Enhancement	Culvert Repair	Disturbed >80m	Riverine	CMWAA1	11.8
Enhancement	Nuiqsut Subsistence Trail	Undisturbed	Flat	CMWAA8	75.9
Enhancement	Nuiqsut Subsistence Trail	Undisturbed	Depression	CMWAA9	17.5
Enhancement	Nuiqsut Subsistence Trail	Disturbed >80m but <800m	Depression	CMWAA7	2.1
Enhancement	Nuiqsut Subsistence Trail	Disturbed >80m	Flat	CMWAA6	13.5
Enhancement Mitigation Total^b					120.8

^a Disturbance class based on distance from existing infrastructure (e.g., roads, pipelines). Disturbance class for mitigation projects reflects disturbance other than infrastructure being modified.

^b Values may not sum to totals because of rounding.

Notes: HGM: hydrogeomorphic; SA: special area; FW: fresh water; m: meters.

2.3 Variable Assessment and Functional Capacity Index Calculation

Following WAA identification and representative point establishment, data were collected through a desktop analysis of the representative data collection points to determine the off-site variables outlined in the NS Assessment Method. Data were collected at two spatial scales from the WAA representative point locations: 80-meter and 800-meter-radius areas. Plot radii of 80 meters and 800 meters were established around the WAA data collection points and divided into quarter segments.

Data collected in the 80-meter-radius plot included the following:

- Percent of the plot occupied by local landscape disturbance exhibited through anthropogenic disturbance/man-made features (V_{LLD})
- Percent of the plot occupied by anthropogenically derived surface water (V_{SW})
- Number of quarter segments in the plot containing impediments to hydrology (V_{IH})
- Evidence of dust accumulation in the plot (yes/no; V_{DD})
- Evidence of anthropogenically derived thermokarst in the plot (yes/no; V_{TK})

Data collected within the 800-meter-radius plot included the following:

- Percent of the plot occupied by landscape disturbance exhibited through anthropogenic disturbance/man-made features (V_{LD})
- Number of quarter segments in the plot containing impediments to wildlife movement (V_{IW})
- Minimum distance to roadway (meters) of any size, class, or condition (V_{DR})

The percent of local landscape disturbance, percent of anthropogenically derived surface water, and percent of landscape disturbance were determined by delineating each of these features' aerial imagery in a Geographical Informational System (GIS) and calculating overlap with the 80- and 800-meter plot radii as appropriate. The evidence of dust, evidence of thermokarst, and number of quarter segments containing impediments to hydrology or impediments to wildlife movement were visually assessed by reviewing aerial imagery. The minimum distance to roadway was measured in GIS using the measure tool.

The data collected with respect to the above criteria were tabulated in an electronic data form (Appendix A) developed by HDR using the equations and formulas provided by USACE to calculate subindex scores for each variable. The subindex scores for landscape disturbance, surface water, and impediments to hydrology and wildlife decrease linearly as the percent or number of quadrants increases. The subindex score for distance to roadway increases with increasing distance to roadway.

The eight subindex variables are then used to calculate three wetland function scores: habitat, hydrology, and biogeochemical cycling. The formulas used are as follows:

- The habitat assessment score equals the $(MIN(V_{IW}, V_{DR}) + \frac{(V_{LD} + V_{LLD})}{2})/2$
- The hydrology assessment score equals the $\sqrt{((V_{IH} + V_{SW})/2) \times ((V_{LD} + V_{LLD})/2)}$
- The biogeochemical cycling score equals the $MIN(V_{LD}, V_{LLD})$

The evidence of dust and evidence of thermokarst variables are not used in the calculation of any of the wetland function scores. Rather, when present, they limit the maximum attainable assessment scores. Evidence of dust limits the maximum attainable score for habitat and biogeochemical cycling to 0.80. Evidence of thermokarst limits the maximum attainable score for habitat, hydrology, and biogeochemical cycling to 0.70.

Once calculated, the three wetland function assessment scores are averaged to calculate an overall functional capacity index (FCI) for the WAA. The FCI represents the overall wetland condition from 0.00, representing no function (or an upland), to 1.00, representing pristine conditions.

Data were collected and FCI scores were calculated for each representative point for both pre-project and post-project conditions. Per the guidance of the NS Assessment Method, all wetlands that are converted to uplands received a post-project FCI score of 0.0. Functional gains for compensatory mitigation projects were evaluated based on changes in the FCI prior to and then following implementation of the mitigation project based on professional judgment regarding how the mitigation project would affect existing conditions in each WAA.

2.4 Debit and Credit Calculation

Once calculated, the change in FCI score between the pre-project and post-project condition (the FCI Δ) and the acreage of the affected area were used to calculate debits and credits for each area consistent with the Alaska District: Credit Debit Methodology. Credits for mitigation projects also considered factors of time lag and risk, which discount credits received based on when the assessment area can be expected to reach the calculated post-project FCI and the degree of uncertainty that the proposed conditions will be obtained.

2.5 Indirect Impact Debits

CPAI also considered debits that could result from indirect impacts. There are no approved methods for quantifying indirect debits resulting from functional losses of aquatic resources on Alaska's North Slope for compensatory mitigation purposes. The North Slope Rapid Assessment Method (Berkowitz et al. 2017) provides guidance in evaluating the current condition of WOUS and states that in areas converted from jurisdictional wetlands to uplands, the post-project assessment score quantifying wetland function is zero. It does not, however, include guidance for predicting indirect impacts from proposed fill.

The Final EIS identified road dust, the indirect impact likely to affect the largest spatial area, as having greatest effect within 35 feet of gravel roads (BLM 2020). Furthermore, studies of dust deposition from nearby gravel roads (ERM Alaska 2016), comments from the EPA, and BLM-imposed Required Operating Procedures including measures documented in CPAI's Project Dust Control Plan support focusing mitigation for indirect impacts on areas immediately adjacent to the proposed gravel fill footprint. Therefore, CPAI determined the extent of indirect impacts requiring mitigation by identifying areas within 35-feet of proposed gravel fill placement and within 500 feet of anadromous fish-bearing waters, the CRSA, or the TLSA. The Willow Project would result in 115.0 acres of indirect impacts requiring compensatory mitigation over both project phases (Table 2-2).

Table 2-2. Indirect Impact Assessment Areas

Area	Acres
Phase 1 Willow Project Indirect Impacts	
Wetlands and Waters within 500-feet of Anadromous Fish-Bearing Waters	11.6
Wetlands and Waters in the TLSA	19.9
Wetlands and Waters in the CRSA	9.3
<i>Phase 1 Subtotals^a</i>	<i>40.7</i>
Phase 2 Willow Project Indirect Impacts	
Wetlands and Waters within 500-feet of Anadromous Fish-Bearing Waters	71.4
Wetlands and Waters in the TLSA	2.9
<i>Phase 2 Subtotals^a</i>	<i>74.2</i>
Phase 1 and Phase 2 Willow Project Indirect Impact Total^a	115.0

^a Values may not sum to totals because of rounding.

Note: TLSA: Teshekpuk Lake Special Area; CRSA: Colville River Special Area.

To determine the number of debits incurred from this area, CPAI followed past precedent from large North Slope projects where the functional loss to wetlands within the indirect impact area is assumed to be 10 percent. By their nature, indirect impacts do not result in a complete loss of wetland function because the wetlands continue to provide wetland functions, although at a reduced capacity. The 10 percent functional loss factor has been used in calculating debits for indirect impacts on previous authorizations for North Slope projects, including the Point Thomson Project and GMT1/MT6. CPAI applied the 10 percent functional loss factor to the indirect impact areas to determine debits for indirect impacts.

3.0 RESULTS

Sections 3.1 through 3.2 describe the findings from the application of the NS Assessment Method to the Willow Project impact and mitigation areas.

3.1 Willow Project Debit Areas

As described above, the Willow Project debit areas consist of three areas: fill footprint within wetlands or other waterbodies within 500 feet of anadromous fish-bearing waterbodies, within the CRSA, and within the TLSA. The FCI for all debit areas is assumed to be 0.0 in the post-condition as wetlands are converted to uplands.

3.1.1 Wetlands and Waters within 500 feet of Anadromous Fish-bearing Waters

Table 3-1 provides wetland function score data calculated for each representative point within 500 feet of an anadromous fish-bearing waterbody. The full suite of variable data is provided in the electronic data forms in Appendix A.

Table 3-1. 500 Feet of Anadromous Fish-Bearing Waterbodies Representative Points

Point	Disturbance Class ^a	HGM Class	Lat. (°N)	Long. (°W)	Habitat Score	Hydro Score	BGC Score	FCI
FBWAA1	Undisturbed	Depression	70.1284	152.0655	1.00	1.00	1.00	1.00
FBWAA2	Undisturbed	Flat	70.1096	152.0807	1.00	1.00	1.00	1.00
FBWAA5	Undisturbed	Riverine	70.1289	152.0630	1.00	1.00	1.00	1.00
FBWAA9	Disturb 800m	Flat	70.2821	151.2622	0.63	1.00	1.00	0.88
FBWAA10	Disturb 800m	Flat	70.2379	151.2967	1.00	1.00	1.00	1.00

^a Disturbance class based on distance from existing infrastructure (e.g., roads, pipelines).

Notes: HGM: hydrogeomorphic; Lat.: latitude; °N: degrees North; Long.: longitude; °W: degrees West; m: meters; Hydro: hydrology; BGC: biogeochemical cycling; FCI: functional capacity index.

3.1.1.1 FBWAA1, FBWAA2, FBWAA5

Representative points FBWAA1 (Figure 2), FBWAA2 (Figure 3), and FBWAA5 (Figure 4) are in completely undisturbed areas and received an FCI score of 1.00. FBWAA1 and FBWAA5 both occur within wetlands that would be filled within 500 feet of an anadromous fish-bearing swale near the proposed WCF. FBWAA2 is located at proposed perimeter berm at the Constructed Freshwater Reservoir near Lake M0015. The post-Willow Project FCI for the three sites would be 0.0 because the sites would become uplands.

3.1.1.2 FBWAA9

Representative point FBWAA9 (Figure 5) is near, but more than 80 meters from, the Colville Delta 5 to Greater Mooses Tooth 1 access road. The point is located where new fill would be placed to construct the proposed subsistence boat ramp at the Tiñmiaqsiuġvik River. The point does not contain anthropogenic landscape disturbance (V_{LLD}), impediments to hydrology (V_{IH}), anthropogenically derived surface water (V_{SW}), or evidence of dust (V_{DD}) or thermokarst (V_{TK}) within the 80-meter-radius plot. However, FBWAA9 contains 11.4 acres of existing landscape disturbance (V_{LD}) within the 800-meter-radius plot and potential impediments to wildlife in three quadrants (V_{IW}). It is 127 meters from the nearest road (V_{DR}).

The post-Willow Project FCI for FBWAA9 would be 0.0 because the site would become an upland.

3.1.1.3 FBWAA10

Representative point FBWAA10 (Figure 6) is located in the excavation area at the proposed gravel mine site (Mine Site Area 2). The point does not contain anthropogenic landscape disturbance (V_{LLD}), impediments to hydrology (V_{IH}), anthropogenically derived surface water (V_{SW}), or evidence of dust (V_{DD}) or thermokarst (V_{TK}) within the 80-meter-radius plot. There are no impediments to wildlife (V_{IW}) within the 800-meter-radius plot and the point is more than 800 meters from the nearest road (V_{DR}). However, FBWAA10 contains 3.3 acres of existing landscape disturbance (V_{LD}) within the 800-meter-radius plot.

The post-Willow Project FCI for FBWAA10 is conservatively estimated to be 0.0 although, in reality, the functional score would not drop all the way to zero as the area would remain an aquatic site and would continue to perform some aquatic functions after mine site rehabilitation.

3.1.1.4 Debit Analysis

Based on the acreages and FCI scores described above, placement of fill within wetlands within 500 feet of anadromous fish-bearing waterbodies would incur 8.1 debits (Table 3-2).

Table 3-2. Anadromous Fish-Bearing Waterbody Debit Analysis

Disturbance Class ^a	HGM Class	Representative Point(s)	Acres	Pre FCI	Post FCI	FCI Δ	Debits ^c
Undisturbed	Flat	FBWAA2	8.3	1.00	0.00	1.00	8.3
Undisturbed	Depression	FBWAA1	1.7	1.00	0.00	1.00	1.7
Undisturbed	Riverine	FBWAA5	1.0	1.00	0.00	1.00	1.0
Disturbed >80 but <800m	Flat	FBWAA9	2.6	0.88	0.00	0.88	2.3
Disturbed >80 but <800m	Riverine	FBWAA9 ^b	0.2	0.88	0.00	0.88	0.1
Disturbed >80 but <800m	Lacustrine	FBWAA9 ^b	<0.1	0.88	0.00	0.88	0.0
Disturbed >80 but <800m	Slope	FBWAA9 ^b	<0.1	0.88	0.00	0.88	0.0
Disturbed >80 but <800m	Flat	FBWAA10	1.1	1.00	0.00	0.88	1.1
Totals			14.8	-	-	-	14.5

^a Disturbance class based on distance from existing infrastructure (e.g., roads, pipelines).

^b Extrapolated from similar point.

^c Values may not sum to totals because of rounding.

Notes: HGM: hydrogeomorphic; FCI: functional capacity index; Δ: change; m: meters.

3.1.2 Wetlands and Waters within the Teshekpuk Lake Special Area

Table 3-3 provides variable data calculated for each representative point within the TLISA. The full suite of variable data is provided in the electronic data forms in Appendix A.

Table 3-3. Teshekpuk Lake Special Area Representative Points

Point	Disturb. Class ^a	HGM Class	Lat. (°N)	Long. (°W)	Habitat Score	Hydro. Score	BGC Score	FCI
TLSAWAA1	Undisturbed	Flat	70.2299	152.1152	1.00	1.00	1.00	1.00
TLSAWAA2	Undisturbed	Depression	70.2369	152.1451	1.00	1.00	1.00	1.00
TLSAWAA3	Undisturbed	Slope	70.2760	152.1936	1.00	1.00	1.00	1.00

^a Disturbance class based on distance from existing infrastructure (roads, pipelines, etc.).

Notes: Disturb.: disturbance; HGM: hydrogeomorphic; Lat.: latitude; °N: degrees North; Long.: longitude; °W: degrees West; Hydro.: hydrology; BGC: biogeochemical cycling; FCI: functional capacity index.

Representative points TLSAWAA1 (Figure 7), TLSAWAA2 (Figure 8), and TLSAWAA3 (Figure 9) are located in completely undisturbed areas and received an FCI score of 1.00. TLSAWAA1 is located along the proposed BT2 access road near BT2. TLSAWAA2 is located along the proposed BT4 access road near BT2. TLSAWAA3 is located along the proposed BT4 access road. The post-Willow Project score at these sites would be 0.0 because the sites would become uplands.

Based on the acreages and FCI scores described above, placement of fill within wetlands within the TLSA would incur 99.5 debits (Table 3-4).

Table 3-4. TLSA Debit Analysis

Disturbance Class ^a	HGM Class	Representative Points	Acres	Pre FCI	Post FCI	FCI Δ	Debits
Undisturbed	Flat	TLSAWAA1	73.2	1.00	0.00	1.00	73.2
Undisturbed	Depression	TLSAWAA2	25.9	1.00	0.00	1.00	25.9
Undisturbed	Slope	TLSAWAA3	0.6	1.00	0.00	1.00	0.6
Undisturbed	Riverine	NA	0.1	1.00	0.00	1.00	0.1
Totals			99.8	-	-	-	99.8

^a Disturbance class based on distance from existing infrastructure (roads, pipelines, etc.).

Notes: HGM: hydrogeomorphic; FCI: functional capacity index; Δ: change; NA: not available.

3.1.3 Wetlands and Waters within the Colville River Special Area

Table 3-5 provides wetland function score data calculated for each representative point within the CRSA. The full suite of variable data is provided in the electronic data forms in Appendix A.

Table 3-5. Colville River Special Area Representative Points

Point	Disturbance Class ^a	HGM Class	Lat. (°N)	Long. (°W)	Habitat Score	Hydro. Score	BGC Score	FCI
CRSAWAA1	Undisturbed	Flat	70.1657	151.7289	1.00	1.00	1.00	1.00
CRSAWAA2	Disturb 800m	Flat	70.1700	151.7148	0.88	1.00	1.00	0.96

^a Disturbance class based on distance from existing infrastructure (e.g., roads, pipelines).

Notes: Disturb: disturbed; HGM: hydrogeomorphic; Lat.: latitude; °N: degrees North; Long.: longitude; °W: degrees West; m: meters; Hydro.: hydrology; BGC: biogeochemical cycling; FCI: functional capacity index.

3.1.3.1 CRSAWAA1

Representative point CRSAWAA1 (Figure 10) is in a completely undisturbed area and received an FCI score of 1.00. CRSAWAA1 is located along the proposed Willow access road in the CRSA more than 800 meters from the closest existing anthropogenic disturbance (Greater Mooses Tooth 2 [GMT2]). The post-Willow Project score at the site would be 0.0 because the site would become an upland.

3.1.3.2 CRSAWAA2

Representative point CRSAWAA2 (Figure 11) is located along the proposed Willow access road in the CRSA within 800 meters of GMT2. The point does not contain anthropogenic local landscape disturbance

(V_{LDD}), impediments to hydrology (V_{IH}), anthropogenically derived surface water (V_{SW}), or evidence of dust (V_{DD}) or thermokarst (V_{TK}) within the 80-meter-radius plot. FBWAA9 does contain 3.36 acres existing landscape disturbance (V_{LD}) within the 800-meter-radius plot and contains an impediment to wildlife in one quadrant (V_{IW}). The site is more than 800 meters from the nearest road (V_{DR}).

The post-Willow Project score at the site would be 0.0 because the site would become an upland.

3.1.3.3 Debit Analysis

Based on the acreages and FCI scores described above, placement of fill within wetlands within the TLSA would incur 8.1 debits (Table 3-6).

Table 3-6. CRSA Debit Analysis

Disturbance Class ^a	HGM Class	Representative Points	Acres ^b	Pre FCI	Post FCI	FCI Δ	Debits
Undisturbed	Flat	CRSAWAA1	7.3	1.00	0.00	1.00	7.3
Disturbed >80m but <800m	Flat	CRSAWAA2	0.8	0.96	0.00	0.96	0.8
Totals			8.1	-	-	-	8.1

^a Disturbance class based on distance from existing infrastructure (e.g., roads, pipelines).

^b Values may not sum to totals because of rounding.

Notes: HGM: hydrogeomorphic; FCI: functional capacity index; Δ : change; m: meters.

3.1.4 Indirect Impact Debits

As described in Section 2.5, Indirect Impact Debits, indirect impacts were calculated for 115.0 acres using a functional loss factor of 10 percent (i.e., FCI Δ equals 0.10) relative to an assumed current pristine condition. Based on this analysis, the Willow Project would incur an additional 11.5 debits from indirect effects (Table 3-7).

Table 3-7. Indirect Impact Assessment Areas

Area	Acres	Pre-FCI	Post-FCI	FCI Δ	Debits
Wetlands and Waters within 500-feet of Anadromous Fish-Bearing Waters	14.5	1.00	0.90	0.10	1.5
Wetlands and Waters in the TLSA	91.3	1.00	0.90	0.10	9.1
Wetlands and Waters in the CRSA	9.3	1.00	0.90	0.10	0.9
Indirect Impact Total	115.0				11.5

Note: TLSA: Teshekpuk Lake Special Area; CRSA: Colville River Special Area.

3.2 Compensatory Mitigation Project Credit Areas

Compensatory mitigation project sites were also evaluated using the NS Assessment Method (Figure 12). As described above, functional gains for compensatory mitigation projects were evaluated based on changes in the FCI prior to and following implementation of the mitigation project based on professional judgment regarding how the mitigation project would affect existing conditions in each WAA.

3.2.1 Nuiqsut Subsistence Trail Tundra Rehabilitation

Table 3-8 provides wetland function score data calculated for each representative point for the Nuiqsut Subsistence Trail compensatory mitigation project. The evaluation included four sites—CMWAA6, CMWAA7, CMWAA8, and CMWAA9—that assessed areas of potential functional lift due to trail rehabilitation. The full suite of variable data is in the electronic data forms in Appendix A.

Table 3-8. Nuiqsut Subsistence Trail Representative Points

Point	Disturb. Class ^a	HGM Class	Lat. (°N)	Long. (°W)	Pre/Post	Habitat Score	Hydro. Score	BGC Score	FCI
CMWAA6	Disturbed 80m	Flat	70.2286	151.0494	Pre	0.31	0.00	0.00	0.10
					Post	0.51	0.70	0.70	0.64
CMWAA7	Disturbed 800m	Depression	70.2289	151.0626	Pre	0.70	0.33	0.45	0.49
					Post	0.70	0.70	0.70	0.70
CMWAA8	Undisturbed	Flat	70.2302	151.2499	Pre	0.78	0.52	0.10	0.47
					Post	0.99	0.99	0.95	0.97
CMWAA9	Undisturbed	Depression	70.2273	151.2391	Pre	0.77	0.52	0.08	0.45
					Post	0.99	0.99	0.95	0.97

^a Disturbance class based on distance from existing infrastructure (e.g., roads, pipelines).

Notes: Disturb: disturbance; HGM: hydrogeomorphic; Lat.: latitude; °N: degrees North; Long.: longitude; °W: degrees West; m: meters; Hydro.: hydrology; BGC: biogeochemical cycling; FCI: functional capacity index.

3.2.1.1 CMWAA6

Representative point CMWAA6 is located in a flat-HGM class wetland along the subsistence trail within 80 meters of the Nuiqsut landfill and the landfill access road (Figure 13). This area represents the most widespread damage associated with the trail, with multiple tracks and ruts fanning out from the road and curving around the landfill. Hydrological changes also appear to be occurring because of the landfill and the subsistence trail. Table 3-9 provides the NS Assessment Method variables, subindex scores, and assessment scores for CMWAA6.

Table 3-9. CM Wetland Assessment Area 6

Variables			Pre	Post
80-m radius plot	1. V_{LLD}	Local Landscape Disturbance	82%	11%
		V_{LLD} Subindex score	0.00	0.73
	2. V_{SW}	Anthropogenically-derived surface water	46%	0%
		V_{SW} Subindex Score	0.00	1.00
	3. V_{IH}	Impediment to Hydrology	4	1
800-m radius plot		V_{IH} Subindex Score	0.00	0.75
	4. V_{DD}	Evidence of Dust	Yes	Yes
	5. V_{TK}	Evidence of Thermokarst	Yes	Yes
	6. V_{LD}	Landscape Disturbance	11%	8%
		V_{LD} Subindex Score	0.87	0.93
800-m radius plot	7. V_{IW}	Impediment to Wildlife	3	3
		V_{IW} Subindex Score	0.25	0.25
800-m radius plot	8. V_{DR}	Distance to Roadway	96 m	96 m
		V_{DR} Subindex Score	0.19	0.19
Habitat Assessment Score			0.31	0.51
Hydrology Assessment Score			0.00	0.70
Biogeochemical Cycling Assessment Score			0.00	0.70
Average Score			0.10	0.64

Local Landscape Disturbance (V_{LLD})

Local Landscape Disturbance is defined as the total anthropogenic disturbance quantified as a percentage of the 80-meter-radius-plot area. According to the NS Assessment Method, disturbances include, but are not limited to, roads, levees, utility lines, structural features, borrow pits, pads, pipelines, and parking lots. Areas with peculiar coloration and/or textures can often be verified as disturbed by referring to historical aerial (Berkowitz et al., 2017).

Currently, CMWAA6 contains 4.1 acres of existing local landscape disturbance in the 80-meter-radius plot (82 percent of the plot area) related to a web of rutted trail sections caused by the repeated use of all-terrain vehicles (ATVs). These trail ruts are evident on aerial imagery as texture and discoloration differences from the surrounding un-impacted wetlands, and from historical imagery where no discernible disturbance is evident (Photos 1 and 2).



Photo 1: Nuiqsut trail area showing no discernable areas of textural changes or discoloration (2001)



Photo 2: Nuiqsut trail anthropogenic disturbance showing areas of textural and discoloration (2018)



Photo 3: Example of anthropogenic disturbance caused by rutting along a similar trail in Utqiaġvik



Photo 4: Example of geogrid application mitigating anthropogenic disturbance in Utqiaġvik. Photo Credit: NSB Website- Robert Suydam.

A similar level and type of disturbance has occurred in Utqiagvik along an ATV trail near the community's fresh water supply lake. Geogrid was placed successfully along that trail and resulted in a noticeable improvement in 2 years (Photos 3 and 4). The disturbance appears to have been mitigated by the geogrid trail allowing natural revegetation to take place, and the rutting was eliminated by residents limiting travel to the new trail surface.

A similar effect is anticipated in Nuiqsut; however, anthropogenic landscape disturbance related to the Nuiqsut trail ruts at WAA6 appears heavier than the Utqiagvik example. Therefore, CPAI anticipates the recovery in Nuiqsut may take longer (conservatively estimated between 6 to 10 years) to achieve functional uplift due to reduction in anthropogenic disturbance from the existing trail disturbance. Additionally, the geogrid would add new anthropogenic disturbance in the form of a structural feature. This new disturbance was accounted for in the post assessment condition. The acreage of geogrid disturbance was estimated by buffering the trail centerline by 8 feet (4 feet to either side). To remain conservative in our approach, CPAI considered the full footprint of the new geogrid trail as an anthropogenic impact in our post-mitigation assessment even though the material does not represent fill, and the perforated design will allow for vegetation growth. Anthropogenic disturbance related to the landfill would also remain. The total acreage of anthropogenic disturbance in the post-mitigation plot is estimated to be 0.6 acre (11 percent of the plot area).

Anthropogenically-Derived Surface Water (V_{sw})

Anthropogenically-derived surface water is defined in the NS Assessment Method as the total amount of anthropogenically-derived surface water, quantified as a percentage of an 80-meter-radius plot. This variable indicates altered hydrology, human-induced surface water ponding, or alteration of the local geomorphology by removal of the substrate and subsequent collection of surface water aerial (Berkowitz et al. 2017). Currently, CMWAA6 contains 2.3 acres of anthropogenically-derived surface water in the 80-meter-radius plot (46 percent of the plot area) caused by repeated use of ATVs that result in ruts and tundra damage that fill with water. These trail ruts are evident on aerial imagery (Photos 1 and 2) that show ponded water where tundra damage has occurred along the trail since 2007.

As with the local anthropogenic disturbance example presented above, a similar level and type of disturbance previously existed in Utqiagvik near the community's fresh water supply lake. Geogrid was placed successfully along that trail and resulted in a noticeable improvement in reduction in anthropogenically-derived surface water in 2 years (see photos 5 and 6). The disturbance appears to have been mitigated by the geogrid allowing natural revegetation to take place, and the rutting and ponding was eliminated by residents limiting travel to the new trail surface.

Based on the Utqiagvik trail recovery example, CPAI anticipates that anthropogenically-derived water related to the subsistence trail damage would decrease to zero in the post-mitigation project condition as natural vegetation recovers and residents use the geogrid trail instead of the tundra surface. In addition, the geogrid trail would float on the natural surface water, which would avoid creation of ruts and prevent compaction of the soil that could inhibit percolation and natural water movement. However, as with anthropogenic disturbance, recovery of the Nuiqsut trail may take longer than in the Utqiagvik example due to the deeper ruts related to the Nuiqsut trail ruts. Therefore, CPAI estimates reduction of all anthropogenic surface water along the Nuiqsut trail within 6 to 10 years.



Photo 5: Example of anthropogenically-derived surface water along similar trail in Utqiagvik. Photo Credit: NSB Website- Robert Suydam.



Photo 6: Example of geogrid application mitigating anthropogenically-derived surface water in Utqiagvik. Photo Credit: NSB Website- Robert Suydam

Impediment to Hydrology (V_{IH})

The NS Assessment Method defined an impediment to hydrology as the number of quarter segments assigned in any direction that contain hydrologic impediment, which is caused by the presence of man-made structures, excavations, or fill material. Impediments to hydrology include any activities capable of increasing or decreasing the frequency and duration of surface or near-surface water flow within the assessment area. The structure must have the capacity to impede flow. Other features occurring in a segment that do not impede flow should not be included in the determination of V_{IH} (Berkowitz et al. 2017).

Currently, CMWAA6 contains impediments to hydrology in four quadrants from ruts within the trail footprint and web effect that impedes or redirects lateral surface water movement. Compacted soils may also affect the lateral and vertical shallow subsurface movement that results in abnormal ponding. The adjacent Nuiqsut landfill is also present in the plot and also impedes natural water movement.

As evidenced by the Utqiagvik example, the subsistence trail ruts would no longer serve as impediments to natural hydrology as the vegetation and soils recover (Photos 5 and 6). As described above, functional uplift resulting from reduction in impediments to hydrology is expected to occur within 6 to 10 years. Recovery of natural vegetation through reduction in anthropogenic disturbance would allow re-establishment of natural drainage patterns. The new geogrid trail is not expected to result in a barrier to surface and subsurface water movements because it is designed to float on the surface and allow water to pass laterally. The perforated open cell design will allow vertical movement as well. At CMWAA6, the adjacent landfill would continue to serve as an impediment to hydrology in one quadrant after the geogrid trail is constructed.

Landscape Disturbance (V_{LD})

Landscape disturbance is defined identically to Local Landscape Disturbance, but it is measured within the 800-meter-radius plot. Currently, CMWAA6 contains 52.7 acres of existing anthropogenic landscape disturbance within the 800-meter-radius plot (11 percent of the plot area). In a similar fashion as the local landscape disturbance metric, anthropogenic disturbance related to the landfill, landfill access road, and Kuukpik Spur Road would remain following mitigation project completion, but disturbance resulting from trail rutting would be removed in 6 to 10 years through use of the new geogrid trail. However, the geogrid would add new anthropogenic disturbance within the geogrid footprint. The total acreage of disturbance in the post-mitigation plot is estimated to be 41.7 acre (8 percent of the plot area).

Other Variables

Dust (V_{DD}) is assumed to be present adjacent to gravel fill and the landfill. Thermokarst (V_{TK}) is visible in the aerial imagery, particularly near the landfill (Photo 2). The plot also includes impediments to wildlife movement (V_{IW}) in three quadrants. The current trail rutting could act in some degree to impede wildlife movement; however, because the definition in the method appears to restrict this metric to larger gravel roads and above ground pipelines, the rutting was not accounted for in either the pre or post condition assessment. The site is 96 meters from the nearest road (V_{DR}).

In the post-mitigation condition, no change would occur to evidence of dust, evidence of thermokarst, impediments to wildlife, or distance to roadway.

Assessment Scores and Average Score

The average pre-assessment score is estimated to be 0.10; the average post-assessment score is anticipated to be 0.64 within 6 to 10 years. Based on the pre- and post-assessments, the FCI Δ for CMWAA6 would be 0.54.

3.2.1.2 CMWAA7

Representative point CMWAA7 is located in a depression-HGM class wetland along the subsistence trail more than 80 meters but less than 800 meters from the Nuiqsut landfill (Figure 14). In this area, there is a visible network of parallel trails and thermokarst, but the disturbance footprint is not as wide as at CMWAA6. Table 3-10 provides the NS Assessment Method variables, subindex scores, and assessment scores for CMWAA7.

Table 3-10. CM Wetland Assessment Area 7

Variables		Pre	Post
80-m radius plot	1. V _{LDD} Local Landscape Disturbance	22%	2%
	V _{LDD} Subindex score	0.45	0.95
	2. V _{SW} Anthropogenically-derived surface water	11%	0%
	V _{SW} Subindex Score	0.31	1.00
	3. V _{IH} Impediment to Hydrology	4	0
800-m radius plot	V _{IH} Subindex Score	0.00	1.00
	4. V _{DD} Evidence of Dust	No	No
	5. V _{TK} Evidence of Thermokarst	Yes	Yes
	6. V _{LD} Landscape Disturbance	9%	6%
	V _{LD} Subindex Score	0.91	0.98
800-m radius plot	7. V _{IW} Impediment to Wildlife	1	1
	V _{IW} Subindex Score	0.75	0.75
	8. V _{DR} Distance to Roadway	417 m	417 m
V _{DR} Subindex Score		0.83	0.83
Habitat Assessment Score		0.70	0.70
Hydrology Assessment Score		0.33	0.70
Biogeochemical Cycling Assessment Score		0.45	0.70
Average Score		0.49	0.70

Local Landscape Disturbance (V_{LDD})

Currently, CMWAA7 contains 1.1 acres of existing local landscape disturbance in the 80-meter-radius plot (22 percent of the plot area). Anthropogenic landscape disturbance related to the trail would be removed. However, the geogrid would add new anthropogenic disturbance. The total acreage of disturbance in the post-mitigation plot is estimated to be 0.1 acre (2 percent of the plot area). The

rationale for the new geogrid trail resulting in reduction to local landscape disturbance is similar to what is described in CMWAA6 and presented in the above photographs.

Anthropogenically-Derived Surface Water (V_{SW})

Currently, CMWAA7 contains 0.6 acre of anthropogenically-derived surface water in the 80-meter-radius plot (11 percent of the plot area). In the post condition, anthropogenically-derived surface water related to the subsistence trail damage would decrease to zero as natural vegetation recovers. The rationale for the new geogrid trail resulting in a reduction in anthropogenically-derived surface water is similar to what is described in CMWAA6 and presented in the above photographs.

Impediment to Hydrology (V_{IH})

Currently, CMWAA7 contains impediments to hydrology occur in four quadrants from ruts within the footprint of the multiple parallel trails. The subsistence trail ruts would recover in the 6 to 10-year timeframe and would no longer serve as impediments to natural hydrology as the vegetation recovers. The rationale for the new geogrid trail resulting in a reduction in impediments to hydrology is similar to what is described in CMWAA6 and presented in the above photographs.

Landscape Disturbance (V_{LD})

Currently, CMWAA7 contains 47.1 acres of existing anthropogenic landscape disturbance within the 800-meter-radius plot (9 percent of the plot area) related to the existing trail ruts and adjacent landfill. Anthropogenic landscape disturbance related to the trail would be removed; anthropogenic disturbance related to the landfill would remain. In addition, the geogrid would add new anthropogenic disturbance. The total acreage of disturbance in the post-mitigation plot is estimated to be 32.1 acres (6 percent of the plot area). The rationale for the new geogrid trail resulting in a reduction to landscape disturbance is similar to what is described in CMWAA6 and presented in the above photographs.

Other Variables

No sources of dust occur within 80 meters, and no dust is visible on the aerial imagery (V_{DD}). Minor thermokarst is visible in the aerial imagery within the trail ruts (V_{TK}). The plot includes an impediment to wildlife movement (V_{IW}) in one quadrant from the landfill. The site is 417 meters from the nearest road (V_{DR}).

In the post-mitigation condition, no change would occur to evidence of dust, evidence of thermokarst, impediments to wildlife, or distance to roadway.

Assessment Scores and Average Score

The average pre-assessment score is estimated to be 0.49; the average post-assessment score is anticipated to be 0.70 within 6 to 10 years. Based on these values, the FCI Δ for CMWAA7 would be 0.21.

3.2.1.3 CMWAA8 and CMWAA9

Representative points CMWAA8 and CMWAA9 are both located along the subsistence trail more than 800 meters from anthropogenic disturbance other than the disturbance resulting from the current rutted trail (Figures 15 and 16). In these areas, the trail network is more consolidated in some locations but continues to fan out in other areas, particularly as it crosses wetter wetland types. Trail ruts in CMWAA8 and CMWAA9 do not appear as deep as those observed at CMWAA6 or CMWAA7. CMWAA8 is

located in a flat-HGM class wetland while CMWAA9 is located in a depression-HGM class wetland. As the two sites are very similar, however, both are described in this section. Table 3-11 provides the NS Assessment Method variables, subindex scores, and assessment scores for CMWAA8 and CMWAA9.

Table 3-11. CM Wetland Assessment Areas 8 and 9

Variables			WAA8		WAA9	
			Pre	Post	Pre	Post
80-m radius plot	1. V_{LLD}	Local Landscape Disturbance	36%	2%	37%	2%
		V_{LLD} Subindex score	0.10	0.95	0.08	0.95
	2. V_{SW}	Anthropogenically-derived surface water	0%	0%	0%	0%
		V_{SW} Subindex Score	1.00	1.00	1.00	1.00
	3. V_{IH}	Impediment to Hydrology	4	0	4	0
800-m radius plot		V_{IH} Subindex Score	0.00	1.00	0.00	1.00
	4. V_{DD}	Evidence of Dust	No	No	No	No
	5. V_{TK}	Evidence of Thermokarst	No	No	No	No
	6. V_{LD}	Landscape Disturbance	4%	0%	4%	0%
		V_{LD} Subindex Score	1.00	1.00	1.00	1.00
800-m radius plot	7. V_{IW}	Impediment to Wildlife	0	0	0	0
		V_{IW} Subindex Score	1.00	1.00	1.00	1.00
	8. V_{DR}	Distance to Roadway	800 m	800 m	800 m	800 m
			1.00	1.00	1.00	1.00
Habitat Assessment Score			0.78	0.99	0.77	0.99
Hydrology Assessment Score			0.52	0.99	0.52	0.99
Biogeochemical Cycling Assessment Score			0.10	0.95	0.08	0.95
Average Score			0.47	0.97	0.45	0.97

Local Landscape Disturbance (V_{LLD})

Currently, CMWAA8 and CMWAA9 contain 1.8 and 1.8 acres, respectively, of existing local landscape disturbance (36 and 37 percent of the plot areas, respectively). This disturbance is related to the existing trail ruts and vegetation disturbance only. In the post condition, anthropogenic landscape disturbance related to the trail would be removed in 6 to 10 years, but new geogrid trail would be added. The total acreage of disturbance in the post-mitigation plot is estimated to be 0.1 acre (2 percent of each plot area). The rationale for the new geogrid trail resulting in reduction to local landscape disturbance is similar to what is described in CMWAA6 and presented in the above photographs.

Impediment to Hydrology (V_{IH})

Impediments to hydrology occur in four quadrants for both sites from ruts within the trail footprint which increase the duration of surface water. Within 6 to 10 years following completion of the mitigation project, the subsistence trail ruts would no longer serve as impediments to natural hydrology as the

vegetation recovers and soil compaction is mitigated by the new geogrid trail. The rationale for the new geogrid trail resulting in a reduction in impediments to hydrology is similar to what is described in CMWAA6 and presented in the above photographs.

Landscape Disturbance (V_{LD})

CMWAA8 and CMWAA9 contain 18.6 and 18.5 acres, respectively, of existing anthropogenic landscape disturbance within the 800-meter-radius plot (4 percent of each plot area). In the post-mitigation condition, disturbance related to the trail would be removed but disturbance from the new geogrid trail would be added. The total acreage of disturbance in the post-mitigation plot is estimated to be 1.0 acre (0 percent of each plot area). Based on the NS Assessment Method, the small acreage of new disturbance would result in a 1.00 for the VLD subindex score. The rationale for the new geogrid trail resulting in reduction in landscape disturbance is similar to what is described in CMWAA6 and presented in the above photographs.

Other Variables

Current, CMWAA8 and CMWAA9 have no anthropogenically-derived surface water (V_{SW}) in the 80-meter-radius plot. No sources of dust occur within 80 meters, and no dust is visible on the aerial imagery (V_{DD}). No thermokarst is visible in the aerial imagery (V_{TK}). The plots contain include no impediments to wildlife movement (V_{IW}). The sites are more than 800 meters from the nearest road (V_{DR}).

In the post-mitigation condition, no change would occur to anthropogenically-derived surface water, evidence of dust, evidence of thermokarst, impediments to wildlife, or distance to roadway.

Assessment Scores and Average Score

The average pre-assessment score for CMWAA8 is estimated to be 0.47; the average post-assessment score is anticipated to be 0.97 within 6 to 10 years. The average pre-assessment score for CMWAA9 is estimated to be 0.45; the average post-assessment score is anticipated to be 0.97 within 6 to 10 years. Based on these values, the FCI Δ for CMWAA8 and CMWAA9 would be 0.50 and 0.52, respectively.

3.2.1.4 Credit Analysis

Following the Alaska District: Credit Debit Methodology, the FCI Δ for mitigation projects is adjusted through application of time lag and risk factors to determine the overall credits gained.

Risk

In the Alaska District: Credit Debit Methodology, mitigation risk accounts for the degree of uncertainty that the proposed conditions will be achieved. Risk is measured on a scale from 1.0 (no or *de minimis* risk) to 3.0 (high risk). The Nuiqsut Subsistence Trail Project would be subject to moderate risk (1.75) risk of success due to the absence of a traditional site protection instrument and the potential for future impacts associated with ATV use adjacent to or stemming from the geogrid trail.

CPAI assigned a risk of +0.50 to the project due to the lack of a traditional site protection instrument. The portion of the project located on private lands owned by the local village native corporation and public lands managed by the Bureau of Land Management (BLM) would experience only a slight increase in risk associated with lack of a protection instrument. Consistent with the recent Memorandum of Agreement (MOA) between the USACE and Environmental Protection Agency. As outlined in the MOA:

Compensatory mitigation projects on public land must be based solely on aquatic resource functions provided by compensatory mitigation projects that are over and above the aquatic resource functions already being provided by the public land in accordance with how that land is currently being managed by the responsible land management entity (see 33 CFR Part 332.3(a)(3) and 40 CFR Part 230.93(a)(3)). For example, compensation credit could be generated by implementing aquatic resource restoration or enhancement projects on public lands that are not currently being planned or by providing additional levels of protection to publically held sites. (USACE and USEPA 2018 pg. 6)

The portion of the Nuiqsut Subsistence Trail Project located on BLM-managed land would benefit from enhanced functions because there are no known enhancement projects planned for the area, and the lands do not require additional levels of protection because of the stewardship provided by the BLM. The BLM and the USACE would have discretion in permitting projects that could result in impacts to the enhanced functions of wetlands associated with the Nuiqsut Subsistence Trail Project. Furthermore, the BLM is required to consider protection of important surface resources and uses, such as land used for subsistence purposes such as the Nuiqsut Subsistence Trail as part of its applicable NPR-A land management laws and regulations including the Naval Petroleum Reserves Production Act², Section 302 of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.)³, and Section 810 of the Alaska National Interest Lands Conservation Act (16 U.S.C. 3101).⁴ These laws and regulations would provide additional protection to the Nuiqsut Subsistence Trail Project.

CPAI assigned an additional risk of +0.25 due to the potential for future or ongoing impacts related to ATV adjacent to or stemming from the new geogrid trail. Based on discussion with local residents who use the existing trail, support for construction of the geogrid trail is high. The geogrid would provide a more reliable and efficient method of accessing subsistence resources in the area and would reduce delays and/or increased equipment maintenance costs associated with navigating through currently rutted and boggy trail. Residents may occasionally leave the trail to pursue subsistence resources but it is unlikely that this would occur repeatedly in the same location, thus avoiding conditions under which tundra damage is likely. Moreover, the cumulative impacts from future rutting and web effect tundra damage would be much greater in the absence of a geogrid system. It is anticipated the central geogrid system will allow trail users to be more selective about where they would divert to access subsistence resources, which would further minimize the potential for future impacts.

Based on these factors, the total risk factor used in an adjusted FCI Δ is 1.75.

² Provides that the Secretary “shall assume all responsibilities” for “any activities related to the protection of environmental, fish and wildlife, and historical or scenic values” and authorizes the Secretary to “promulgate such rules and regulations as he deems necessary and appropriate for the protection of such values within the Reserve.”

³ Describes the broad authority of the Secretary of the Interior to regulate the use, occupancy, and development of public lands and to take whatever action is required to prevent unnecessary or undue degradation of public lands (43 U.S.C. 1732).

⁴ Establishes procedures for federal land management agencies to evaluate the effect of federal actions on subsistence uses and needs, the availability of other lands for the purposes sought to be achieved, and other alternatives that would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes (16 U.S.C. 3120).

Time Lag

Based on the Alaska Debit-Credit Methodology, time lag means the period of time (in years) between when the functions are lost at an impact site and when the compensatory mitigation site has achieved the outcome that was scored using the appropriate functional or conditional assessment methodology. A project that would meet success criteria in 1 year or less would receive an adjustment factor of 1.0.

Based on the success of the similar project in Utqiagvik, this project may attain success criteria within 2 years of construction; however, the Nuiqsut project's current conditions appear somewhat worse, especially on the eastern half near Nuiqsut infrastructure, than those experienced in Utqiagvik. Therefore, CPAI has conservatively estimated the time lag to achieve functional uplift described above as 6 to 10 years. Therefore, the Nuiqsut Subsistence Trail Project would experience an adjusted FCI delta based on a Time Lag factor of 1.0876.

Credit Analysis Summary

Based on the acreages and FCI scores described above, the Nuiqsut Subsistence Trail mitigation project would gain 28.7 credits (Table 3-12). The adjusted FCI is based on an assumed time lag of 6 to 10 years (relative to when Willow Project impacts occur) to achieve post-mitigation project conditions. The risk of the project is minor to moderate (1.75). Additional information regarding time lag and risk is provided below.

Table 3-12. Nuiqsut Subsistence Trail Credit Analysis

Disturbance Class ^a	HGM Class	Representative Points	Acres	Pre FCI	Post FCI	FCI Δ	Adjust. Δ	Credits
Disturbed 80m	Flat	CMWAA6	13.5	0.10	0.64	0.54	0.28	3.8
Disturbed 800m	Depression	CMWAA7	2.1	0.49	0.70	0.21	0.11	0.2
Undisturbed	Flat	CMWAA8	75.9	0.47	0.97	0.50	0.26	19.9
Undisturbed	Depression	CMWAA9	17.5	0.45	0.97	0.52	0.27	4.8
Totals			109.0	-	-	-	-	28.7

^a Disturbance class based on distance from existing infrastructure (e.g., roads, pipelines).

Notes: HGM: hydrogeomorphic; FCI: functional capacity index; Δ: change.

3.2.2 Nuiqsut Culvert Repair

Table 3-13 provides wetland function score data calculated for each representative point for the Culvert Repairs compensatory mitigation project. The evaluation included one site, CMWAA1, which assessed areas of potential functional lift due to repair of culverts at up to four road crossings. The full suite of variable data is provided in the electronic data forms in Appendix A.

Table 3-13. Nuiqsut Culverts Repair Representative Points

Point	Disturbance Class ^a	HGM Class	Lat. (°N)	Long. (°W)	Pre/Post	Habitat Score	Hydro. Score	BGC Score	FCI
CMWAA1	Disturbed 80m	Riverine	70.2179	-150.9986	Pre	0.17	0.00	0.00	0.06
					Post	0.17	0.42	0.00	0.20

^a Disturbance class based on distance from existing infrastructure (roads, pipelines, etc.).

Notes: HGM: hydrogeomorphic; Lat.: latitude; °N: degrees North; Long.: longitude; °W: degrees West; m: meters; Hydro.: hydrology; BGC: biogeochemical cycling; FCI: functional capacity index.

Representative point CMWAA1 is in a riverine-HGM class area immediately west of one of the culverts that would be repaired by the Culvert Repair mitigation project (Figure 17). The area has existing gravel fill and other anthropogenic disturbance both upstream, downstream, and to either side. Table 3-14 provides the NS Assessment Method variables, subindex scores, and assessment scores for CMWAA1.

Table 3-14. CM Wetland Assessment Area 1

Variables			Pre	Post
80-m radius plot	1. V _{LLD}	Local Landscape Disturbance	42%	42%
		V _{LLD} Subindex score	0.00	0.00
	2. V _{SW}	Anthropogenically-derived surface water	29%	0%
		V _{SW} Subindex Score	0.00	1.00
	3. V _{IH}	Impediment to Hydrology	4	4
800-m radius plot		V _{IH} Subindex Score	0.00	0.00
	4. V _{DD}	Evidence of Dust	Yes	Yes
	5. V _{TK}	Evidence of Thermokarst	Yes	Yes
	6. V _{LD}	Landscape Disturbance	19%	19%
		V _{LD} Subindex Score	0.69	0.69
800-m radius plot	7. V _{IW}	Impediment to Wildlife	4	4
		V _{IW} Subindex Score	0.00	0.00
	8. V _{DR}	Distance to Roadway	0 m	0 m
			0.00	0.00
Habitat Assessment Score			0.17	0.17
Hydrology Assessment Score			0.00	0.42
Biogeochemical Cycling Assessment Score			0.00	0.00
Average Score			0.06	0.20

Anthropogenically-Derived Surface Water (V_{SW})

At present, CMWAA1 contains 1.4 acres of anthropogenically-derived surface water in the 80-meter-radius plot. In post-condition, anthropogenically-derived surface water would decrease to zero as the culverts would be replaced and brought up to current and appropriate hydraulic design.

Other Variables

At present, CMWAA1 contains 2.1 acres of existing local landscape disturbance (V_{LLD}) in the 80-meter-radius plot and 92.5 acres of existing anthropogenic landscape disturbance (V_{LLD}) within the 800-meter-radius plot. Impediments to hydrology occur in all four quadrants (V_{IH}) from gravel roads and pads in Nuiqsut. Thermokarst is visible in the aerial imagery where ponded water has increased underlying substrate temperatures (V_{TK}). Dust is visible adjacent to gravel fill (V_{DD}). CMWAA1 contains impediments to wildlife movement in all four quadrants (V_{IW}). The plot is less than 1 meter from the closest road (V_{DR}).

In post-condition, repair of the existing culverts would substantially reduce the degree to which existing infrastructure serve as impediments to hydrology. However, because those impediments would still exist, although the degree to which they would impede hydrology would be reduced, there would be no change in the number of impediments to hydrology identified on the NS Assessment Method data forms. No change would occur to local landscape disturbance, evidence of dust, evidence of thermokarst, landscape disturbance, impediments to wildlife, or distance to roadway.

Based on the values above, the FCI Δ for CMWAA1 would be 0.14.

Credit Analysis

Based on the acreages and FCI scores described above, the Culvert Repair mitigation project would gain 1.7 credits (Table 3-15). The adjusted Δ is based on an assumed time lag of 1 year (relative to when Project impacts occur) to achieve post-mitigation project conditions. The risk of the project is *de minimis*.

Table 3-15. Nuiqsut Culvert Repair Credit Analysis

Disturbance Class ^a	HGM Class	Representative Points	Acres	Pre FCI	Post FCI	FCI Δ	Adjust. Δ	Credits
Disturbed 80m	Riverine	CMWAA1	11.8	0.06	0.20	0.14	0.14	1.7

^a Disturbance class based on distance from existing infrastructure (e.g., roads, pipelines).

Notes: HGM: hydrogeomorphic; FCI: functional capacity index; Δ : change.

3.2.3 Fish Creek or Cape Halkett Preservation

CPAI evaluated both preservation options (Fish Creek and Cape Halkett) following the example and guidance provided in Section 5.3 of the NS Assessment Method (Berkowitz et al., 2017) and direction provided by Sections 3.2 and 7.2.2 of the Alaska District Credit Debit Methodology (USACE, 2016).

In accordance with the methodology, a reasonable development must be considered that would occur in the absence of preservation. To meet this part of the process CPAI proposed a development scenario based on past experience developing oil and gas resources on the North Slope. A development scenario constructed at Fish Creek or Cape Halkett is likely to contain some or all of the following infrastructure:

- Central processing facility
- One or more drillsites
- Airstrip
- Operations center
- Infield roads connecting facilities
- Valve pads at stream crossings
- A material site, and
- Constructed freshwater reservoir

- Subsistence turnouts and boat ramps

A project with some or all these features is estimated to occupy between 50 and 150 acres of gravel fill depending on the specific site, development constraints, and other considerations. CPAI selected an average development footprint of 100 acres within the 800-acre preservation area to evaluate the credits that could be calculated if that footprint were preserved.

3.2.3.1 Wetland Assessment Areas and Functional Capacity Index Estimates

Three wetland assessment areas are evaluated in this analysis. The first is wetlands and other WOUS that would be within the fill footprint of the 100-acre development scenario. The pre-project FCI score (without preservation) using the NS Assessment Method would equal 0.0 because the area would be converted to upland through placement of gravel fill. Because the preservation areas have no existing impacts, the post-project FCI score (with preservation) would equal 1.0. The pre- and post-project FCI scores would thus return an FCI Δ of +1.0 for each acre of wetlands and other WOUS that would be filled according to the development scenario (Table 3-16).

Table 3-16. Preservation Wetland Assessment Areas

Assessment Area	Acres	FCI without Preservation	FCI with Preservation	FCI Δ
Development footprint	100	0.00	1.00	1.00
Indirect impact buffer	7	0.90	1.00	0.10

Notes: FCI: functional capacity index; Δ : change.

CPAI also considered credits generated through avoidance of indirect effects to areas adjacent to the hypothetical development scenario. The size of the indirect buffer area is dependent on the buffer distance and the spatial orientation of the development footprint. For example, a development footprint with a long linear feature, such as a gravel road) would have a larger buffer area than a more compact footprint. Because a spatial layout for the development footprint has not been created, CPAI opted to estimate the size of the buffer area conservatively by assuming the most compact shape for the 100-acre development footprint, a square. Consistent with evaluation of indirect debits resulting from the Willow Project (Section 2.5), CPAI used a buffer distance of 35-feet, resulting in a hypothetical indirect impact area of 7 acres.

Consistent with the evaluation of indirect impacts for the Willow Project, CPAI assumed that without preservation, the FCI score would be reduced by 10 percent due to indirect effects (i.e. the FCI without preservation would equal 0.90). With preservation, the FCI score for the indirect impact area would be 1.00 as it would be pristine (Table 3-16).

3.2.3.2 Preservation Adjustment Factor

An FCI Δ of +1.0 would typically net 1 credit per acre of WOUS preserved. However, the Alaska District: Credit Debit Methodology applies a “preservation adjustment factor” (PAF) to credits gained. The PAF discounts credits based on the level of threat to an area (with preservation of areas under lower threat receiving fewer credits) and ecological significance (with preservation of areas with lower ecological significance also receiving fewer credits). The PAF represents a number between 0.0 and 1.0,

and represents the sum of the threat and the ecological significance scores (Table 3-17). The FCI Δ is multiplied by the PAF to create a preservation-adjusted FCI Δ used to determine the credits that would be generated by preservation of each site.

Table 3-17. Fish Creek or Cape Halkett Preservation Adjustment Factor Determination

Criteria ^a	Fish Creek	Cape Halkett
<i>Threat (select highest applicable threat score)</i>		
Demonstrated land use trend within the boundaries of an incorporated city, town, or borough. (Example: Platted land zoned for development); or Demonstrated threat of mining activities through extensive prospecting, which indicates there are economically recoverable reserves/commodities; or Demonstrated threat of oil/gas activities through exploration activities, which indicate there are economically recoverable reserves. (0.3 pts.)	–	–
Demonstrated land use trend locally or regionally resulting in destruction or alteration of aquatic resources outside of incorporated areas; or Demonstrated threat of mining activities through sampling, i.e. sampling of water quality constituents, which indicate there are economically valuable reserves/commodities. (0.2 pts.)	0.2	0.2
Inholdings within regionally important publicly held lands (0.1 pt.)	–	–
<i>Threat Score Total</i>	0.2	0.2
<i>Ecological Significance (select all that apply)</i>		
Aquatic resources that are adjacent to or connect regionally important publicly held lands. (0.1 pt.)	0.1	0.1
Site contains aquatic resources that have been identified as significant or productive within a specified Ecoregion. (0.3 pts.)	0.3	0.3
Aquatic resources that provide habitat important to species that have some special (Federal, State, or local) designation or importance. (0.2 pts.)	0.2	0.2
Scarcity of Aquatic Resource Type. (0.1 pt.)	0.1	0.1
<i>Ecological Significance Score Total</i>	0.7	0.7
Preservation Adjustment Factor Total (sum of threat and ecological significance)	0.9	0.9

^a Defined in the Alaska District: Credit Debit Methodology (USACE 2016).

Notes: pts: points.

CPAI applied a threat score of 0.2 for both the Fish Creek and the Cape Halkett preservation areas (Table 3-17). Specifically, both areas are located on lands outside of an incorporated city or town (but within an incorporated borough) that have a demonstrated land use trend locally or regionally resulting in destruction or alteration of aquatic resources. In addition, the Fish Creek area is located within the CRU and on leases purchased by CPAI, demonstrating the existence of financial interest in resources in the area.

CPAI applied an ecological significance score of 0.7 for Fish Creek and 0.6 for Cape Halkett (Table 3-17). Both areas contain aquatic resources that have been identified as significant or productive and provide habitat to species that have some special designation or importance. The Fish Creek area abuts and directly supports Fish Creek, which is an anadromous stream listed in the Anadromous Waters Catalog and that supports chum salmon, Chinook salmon, pink salmon, broad whitefish, Dolly Varden, and humpback whitefish (ADF&G 2020) that are categorized by ADF&G as Species of Greatest

Conservation Need (ADF&G 2015). Both sites support species such as caribou that are subsistence resources of major importance to Nuiqsut, Utqiagvik, and other North Slope communities (BLM 2020b, Appendix E.16, pg. 23, 46). Both Fish Creek and Cape Halkett are documented within the ranges of subsistence activities for Utqiagvik and Nuiqsut (BLM 2020b, Appendix E.16, pg. 4, 27). Furthermore, both sites are adjacent to regionally-important publicly held lands within the NPR-A and adjacent to and functionally similar to lands that have been identified as biologically sensitive in previous and current BLM Integrated Activity Plan documents for the NPR-A (Stipulations K-1- River Setbacks and K-5 Coastal Areas) (BLM 2013, BLM 2020a).

The Fish Creek area contains tidally influenced estuarine habitat, an uncommon aquatic resource type on the Alaska North Slope. Artic tidal marshes have been identified as a wetland of conservation concern in Alaska (Flagstad et al. 2018). Wetland types at Cape Halkett are also uncommon. The preservation area at Cape Halkett contains a high proportion of freshwater herbaceous permanently flooded or semi-permanently flooded wetland types. Specifically, PEM1F or PEM1H wetlands make up 57 percent of the total preservation area based on National Wetland Inventory mapping (USFWS 2020) as compared to just 26 of areas mapped within the vicinity of the Willow Project (ABR 2020). Permanently flooded or semi-permanently flooded freshwater emergent wetlands and waterbodies in the preservation area may also support *Arctophila fulva*-dominated communities, which have been observed in the Cape Halkett area. *Arctophila fulva* wetlands are widely considered to be relatively scarce and highly valuable habitat for birds of the Alaskan Arctic Coastal Plain. Based on wetland types present at Cape Halkett with consideration for its coastal location and availability for preservation based on private ownership, the aquatic resources in the Cape Halkett preservation area are uncommon.

3.2.3.3 Preservation Credit Analysis

Based on a PAF of 0.9 and an average development footprint of 100 acres, preservation of either the Fish Creek or Cape Halkett area would generate 90 credits within the development scenario fill footprint (Table 3-18). Inclusion of credits generated within the indirect impact buffer area would increase credits gained by 0.6. Calculated credits are based on an assumed time lag of 1 year or less (relative to when Willow Project impacts occur) and *de minimis* project risk. In total, preservation of 800 acres at either Fish Creek or Cape Halkett would generate 90.6 credits based on a 100-acre development footprint.

Table 3-18. Fish Creek or Cape Halkett Preservation Credit Analysis

Preservation Area	Assessment Area	Acres ^a	Pre FCI	Post FCI	FCI Δ	PAF	Adjust. Δ	Credits ^b
Fish Creek or Cape Halkett	Development footprint	100	0.00	1.00	1.00	0.9	0.90	90.0
	Indirect impact buffer	7	0.90	1.00	0.10	0.9	0.09	0.6
Preservation Area Total		800	-	-	-	-	-	90.6

^a Based on average development footprint and conservative assumption of buffer areas

Notes: FCI: functional capacity index; Δ: change; PAF: preservation adjustment factor.

4.0 CREDIT-DEBIT ANALYSIS SUMMARY

Based on the wetland assessment area acreages and the changes in FCI scores developed above, CPAI estimates that the Willow Project would incur 133.9 debits. The two enhancement mitigation projects would gain a total of 30.4 credits while preservation of 800 acres at either Fish Creek or Cape Halkett would gain an additional 90.6 credits. Table 4-1 summarizes the estimated for the proposed Willow Project and credits estimated for the two compensatory mitigation projects described in this document. A full accounting of total debits and credits for the Willow Project and all proposed mitigation projects is provided in CPAI's Wetlands Compensatory Mitigation Plan.

Table 4-1. Willow Project Debit and Compensatory Mitigation Credit Summary

Area	Direct Impact Acres (acres)	Indirect Impact Area (acres)	Debits	Credits
Phase 1 Willow Project Impacts				
Wetlands and Waters within 500-feet of Anadromous Fish-Bearing Waters	13.2	11.6	(14.0)	–
Wetlands and Waters in the TLSA	32.2	19.9	(34.2)	–
Wetlands and Waters in the CRSA	8.1	9.3	(9.0)	–
<i>Phase 1 Subtotals</i>	<i>53.5</i>	<i>40.7</i>	<i>(57.2)</i>	<i>–</i>
Phase 2 Willow Project Impacts				
Wetlands and Waters within 500-feet of Anadromous Fish-Bearing Waters	1.7	2.9	(2.0)	–
Wetlands and Waters in the TLSA	67.6	71.4	(74.7)	–
<i>Phase 2 Subtotals</i>	<i>69.3</i>	<i>74.2</i>	<i>(76.7)</i>	<i>–</i>
Phase 1 and Phase 2 Willow Project Impacts				
Phase 1 and Phase 2 Willow Project Impact Total	122.8	115.0	(133.9)	–
Mitigation Project Credits				
Nuiqsut Subsistence Trail Rehabilitation	109.0	–	–	28.7
Nuiqsut Culvert Repair (voluntary)	11.8	–	–	1.7
Fish Creek or Cape Halkett Preservation ^a	800	–	–	90.6

Note: TLSA: Teshekpuk Lake Special Area; CRSA: Colville River Special Area.

^a CPAI to select one of two options.

5.0 REFERENCES

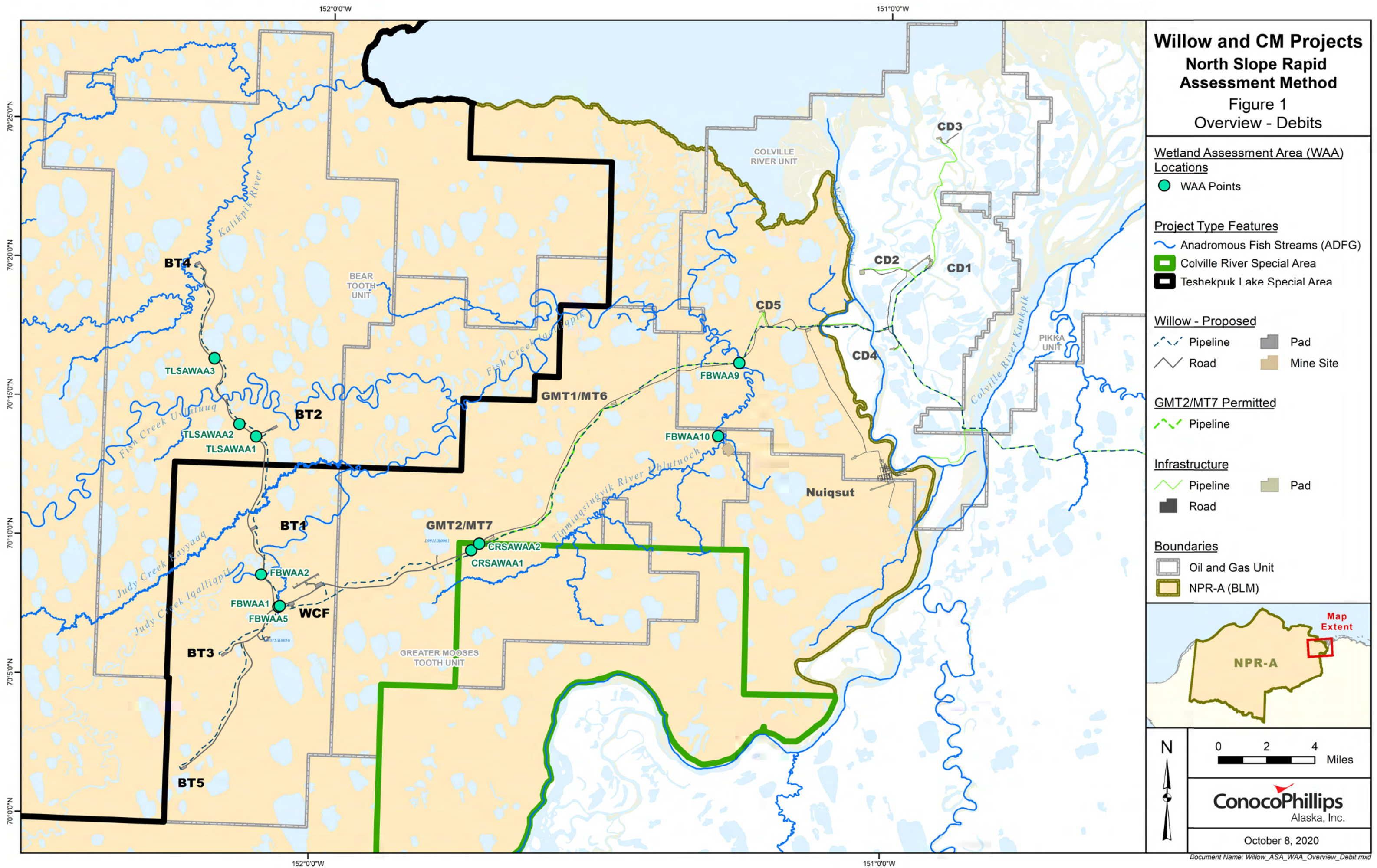
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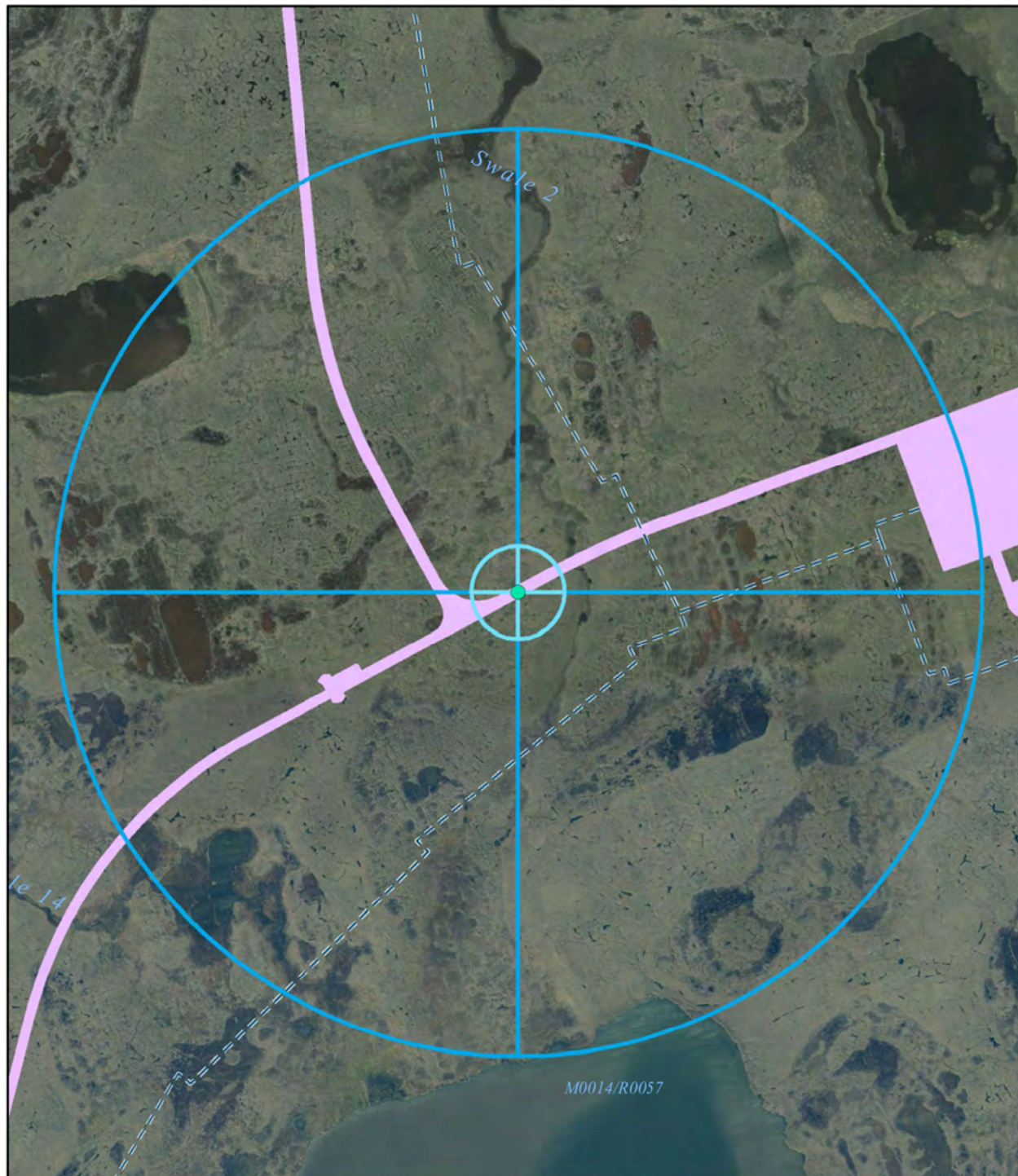
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Figures

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Willow and CM Projects North Slope Rapid Assessment Method

Figure 2

FBWAA1: Fish-Bearing Waters (Anadromous)

Willow - Proposed

- Pipeline
- Gravel Footprint
- Bridge*

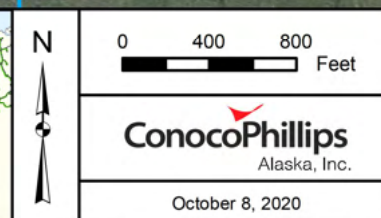
Infrastructure

- GMT2/MT7 Permitted Pipeline
- GMT2/MT7 Road
- GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

- WAA Points
- WAA 80m Buffer
- WAA 800m Buffer
- Anthropogenically - Derived Surface Water
- Disturbed Area

Imagery: Quantum Spatial 2018
*No fill below OHW



Document Name: Willow_ASA_WAA_MapBook.mxd



Willow and CM Projects North Slope Rapid Assessment Method

Figure 3

FBWAA2: Fish-Bearing Waters (Anadromous)

Willow - Proposed

- Pipeline
- Gravel Footprint
- Bridge*

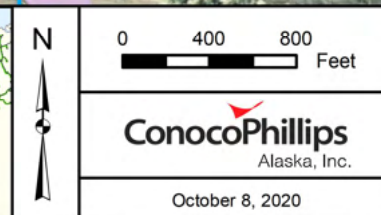
Infrastructure

- GMT2/MT7 Permitted Pipeline
- GMT2/MT7 Road
- GMT2/MT7 Pad

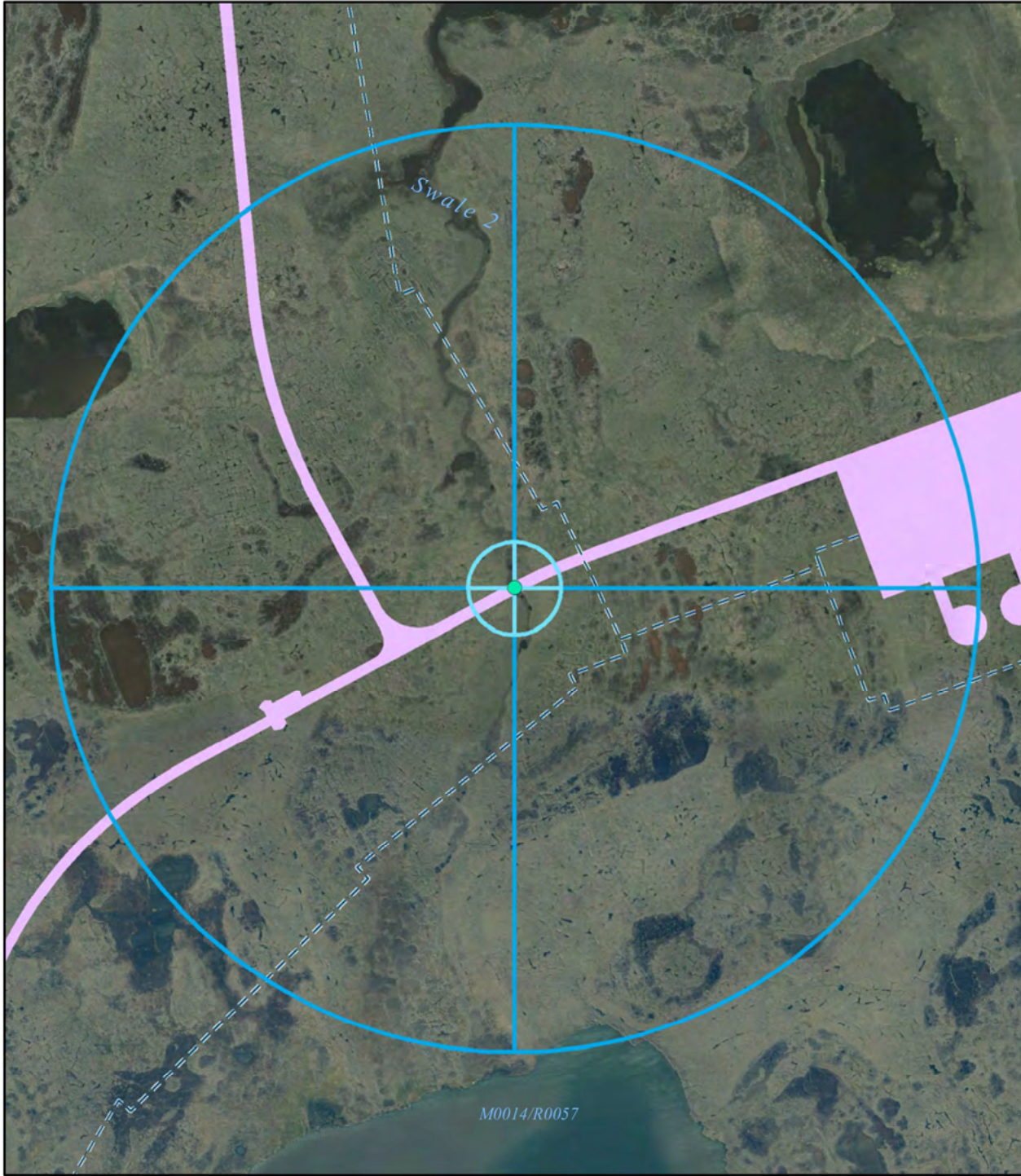
Wetland Assessment Area (WAA) and Project Area

- WAA Points
- WAA 80m Buffer
- WAA 800m Buffer
- Anthropogenically - Derived Surface Water
- Disturbed Area

Imagery: Quantum Spatial 2018
*No fill below OHW



Document Name: Willow_ASA_WAA_MapBook.mxd



Willow and CM Projects North Slope Rapid Assessment Method

Figure 4

FBWAA5: Fish-Bearing Waters (Anadromous)

Willow - Proposed

- Pipeline
- Gravel Footprint
- Bridge*

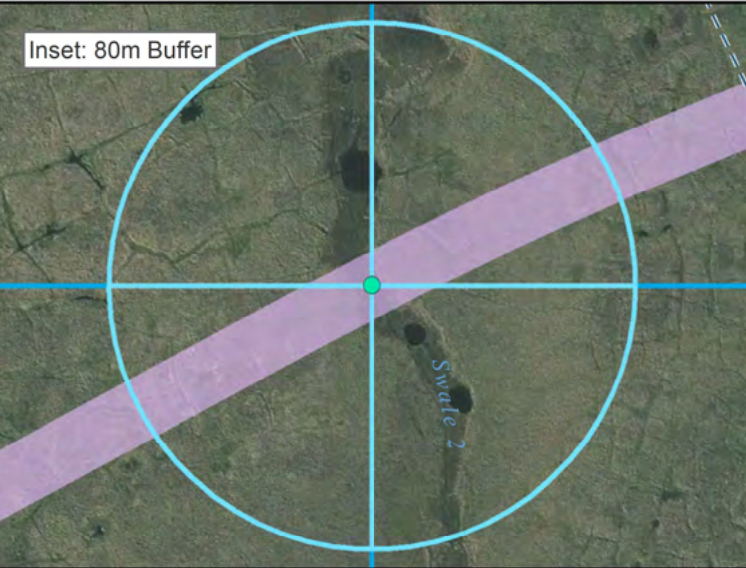
Infrastructure

- GMT2/MT7 Permitted Pipeline
- GMT2/MT7 Road
- GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

- WAA Points
- WAA 80m Buffer
- WAA 800m Buffer
- Anthropogenically - Derived Surface Water
- Disturbed Area

Imagery: Quantum Spatial 2018
 *No fill below OHW

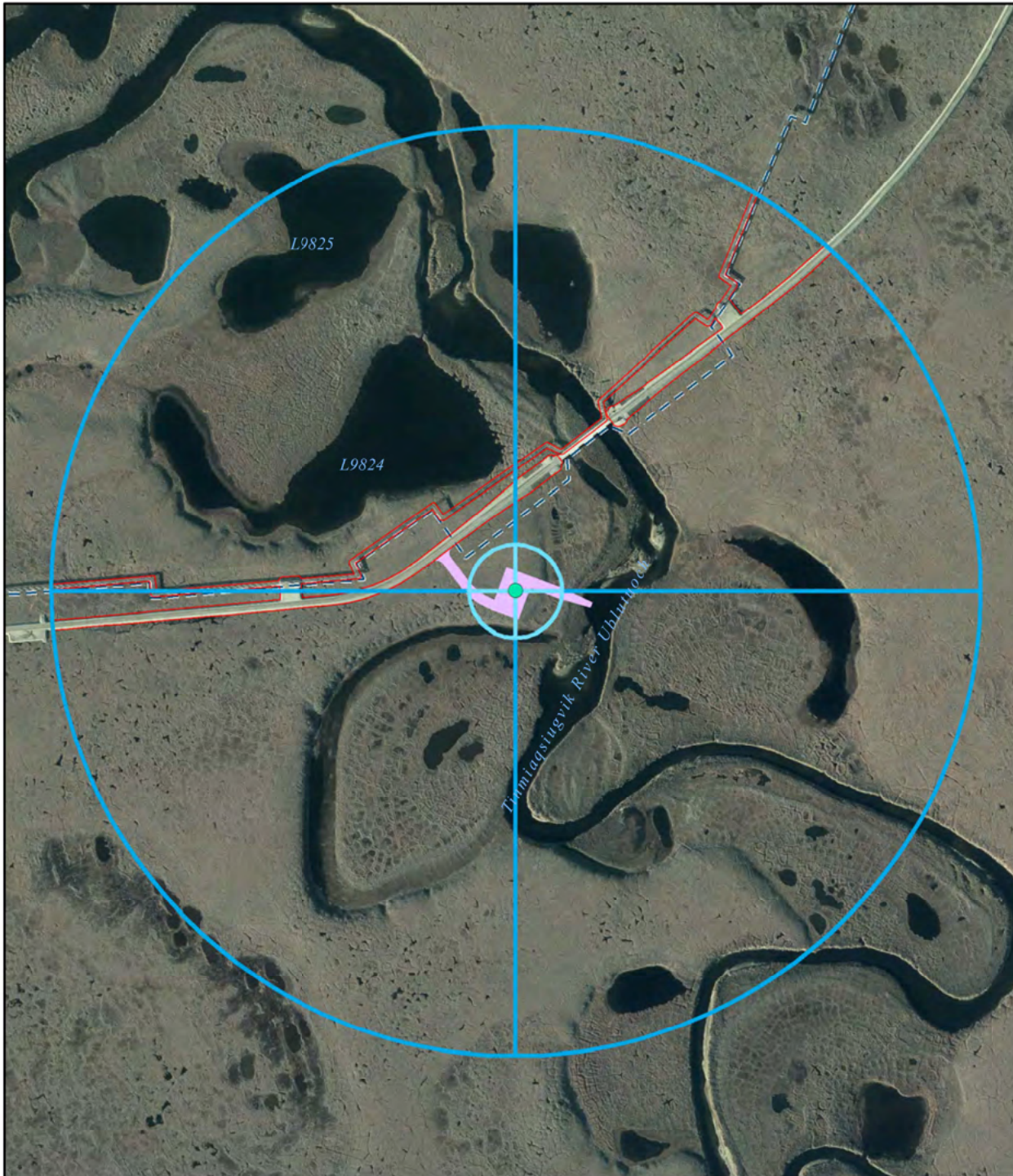


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ConocoPhillips
Alaska, Inc.

October 8, 2020



Willow and CM Projects North Slope Rapid Assessment Method

Figure 5

FBWAA9: Fish-Bearing Waters (Anadromous)

Willow - Proposed

- Pipeline
- Gravel Footprint
- Bridge*

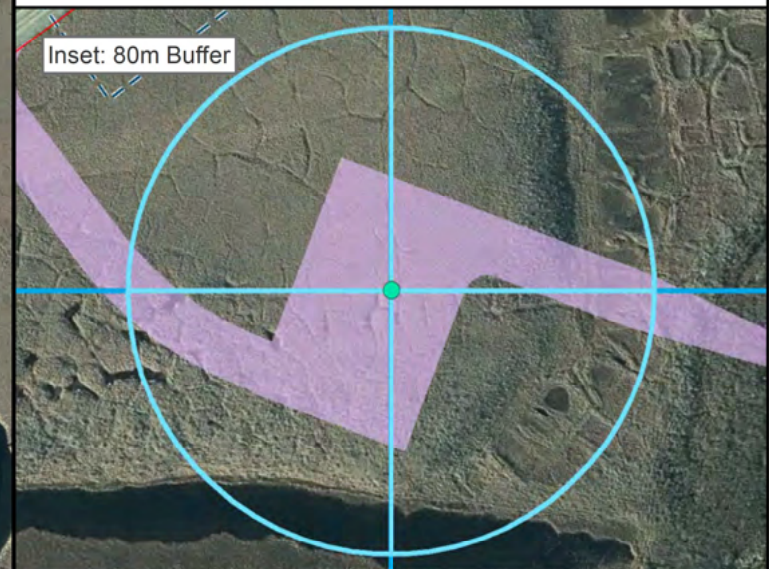
Infrastructure

- GMT2/MT7 Permitted Pipeline
- GMT2/MT7 Road
- GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

- WAA Points
- WAA 80m Buffer
- WAA 800m Buffer
- Anthropogenically - Derived Surface Water
- Disturbed Area

Imagery: Quantum Spatial 2018
*No fill below OHW






Willow and CM Projects North Slope Rapid Assessment Method

Figure 6

FBWAA10: Fish-Bearing Waters (Anadromous)

Willow - Proposed

-  Pipeline
-  Gravel Footprint
-  Bridge*

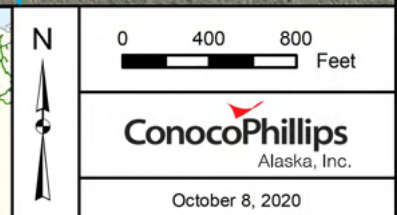
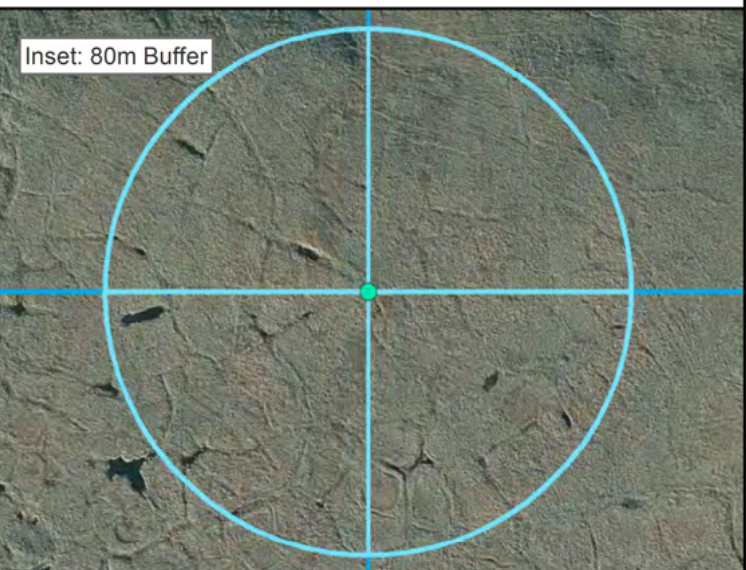
Infrastructure

-  GMT2/MT7 Permitted Pipeline
-  GMT2/MT7 Road
-  GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

-  WAA Points
-  WAA 80m Buffer
-  WAA 800m Buffer
-  Anthropogenically - Derived Surface Water
-  Disturbed Area
-  Subsistence Trail Tundra Rehabilitation

Imagery: Quantum Spatial 2018
*No fill below OHW





Willow and CM Projects North Slope Rapid Assessment Method

Figure 7

TLSAWAA1: Teshekpuk Lake Special Area

Willow - Proposed

- Pipeline
- Gravel Footprint
- Bridge*

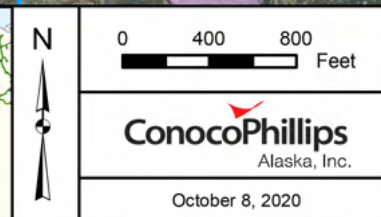
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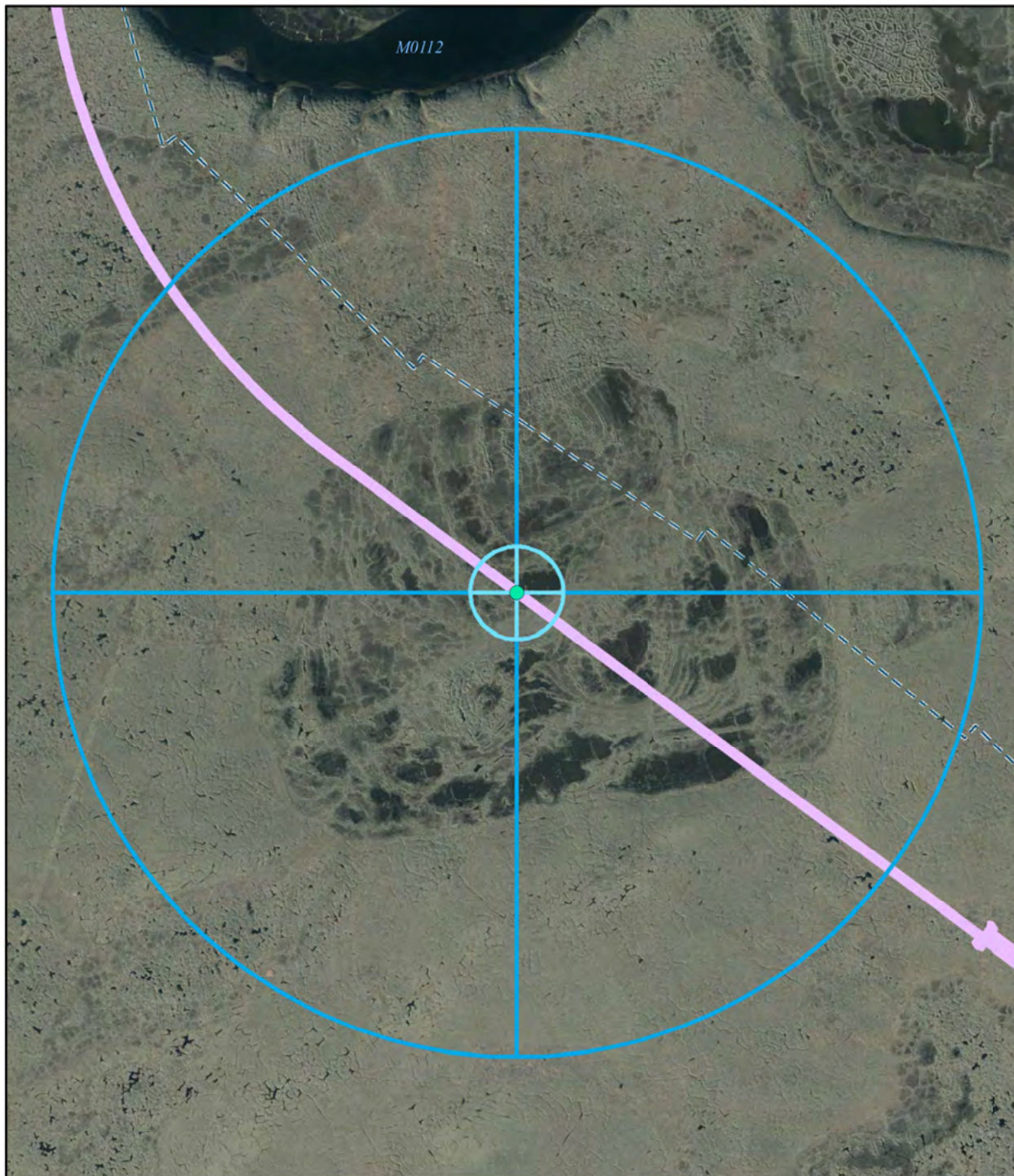
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- GMT2/MT7 Road
- GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

- WAA Points
- WAA 80m Buffer
- WAA 800m Buffer
- Anthropogenically - Derived Surface Water
- Disturbed Area
- Teshekpuk Lake Special Area

Imagery: Quantum Spatial 2018
 *No fill below OHW





Willow and CM Projects North Slope Rapid Assessment Method

Figure 8

TLSAWAA2: Teshekpuk Lake Special Area

Willow - Proposed

- Pipeline
- Gravel Footprint
- Bridge*

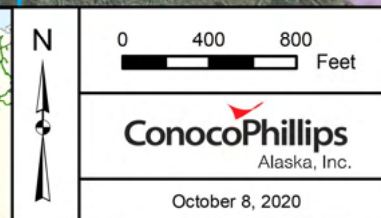
Infrastructure

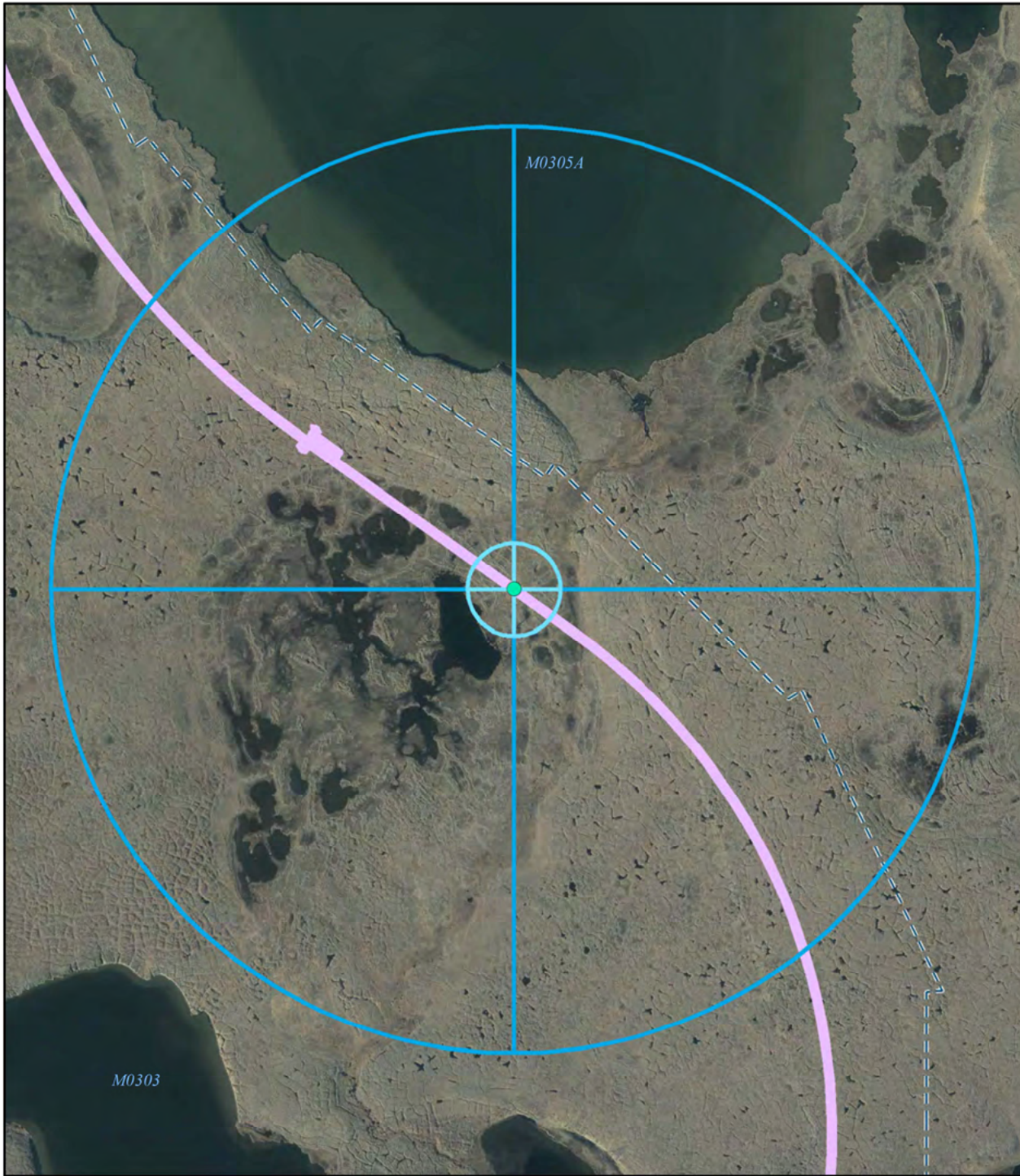
- GMT2/MT7 Permitted Pipeline
- GMT2/MT7 Road
- GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

- WAA Points
- WAA 80m Buffer
- WAA 800m Buffer
- Anthropogenically - Derived Surface Water
- Disturbed Area
- Teshekpuk Lake Special Area

Imagery: Quantum Spatial 2018
 *No fill below OHW





Willow and CM Projects North Slope Rapid Assessment Method

Figure 9

TLSAWAA3: Teshekpuk Lake Special Area

Willow - Proposed

- Pipeline
- Gravel Footprint
- Bridge*

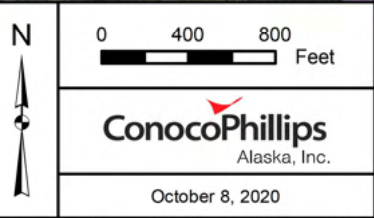
Infrastructure

- GMT2/MT7 Permitted Pipeline
- GMT2/MT7 Road
- GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

- WAA Points
- WAA 80m Buffer
- WAA 800m Buffer
- Anthropogenically - Derived Surface Water
- Disturbed Area
- Teshekpuk Lake Special Area

Imagery: Quantum Spatial 2018
 *No fill below OHW






Willow and CM Projects North Slope Rapid Assessment Method

Figure 10

CRSAWAA1: Colville River Special Area

Willow - Proposed

-  Pipeline
-  Gravel Footprint
-  Bridge*

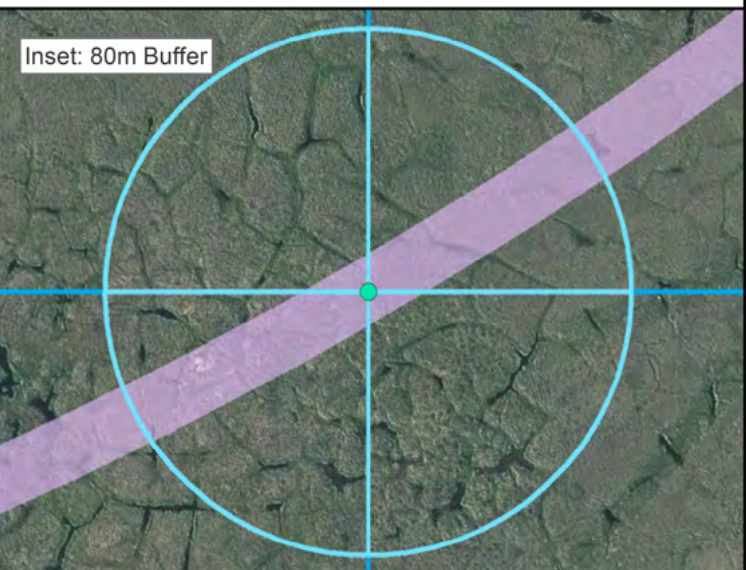
Infrastructure

-  GMT2/MT7 Permitted Pipeline
-  GMT2/MT7 Road
-  GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

-  WAA Points
-  WAA 80m Buffer
-  WAA 800m Buffer
-  Anthropogenically - Derived Surface Water
-  Disturbed Area
-  Colville River Special Area

Imagery: Quantum Spatial 2018
*No fill below OHW






Willow and CM Projects North Slope Rapid Assessment Method

Figure 11

CRSAWAA2: Colville River Special Area

Willow - Proposed

-  Pipeline
-  Gravel Footprint
-  Bridge*

Infrastructure

-  GMT2/MT7 Permitted Pipeline
-  GMT2/MT7 Road
-  GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

-  WAA Points
-  WAA 80m Buffer
-  WAA 800m Buffer
-  Anthropogenically - Derived Surface Water
-  Disturbed Area
-  Colville River Special Area

Imagery: Quantum Spatial 2018
*No fill below OHW

Inset: 80m Buffer



0 400 800
Feet

ConocoPhillips
Alaska, Inc.

October 8, 2020

Document Name: Willow_ASA_WAA_Mapbook.mxd

Willow and CM Projects
North Slope Rapid
Assessment Method
 Figure 12
 Overview - Credits

- Wetland Assessment Area (WAA)
Locations
 ● WAA Credit Point
- Compensatory Mitigation Proposed Projects
 ~ Subsistence Trail Rehabilitation
 □ Nuiqsut Culvert Repair
- Infrastructure
 ~ Pipeline ▢ Pad
 ■ Road
- Boundaries
 □ Oil and Gas Unit
 ▢ NPR-A (BLM)



N



0 2,000 4,000 Feet

ConocoPhillips
 Alaska, Inc.

August 19, 2020

Document Name: Willow_ASA_WAA_Overview_credit.mxd




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Willow and CM Projects North Slope Rapid Assessment Method

Figure 13

CMWAA6: Subsistence Trail Rehabilitation

Willow - Proposed

-  Pipeline
-  Gravel Footprint
-  Bridge*

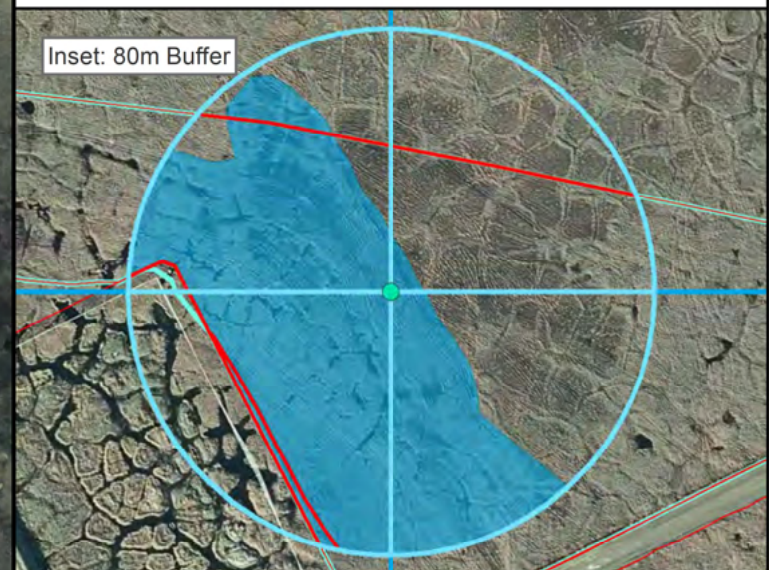
Infrastructure

-  GMT2/MT7 Permitted Pipeline
-  GMT2/MT7 Road
-  GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

-  WAA Points
-  WAA 80m Buffer
-  WAA 800m Buffer
-  Anthropogenically - Derived Surface Water
-  Disturbed Area
-  Subsistence Trail Tundra Rehabilitation

Imagery: Quantum Spatial 2018
*No fill below OHW






Willow and CM Projects North Slope Rapid Assessment Method

Figure 14

CMWAA7: Subsistence Trail Rehabilitation

Willow - Proposed

-  Pipeline
-  Gravel Footprint
-  Bridge*

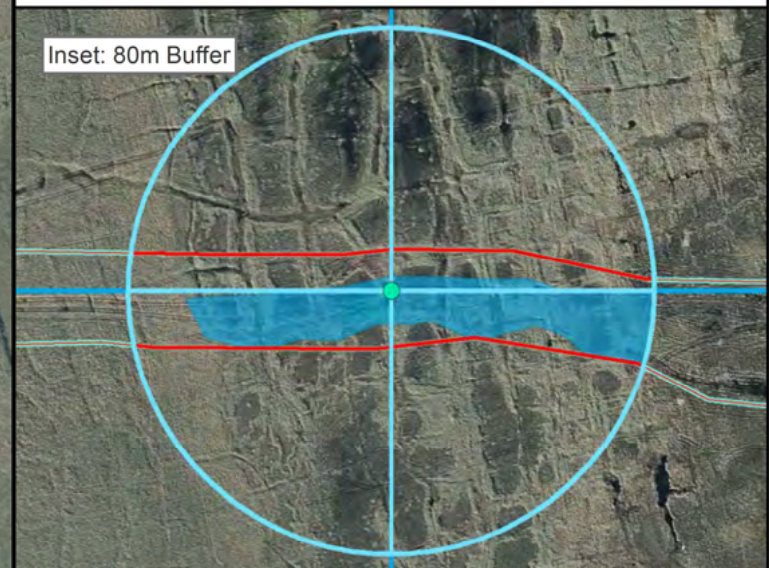
Infrastructure

-  GMT2/MT7 Permitted Pipeline
-  GMT2/MT7 Road
-  GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

-  WAA Points
-  WAA 80m Buffer
-  WAA 800m Buffer
-  Anthropogenically - Derived Surface Water
-  Disturbed Area
-  Subsistence Trail Tundra Rehabilitation

Imagery: Quantum Spatial 2018
*No fill below OHW






Willow and CM Projects North Slope Rapid Assessment Method

Figure 15

CMWAA8: Subsistence Trail Rehabilitation

Willow - Proposed

-  Pipeline
-  Gravel Footprint
-  Bridge*

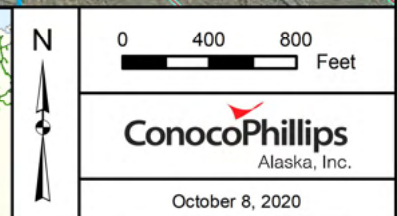
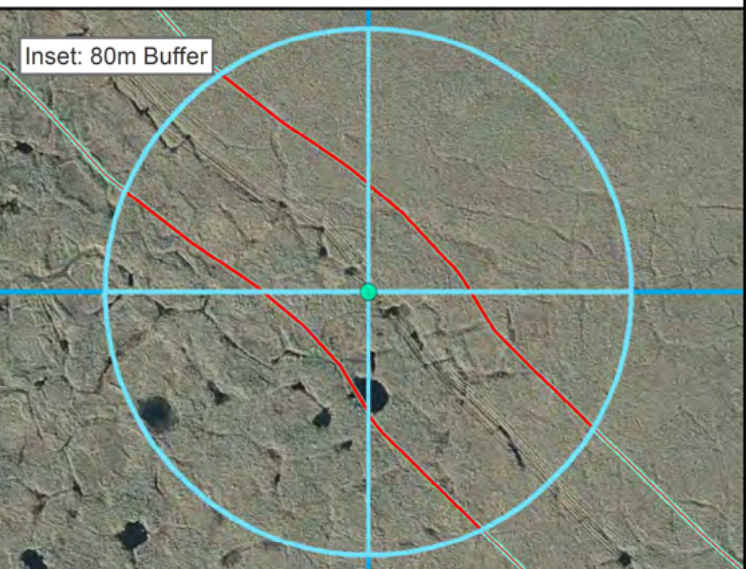
Infrastructure

-  GMT2/MT7 Permitted Pipeline
-  GMT2/MT7 Road
-  GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

-  WAA Points
-  WAA 80m Buffer
-  WAA 800m Buffer
-  Anthropogenically - Derived Surface Water
-  Disturbed Area
-  Subsistence Trail Tundra Rehabilitation

Imagery: Quantum Spatial 2018
*No fill below OHW






Willow and CM Projects North Slope Rapid Assessment Method

Figure 16

CMWAA9: Subsistence Trail Rehabilitation

Willow - Proposed

-  Pipeline
-  Gravel Footprint
-  Bridge*

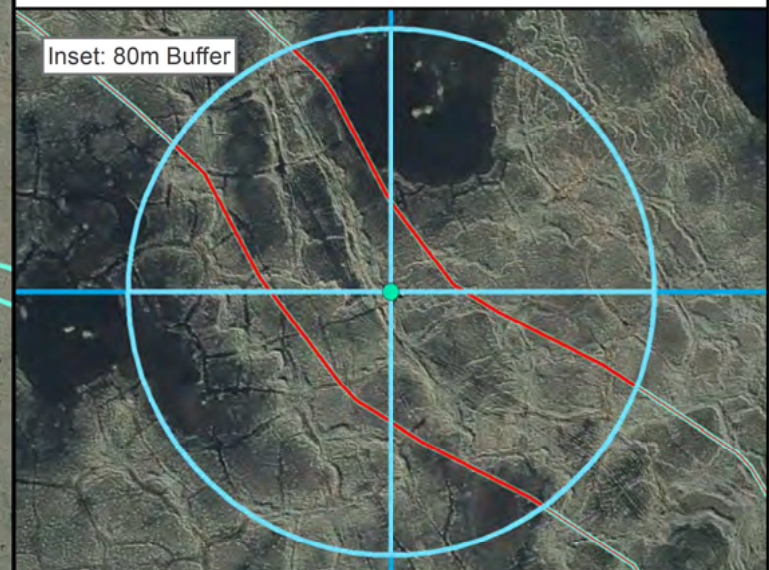
Infrastructure

-  GMT2/MT7 Permitted Pipeline
-  GMT2/MT7 Road
-  GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

-  WAA Points
-  WAA 80m Buffer
-  WAA 800m Buffer
-  Anthropogenically - Derived Surface Water
-  Disturbed Area
-  Subsistence Trail Tundra Rehabilitation

Imagery: Quantum Spatial 2018
*No fill below OHW






Willow and CM Projects North Slope Rapid Assessment Method

Figure 17

CMWAA1: Nuiqsut Culvert Repair

Willow - Proposed

-  Pipeline
-  Gravel Footprint
-  Bridge*

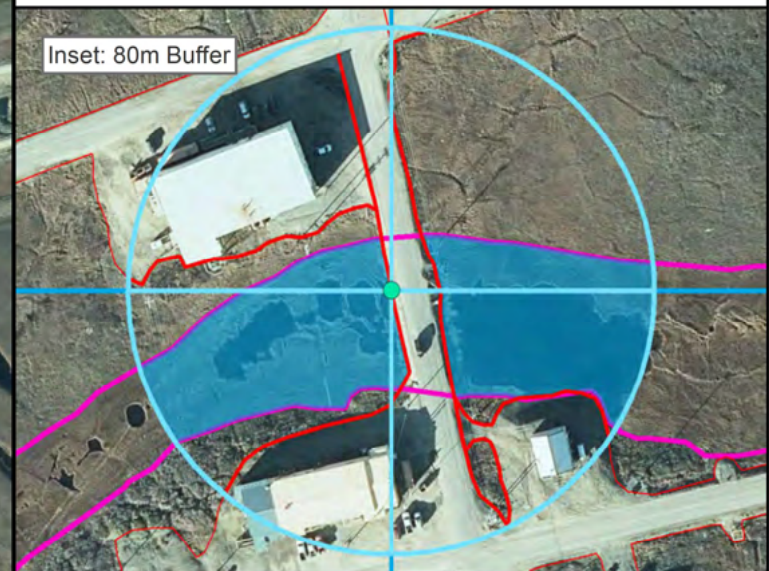
Infrastructure

-  GMT2/MT7 Permitted Pipeline
-  GMT2/MT7 Road
-  GMT2/MT7 Pad

Wetland Assessment Area (WAA) and Project Area

-  WAA Points
-  WAA 80m Buffer
-  WAA 800m Buffer
-  Anthropogenically - Derived Surface Water
-  Disturbed Area
-  Nuiqsut Culvert Repair

Imagery: Quantum Spatial 2018
*No fill below OHW



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Attachment A

North Slope Rapid Assessment Method Data Sheets

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Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	FB WAA1 Undisturbed	Latitude/UTM Northing	70.1284
Date	6/29/2020	Longitude/UTM Easting	-152.0655
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Depression	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess. Post-Assess.
1. V_{LD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features		
	V_{LD} Subindex score	0	
		1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.		
	V_{SW} Subindex Score	0	
		1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.		
	V_{IH} Subindex Score	0	
		1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.		
		No	Yes
5. V_{TK}	Evidence of Thermokarst		
		No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			Pre-Assess. Post-Assess.
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.		
	V_{LD} Subindex Score	0	
		1.00	0.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.		
	V_{IW} Subindex Score	0	
		1.00	0.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.		
	V_{DR} Subindex Score	800	
		1.00	0.00
Habitat Assessment Score		1.00	0.00
Hydrology Assessment Score		1.00	0.00
Biogeochemical Cycling Assessment Score		1.00	0.00
Average Score		1.00	0.00

Remarks: Point at proposed crossing of fish bearing swale near the proposed Willow Central Processing Facility. Post-score is 0.0 because site becomes an upland.

Alaska North Slope Rapid Assessment Method				
Section A: Desk Top (Offsite) Data				
Site Name/Location	FB WAA2 Undisturbed	Latitude/UTM Northing	70.1096	
Date	6/29/2020	Longitude/UTM Easting	-152.0807	
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment	
Region	Arctic Coastal Plain	Coordinate System	NAD 1983	
HGM Class	Flat	Imagery Source (Year)	2018	
Investigators	Joe Christopher, Hannah Griego			
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess.	Post-Assess.
1. V_{LD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)		0	
	V_{LD} Subindex score		1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.		0	
	V_{SW} Subindex Score		1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.		0	
	V_{IH} Subindex Score		1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.		No	Yes
5. V_{TK}	Evidence of Thermokarst		No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.				
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.		0	
	V_{LD} Subindex Score		1.00	0.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.		0	
	V_{IW} Subindex Score		1.00	0.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.		800	
	V_{DR} Subindex Score		1.00	0.00
	Habitat Assessment Score		1.00	0.00
	Hydrology Assessment Score		1.00	0.00
	Biogeochemical Cycling Assessment Score		1.00	0.00
	Average Score		1.00	0.00

Remarks: Point at proposed perimeter berm at the Constructed Freshwater Reservoir near Lake M0015. Post-score is 0.0 because site becomes an upland.

Alaska North Slope Rapid Assessment Method				
Section A: Desk Top (Offsite) Data				
Site Name/Location	FB WAA5 Undisturbed	Latitude/UTM Northing	70.1289	
Date	6/29/2020	Longitude/UTM Easting	-152.0630	
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment	
Region	Arctic Coastal Plain	Coordinate System	NAD 1983	
HGM Class	Riverine	Imagery Source (Year)	2018	
Investigators	Joe Christopher, Hannah Griego			
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess.	Post-Assess.
1. V_{LD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)		0	
	V_{LD} Subindex score		1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.		0	
	V_{SW} Subindex Score		1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.		0	
	V_{IH} Subindex Score		1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.		No	Yes
5. V_{TK}	Evidence of Thermokarst		No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.				
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.		0	
	V_{LD} Subindex Score		1.00	0.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.		0	
	V_{IW} Subindex Score		1.00	0.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.		800	
	V_{DR} Subindex Score		1.00	0.00
	Habitat Assessment Score		1.00	0.00
	Hydrology Assessment Score		1.00	0.00
	iogeochemical Cycling Assessment Score		1.00	0.00
	Average Score		1.00	0.00

Remarks: Point at proposed crossing of fish bearing swale near the proposed Willow Central Processing Facility. Post-score is 0.0 because site becomes an upland.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	FB WAA9 Disturbed 800m	Latitude/UTM Northing	70.2821
Date	7/6/2020	Longitude/UTM Easting	-151.2622
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Flat	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot		Pre-Assess.	Post-Assess.
1. V_{LLD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features	0	
	V_{LLD} Subindex score	1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.	0	
	V_{SW} Subindex Score	1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.	0	
	V_{IH} Subindex Score	1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	No	Yes
5. V_{TK}	Evidence of Thermokarst	No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			
6 V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.	2	
	V_{LD} Subindex Score	1.00	0.00
7 V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.	3	
	V_{IW} Subindex Score	0.25	0.00
8 V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.	127	
	V_{DR} Subindex Score	0.25	0.00
Habitat Assessment Score		0.63	0.00
Hydrology Assessment Score		1.00	0.00
Biogeochemical Cycling Assessment Score		1.00	0.00
Average Score		0.88	0.00

Remarks: Point located at subsistence boat ramp at Tiṛṁiaqsiuḡvik River. Does not contain anthropogenic disturbance within the 80 m buffer. Contains 11.4 acres existing disturbance within the 800m buffer (VLD). Post-score is 0.0 because site becomes an upland.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	FB WAA10 Disturbed 800m	Latitude/UTM Northing	70.2379
Date	10/8/2020	Longitude/UTM Easting	-151.2967
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Flat	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess. Post-Assess.
1. V_{LLD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)	0	
	V_{LLD} Subindex score	1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.	0	
	V_{SW} Subindex Score	1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.	0	
	V_{IH} Subindex Score	1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	No	Yes
5. V_{TK}	Evidence of Thermokarst	No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.	2	
	V_{LD} Subindex Score	1.00	0.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.	0	
	V_{IW} Subindex Score	1.00	0.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.	800	
	V_{DR} Subindex Score	1.00	0.00
	Habitat Assessment Score	1.00	0.00
	Hydrology Assessment Score	1.00	0.00
	Biogeochemical Cycling Assessment Score	1.00	0.00
	Average Score	1.00	0.00

Remarks: Point located in excavation area at Mine Area 2.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	TLSA WAA1 Undisturbed	Latitude/UTM Northing	70.2299
Date	6/29/2020	Longitude/UTM Easting	-152.1152
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Flat	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess. Post-Assess.
1. V_{LD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)	0	
	V_{LD} Subindex score	1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.	0	
	V_{SW} Subindex Score	1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.	0	
	V_{IH} Subindex Score	1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	No	Yes
5. V_{TK}	Evidence of Thermokarst	No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.	0	
	V_{LD} Subindex Score	1.00	0.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.	0	
	V_{IW} Subindex Score	1.00	0.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.	800	
	V_{DR} Subindex Score	1.00	0.00
	Habitat Assessment Score	1.00	0.00
	Hydrology Assessment Score	1.00	0.00
	Biogeochemical Cycling Assessment Score	1.00	0.00
	Average Score	1.00	0.00

Remarks: Point located along proposed BT2 access road near BT2. Post-score is 0.0 because site becomes an upland.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	TLSA WAA2 Undisturbed	Latitude/UTM Northing	70.2369
Date	6/29/2020	Longitude/UTM Easting	-152.1451
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Depression	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess. Post-Assess.
1. V_{LD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)	0	
	V_{LD} Subindex score	1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.	0	
	V_{SW} Subindex Score	1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.	0	
	V_{IH} Subindex Score	1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	No	Yes
5. V_{TK}	Evidence of Thermokarst	No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.	0	
	V_{LD} Subindex Score	1.00	0.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.	0	
	V_{IW} Subindex Score	1.00	0.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.	800	
	V_{DR} Subindex Score	1.00	0.00
	Habitat Assessment Score	1.00	0.00
	Hydrology Assessment Score	1.00	0.00
	Biogeochemical Cycling Assessment Score	1.00	0.00
	Average Score	1.00	0.00

Remarks: Point located along proposed BT4 access road near BT2. Post-score is 0.0 because site becomes an upland.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	TLSA WAA3 Undisturbed	Latitude/UTM Northing	70.2760
Date	6/29/2020	Longitude/UTM Easting	-152.1936
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Slope	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess. Post-Assess.
1. V_{LD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)	0	
	V_{LD} Subindex score	1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.	0	
	V_{SW} Subindex Score	1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.	0	
	V_{IH} Subindex Score	1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	No	Yes
5. V_{TK}	Evidence of Thermokarst	No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.	0	
	V_{LD} Subindex Score	1.00	0.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.	0	
	V_{IW} Subindex Score	1.00	0.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.	800	
	V_{DR} Subindex Score	1.00	0.00
	Habitat Assessment Score	1.00	0.00
	Hydrology Assessment Score	1.00	0.00
	Biogeochemical Cycling Assessment Score	1.00	0.00
	Average Score	1.00	0.00

Remarks: Point located along proposed BT4 access road. Post-score is 0.0 because site becomes an upland.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	CRSA WAA1 Undisturbed	Latitude/UTM Northing	70.1657
Date	6/29/2020	Longitude/UTM Easting	-151.7289
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Flat	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess. Post-Assess.
1. V_{LD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)	0	
	V_{LD} Subindex score	1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.	0	
	V_{SW} Subindex Score	1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.	0	
	V_{IH} Subindex Score	1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	No	Yes
5. V_{TK}	Evidence of Thermokarst	No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.	0	
	V_{LD} Subindex Score	1.00	0.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.	0	
	V_{IW} Subindex Score	1.00	0.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.	800	
	V_{DR} Subindex Score	1.00	0.00
	Habitat Assessment Score	1.00	0.00
	Hydrology Assessment Score	1.00	0.00
	Biogeochemical Cycling Assessment Score	1.00	0.00
	Average Score	1.00	0.00

Remarks: Point located along the proposed Willow access road in the Colville River Special Area. Point more than 800 m from existing anthropogenic disturbance (GMT2). Post-score is 0.0 because site becomes an upland.

Alaska North Slope Rapid Assessment Method				
Section A: Desk Top (Offsite) Data				
Site Name/Location	CRSA WAA2 Disturbed 800 m	Latitude/UTM Northing	70.1700	
Date	6/29/2020	Longitude/UTM Easting	-151.7148	
Impact/Mitigation	Impact	Pre/Post	Pre/Post-Assessment	
Region	Arctic Coastal Plain	Coordinate System	NAD 1983	
HGM Class	Flat	Imagery Source (Year)	2018	
Investigators	Joe Christopher, Hannah Griego			
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess.	Post-Assess.
1. V_{LLD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)		0	
	V_{LLD} Subindex score		1.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.		0	
	V_{SW} Subindex Score		1.00	0.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.		0	
	V_{IH} Subindex Score		1.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.		No	Yes
5. V_{TK}	Evidence of Thermokarst		No	Yes
Determine values for variables 6-8 using an 800 meter radius plot.				
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.		1	
	V_{LD} Subindex Score		1.00	0.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.		1	
	V_{IW} Subindex Score		0.75	0.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.		800	
	V_{DR} Subindex Score		1.00	0.00
	Habitat Assessment Score		0.88	0.00
	Hydrology Assessment Score		1.00	0.00
	Biogeochemical Cycling Assessment Score		1.00	0.00
	Average Score		0.96	0.00

Remarks: Point located along the proposed Willow access road in the Colville River Special Area within 800 m of existing anthropogenic disturbance (GMT2). Does not contain anthropogenic disturbance within the 80 m buffer. Contains 3.36 acre anthropogenic disturbance within the 800 m buffer. Post-score is 0.0 because site becomes an upland.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	WAA6 Trail Disturb Disturb	Latitude/UTM Northing	70.2286
Date	6/19/2020	Longitude/UTM Easting	-151.0494
Impact/Mitigation	Mitigation	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Flat	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot		Pre-Assess.	Post-Assess.
1. V_{LLD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)	82	11
	V_{LLD} Subindex score	0.00	0.73
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.	46	0
	V_{SW} Subindex Score	0.00	1.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.	4	1
	V_{IH} Subindex Score	0.00	0.75
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	Yes	Yes
5. V_{TK}	Evidence of Thermokarst	Yes	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.	11	8
	V_{LD} Subindex Score	0.87	0.93
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.	3	3
	V_{IW} Subindex Score	0.25	0.25
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.	96	96
	V_{DR} Subindex Score	0.19	0.19
	Habitat Assessment Score	0.31	0.51
	Hydrology Assessment Score	0.00	0.70
	Biogeochemical Cycling Assessment Score	0.00	0.70
	Average Score	0.10	0.64

Remarks: Located on trail but includes the landfill within 80m buffer and landfill, and landfill access and spur roads in 800m buffer.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	WAA7 Trail Disturb Disturb	Latitude/UTM Northing	70.2289
Date	6/19/2020	Longitude/UTM Easting	-151.0626
Impact/Mitigation	Mitigation	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Depression	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot		Pre-Assess.	Post-Assess.
1. V_{LLD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features)	22	2
	V_{LLD} Subindex score	0.45	0.95
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.	11	0
	V_{SW} Subindex Score	0.31	1.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.	4	0
	V_{IH} Subindex Score	0.00	1.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	No	No
5. V_{TK}	Evidence of Thermokarst	Yes	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.	9	6
	V_{LD} Subindex Score	0.91	0.98
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.	1	1
	V_{IW} Subindex Score	0.75	0.75
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.	417	417
	V_{DR} Subindex Score	0.83	0.83
	Habitat Assessment Score	0.70	0.70
	Hydrology Assessment Score	0.33	0.70
	Biogeochemical Cycling Assessment Score	0.45	0.70
	Average Score	0.49	0.70

Remarks: Located on trail but includes the landfill and access road within 800m buffer.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	WAA8 Trail Disturb Undisturbed	Latitude/UTM Northing	70.2302
Date	6/19/2020	Longitude/UTM Easting	-151.2499
Impact/Mitigation	Mitigation	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Flat	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot		Pre-Assess.	Post-Assess.
1. V_{LD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features) V_{LD} Subindex score	36 0.10	2 0.95
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked. V_{SW} Subindex Score	0 1.00	0 1.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments. V_{IH} Subindex Score	4 0.00	0 1.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	No	No
5. V_{TK}	Evidence of Thermokarst	No	No
Determine values for variables 6-8 using an 800 meter radius plot.			
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features. V_{LD} Subindex Score	4 1.00	0 1.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife. V_{IW} Subindex Score	0 1.00	0 1.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition. V_{DR} Subindex Score	800 1.00	800 1.00
Habitat Assessment Score		0.78	0.99
Hydrology Assessment Score		0.52	0.99
Biogeochemical Cycling Assessment Score		0.10	0.95
Average Score		0.47	0.97

Remarks: Located on trail with no other anthropogenic disturbance within buffers.

Alaska North Slope Rapid Assessment Method			
Section A: Desk Top (Offsite) Data			
Site Name/Location	WAA9 Trail Disturb Undisturbed	Latitude/UTM Northing	70.2273
Date	6/19/2020	Longitude/UTM Easting	-151.2391
Impact/Mitigation	Mitigation	Pre/Post	Pre/Post-Assessment
Region	Arctic Coastal Plain	Coordinate System	NAD 1983
HGM Class	Depression	Imagery Source (Year)	2018
Investigators	Joe Christopher, Hannah Griego		
Determine values for variables 1-5 using an 80-m radius plot		Pre-Assess.	Post-Assess.
1. V_{LLD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features) V_{LLD} Subindex score	37 0.08	2 0.95
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked. V_{SW} Subindex Score	0 1.00	0 1.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments. V_{IH} Subindex Score	4 0.00	0 1.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.	No	No
5. V_{TK}	Evidence of Thermokarst	No	No
Determine values for variables 6-8 using an 800 meter radius plot.			
6. V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features. V_{LD} Subindex Score	4 1.00	0 1.00
7. V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife. V_{IW} Subindex Score	0 1.00	0 1.00
8. V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition. V_{DR} Subindex Score	800 1.00	800 1.00
Habitat Assessment Score		0.77	0.99
Hydrology Assessment Score		0.52	0.99
Biogeochemical Cycling Assessment Score		0.08	0.95
Average Score		0.45	0.97

Remarks: Located on trail with no other anthropogenic disturbance within buffers.

Alaska North Slope Rapid Assessment Method				
Section A: Desk Top (Offsite) Data				
Site Name/Location	WAA1 Culvert	Latitude/UTM Northing	70.2179	
Date	6/19/2020	Longitude/UTM Easting	-150.9986	
Impact/Mitigation	Mitigation	Pre/Post	Pre/Post-Assessment	
Region	Arctic Coastal Plain	Coordinate System	NAD 1983	
HGM Class	Riverine	Imagery Source (Year)	2018	
Investigators	Joe Christopher, Hannah Griego			
Determine values for variables 1-5 using an 80-m radius plot			Pre-Assess.	Post-Assess.
1. V_{LD}	Local Landscape Disturbance (percent of plot (0-100) occupied by anthropogenic disturbance and/or man-made features		42	42
	V_{LD} Subindex score		0.00	0.00
2. V_{SW}	Anthropogenically derived surface water- percent of the plot (0 - 100) occupied by surface water derived from human activities, including thermokarst if directly associated, and conspicuously linked.		29	0
	V_{SW} Subindex Score		0.00	1.00
3. V_{IH}	Impediment to Hydrology - number of quarter segments (0 - 4) assignable in any direction that have hydrologic impediments.		4	4
	V_{IH} Subindex Score		0.00	0.00
4. V_{DD}	Evidence of Dust - accumulation of sediment on vegetation, appearing as areas of discoloration.		Yes	Yes
5. V_{TK}	Evidence of Thermokarst		Yes	Yes
Determine values for variables 6-8 using an 800 meter radius plot.			Pre-Assess.	Post-Assess.
6 V_{LD}	Landscape Disturbance - percent of the plot (0 - 100) occupied by anthropogenic disturbance and/or man-made features.		19	19
	V_{LD} Subindex Score		0.69	0.69
7 V_{IW}	Impediment to Wildlife - number of quarter segments (0 - 4) assignable in any direction with impediments to the free movement of wildlife.		4	4
	V_{IW} Subindex Score		0.00	0.00
8 V_{DR}	Distance to Roadway - minimum distance in meters (0 - 800) to a roadway of any size, class, or condition.		0	0
	V_{DR} Subindex Score		0.00	0.00
	Habitat Assessment Score		0.17	0.17
	Hydrology Assessment Score		0.00	0.42
	Biogeochemical Cycling Assessment Score		0.00	0.00
	Average Score		0.06	0.20

Remarks: Point located in Nuiqsut at one of culverts to be repaired. Pre-condition includes 2.11 acres of existing anthropogenic disturbance and 1.44 acres of anthropogenic surface water in the 80m buffer (V_{LD} and V_{SW}) and 92.48 acres of existing anthropogenic disturbance in the 800m buffer (V_{LD}). In post-condition, assume that anthropogenic surface water becomes 0 and that cause of thermokarst (surface water) is removed.

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