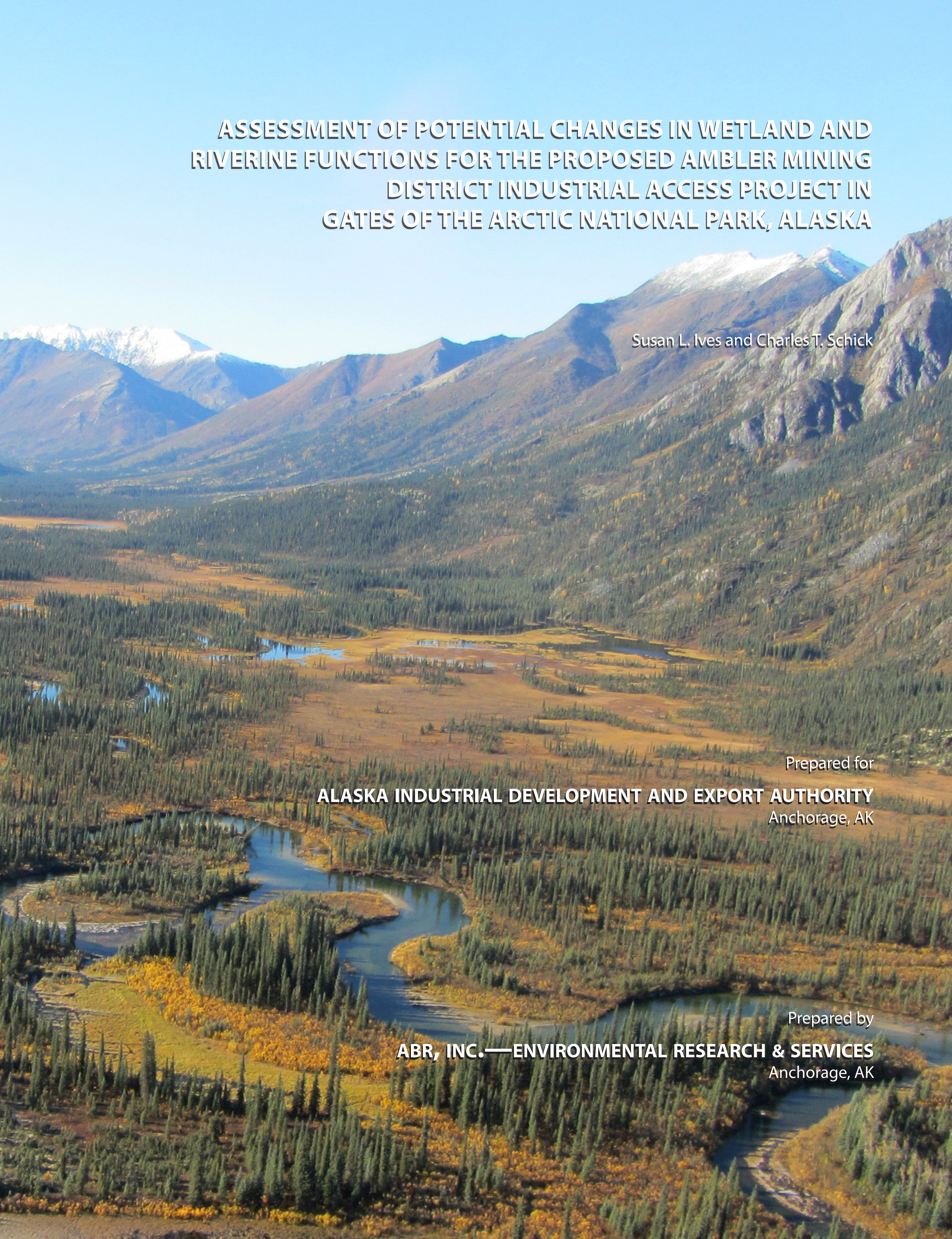

ASSESSMENT OF POTENTIAL CHANGES IN WETLAND AND RIVERINE FUNCTIONS FOR THE PROPOSED AMBLER MINING DISTRICT INDUSTRIAL ACCESS PROJECT IN GATES OF THE ARCTIC NATIONAL PARK, ALASKA

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FINAL REPORT

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January 2017

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ACKNOWLEDGMENTS

We thank National Park Service staff Joe Durrenberger, David Swanson, Kevin Noon, and Paul Burger for providing comments on the study plan and the initial results of this work. At Alaska Industrial Development and Export Authority, we thank Jeff San Juan for project management and Michele Hope for contract management. At ABR, Dorte Dissing and John Seigle ably assisted with delineating flow paths as a wetland functional class and with the development of riverine functional classes and the assessment of riverine functions, Julie Parrett conducted the wildlife habitat-use evaluation, and Janet Kidd assessed the potential indirect impacts to wetland functions for each wetland functional class.

INTRODUCTION

To assist the Alaska Industrial Development and Export Authority (AIDEA) in assessing existing wetland and riverine functions and evaluating how those functions could change from construction and operation of the proposed road that would be developed for the Ambler Mining District Industrial Access Project (AMDIAP) in Gates of the Arctic National Park (GAAR), ABR Inc.—Environmental Research & Services (ABR) prepared a wetland functional assessment and riverine functional assessment for the project. The study involved assessing wetland and riverine functions and functional change for those portions of the northern and southern alignments of the proposed AMDIAP road that would cross the Kobuk River Preserve unit of GAAR.

To assess the functional capacity of wetlands and waters for this study, we applied an Integrated Terrain Unit (ITU) mapping approach to develop multivariate land cover classes that encompass the range of existing wetland and riverine functions occurring along the proposed road alignments. We then developed quantitative measures of the existing wetland and riverine functions, conducted an impact assessment, and evaluated how the wetland and riverine functions could change due to the presence of the proposed road.

The specific objectives of the study were to:

- Review the existing mapping of National Wetland Inventory (NWI) types prepared by DOWL HKM (2014) for the 2 proposed road alignments in the Kobuk River Preserve;
- Review and revise the mapping of hydrogeomorphic (HGM) classes provided by DOWL HKM (2014), map additional geomorphic variables (physiography and macrotopography) and vegetation to the Level IV of the Alaska Vegetation Classification (AVC) (Viereck et al. 1992);
- Using the mapping of NWI, HGM, physiography, macrotopography, and vegetation classes, develop wetland functional classes and wildlife habitat types within the study area using various aggregations of those 5 ITU variables;
- Develop riverine functional classes using a combination Strahler stream order and stream gradient;

- Evaluate habitat use for each mapped wildlife habitat type to inform the assessment of the bird and mammal habitat suitability function of wetlands;
- Assess the functional capacity of each wetland functional class using ABR's Aquatic Function Ranking System while taking into account the likely presence or absence of permafrost;
- Assess the functional capacity of each riverine functional class, using concepts developed by Harman et al. (2012) and Starr et al. (2015);
- Assess the likely direct and indirect impacts to wetlands, lentic waters, and riverine waters due to road construction and operations; and
- Evaluate how the existing wetland and riverine functions are likely to change because of the expected road-induced impacts.

STUDY AREA AND REFERENCE DOMAIN

The study area for this work was the area in which wetlands and waters were mapped in the Kobuk River Preserve by DOWL HKM (2014). This was generally a 2,000-foot corridor surrounding the centerline of the northern (26.0 miles) and southern (17.8 miles) alignments for the proposed AMDIAP road in the Kobuk River Preserve (Figure 1). The reference domain refers to the geographic area that encompasses all, or a portion of, the area in which a regional HGM subclass of wetlands occurs. The reference domain concept is used when defining the boundaries within which reference wetlands would be selected (i.e., for evaluating the functional performance of test wetlands relative to the range of functional performance of reference wetlands). A study involving reference wetlands and performance standards represents a major undertaking, requiring substantial amounts of field survey work and measurements and validation of wetland functions. A study of that magnitude was beyond the scope and resources available for this project. For the purposes of this study, the reference domain encompasses the geographic area on the southern slope of the Brooks Range and adjacent lowland areas in interior Alaska, an area which includes all of the HGM wetland subclasses that occur in the Kobuk River Preserve. With the reference domain defined in this way, the functional assessment models developed for this study will be broad enough to be applied (with modifications where needed) to the full length of the proposed AMDIAP road.

METHODS

To prepare the wetland functional assessment for this study, ABR employed the Aquatic Function Ranking System (AFRS), which the company developed to address the specific wetland functions expected to be performed in any particular region in Alaska, including functions performed in landscapes underlain by permafrost. The AFRS methods have been employed in number of studies of wetland functions for proposed road and industrial projects in Alaska in recent years (ABR 2016a, 2016b, 2015, 2014a, 2014b), many of which have been successfully used in the wetland permitting process under Section 404 of the Clean Water Act. In response to the Request for Proposal (RFP) for this study, ABR expanded upon the standard AFRS procedures (see below) to develop functional criteria for wetlands and lentic waters and a separate set of functional criteria for riverine waters, which apply specifically to the Kobuk River Preserve unit of GAAR.

INTEGRATED TERRAIN UNIT MAPPING

To provide necessary map data for the wetland functional assessment, wetland functional classes and wildlife habitats were mapped using an ITU approach. These methods were developed for Ecological Land Surveys (ELS), which, over the past several decades, have been conducted in tundra, boreal forest, and coastal regions in Alaska, including the Arctic Network (ARCN) of national parks in northwestern Alaska (Jorgenson et al. 2009). The ITU approach involves the mapping of various landscape features (terrain units) and then combining and aggregating (integrating) the variables to develop map classes of ecological importance, in this case wetland and riverine functional classes (see below). The ITU variables included the NWI and HGM wetland classes mapped by DOWL HKM (2014), and additional variables mapped in this study (physiography, macrotopography, and vegetation type). These ITUs were combined into multivariate, composite classes and then aggregated into 2 ecologically important categories that (1) represent the habitats expected to be used by wildlife species in the study area (wildlife habitats), and (2) wetlands and waters that perform similar ecological services (wetland functional classes). Riverine functional classes were derived following a similar multivariate method using different variables (see Riverine Functional Classes below).

Recent mapping of wetlands and waters in the study area, prepared by DOWL HKM (2014), was provided for use in this study; the map attributes available from that study were: Cowardin et al. (1979) wetland type, using NWI nomenclature; HGM class, following Smith et al. (1995); and Level III vegetation type of the AVC, following Viereck et al. (1992).

No edits were made to the map polygon boundaries or the NWI wetland type attributes in the DOWL HKM (2014) mapping for the study area. HGM class revisions were made to the existing mapping, particularly in riverine areas so that riverine conditions in the study area would be more accurately represented. HGM classes were assigned following Smith et al. (1995), whose classification system is based on geomorphic setting, water source and transport mechanisms, and hydrodynamics. Three additional ITU fields were attributed for each of the existing map polygons: physiography, macrotopography, and AVC Level IV vegetation class of Viereck et al. (1992). Physiographic types represent generalized geomorphic features used to describe landscape position and function (e.g., upland, lowland, lacustrine, and riverine). Macrotopography is a fine-scale geomorphic feature (e.g., shoulder, toeslope, basin), modified from the surface-form classification of Washburn (1973) and used by Jorgenson et al. (2009) for the previous ELS work in ARCN. AVC Level IV vegetation classes incorporate dominant plant species and vegetation structure to classify vegetation types in Alaska (e.g., Closed Tall Alder Shrub, Subarctic Lowland Sedge Wet Meadow).

Identification of the ITU variables and map polygon attribution was based on interpretation of high-resolution aerial imagery and elevation data for the study area. Imagery for the northern and southern alignment corridors included 0.75-ft resolution aerial photography, acquired 18–19 June 2012 (provided by DOWL); and 1-m resolution IKONOS satellite imagery (ortho-corrected mosaic provided by NPS, acquired 2004–2010). Elevation data included detailed LiDAR-generated elevation contours (2-ft resolution) for the road alignment corridors, and 10-ft resolution contours for material sites outside the alignment corridors. These remote-sensed data were supported by several sources of ground-reference survey data for the study area, including:

- DOWL HKM (2014) wetland determination plot data including site and soil photographs;

- ABR (2014c) and Lemke et al. (2014) field data and photographs for fish and fish habitat survey work in rivers and streams;
- Swanson (1995) plot data and field photographs for the description and mapping of broad-scale ecosystems;
- NPS Fire Program ground-truth plot data and photographs (NPS 2005); and
- NPS Fire Program paired plots (J. Allen, NPS, unpublished data).

PERMAFROST DISTRIBUTION IN WETLAND CLASSES

The portions of GAAR that would be affected by the proposed AMDIAP road lie near the boundary separating the zones of discontinuous and continuous permafrost (50–90% and >90% of landscape underlain by permafrost, respectively) (Brown et al. 2002). Most wetlands in the proposed road corridors occur in landscape positions in which topography, hydrology, and soils are favorable for permafrost development. Wetlands could exist locally, however, in association with surficial deposits that either lack permafrost or that are underlain by taliks (thaw bulbs), which can support perennial movement of groundwater. Road construction in such relatively permafrost-free wetlands could potentially impair functions related to groundwater recharge and discharge.

Although it is not possible to determine the presence or absence of permafrost at any given location with certainty without field observations, we used existing field-based classifications and map products for landscape physiography (Swanson 1995) and ecosystems (Jorgenson et al. 2009) to identify areas where non-permafrost wetlands are most likely to exist (e.g., the Nutuvukti Moraine physiographic unit). Particularly helpful in this effort were the geotechnical investigations within the Kobuk River Preserve conducted by Speeter (2015) in which areas of thermally unstable permafrost were identified along both the northern and southern road alignments; thawed soils were observed northeast of Nutuvukti Lake in glacial outwash terraces and in proximity to large rivers and streams. Using this information along with the landscape classifications and map products noted above, we developed a set of landscape indicators for areas that tend to lack frozen ground, and characterized the level of certainty regarding permafrost conditions at any given location (with each indicator) as high, medium, or low (Table 1). The landscape indicators include attributes of surficial geology, topography, and vegetation

Table 1. Landscape indicators used to identify areas that have a likelihood of lacking permafrost in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

Indicator	Certainty of Lack of Permafrost	Notes
mixed forest	low	
white spruce forest	low	
broadleaf forest	medium	
terrace deposit	medium	
steep convex slope	medium	
active floodplain	high	larger rivers only
bluff	high	except north-facing
coarse morainal deposit	high	mainly Nutuvukti Moraine (Swanson 1995)
lichen woodland	high	

that could be readily interpreted in the high-resolution imagery available for the project area (see above). Finally, we identified the map units that had one or more of these indicators using the existing wetlands map (DOWL HKM 2014) and the high-resolution imagery; we flagged this subset of wetland map units as "candidate non-permafrost wetland."

WILDLIFE HABITAT MAPPING

Wildlife habitat types were developed to facilitate the wildlife habitat-use evaluation, which in turn was used to inform the bird and mammal habitat suitability function for each wetland functional class (see below). Wildlife habitat types were derived from the ITU mapping data by combining 2 ITU variables (physiography and AVC Level IV vegetation class) and then aggregating those 81 composite classes to develop a smaller set of 20 habitat types that reflect use by the bird and mammals species expected to occur in the study area. This process is similar to that used for classifying wetland functional classes, except that upland as well as wetland vegetation types are included. In deriving wildlife habitat types, emphasis was placed on those vegetation and landscape characteristics known to be important for wildlife, such as food availability (vegetation forage species and prey species habitats), nest and den site characteristics (geomorphic landscape features), and security, escape, and shelter habitats (vegetation cover).

WILDLIFE HABITAT-USE EVALUATION

For evaluation of use of the mapped habitats in the study area by wildlife, data on wildlife habitat use for birds and mammals in western Alaska were compiled from scientific literature, with an emphasis on studies in GAAR and interior and northwestern Alaska. The following literature sources were used to support this evaluation: Abramov (2016), NPS (2016), Reid et al. (2016), Joly and Cameron (2015), Marcot et al. (2015), Rodewald (2015), Ritchie (2013), Walton and Gotthardt (2013), Westing (2013), Coltrane and Sinnott (2012), DeGroot and McMillan (2012), Lewis et al. (2012), Gibson (2011), Joly (2011), Joly et al. (2010), Baltensperger (2009), MacDonald and Cook (2009), Krebs et al. (2007), Cook and MacDonald (2006), Tibbitts et al. (2005), Smith and Schaefer (2002), Swanson (2001), Swaim and Guldager (2000), Lisgo (1999), DiFolco (1996), Paragi et al. (1996), Poole et al. (1996), Swanson (1996), Swanson (1995), Swanson (1992), Robinson (1987), Banci (1981), King and Conant (1981), Wolff (1980), Kessel (1979), Bellrose (1978), Wolff (1978), Dean and Chesemore (1974), and Gabrielson and Lincoln (1959).

The goal of the evaluation was to categorize the mapped wildlife habitats in the study area on a coarse scale, as important or not important (see below), for each species of bird and mammal expected to occur regularly (i.e., at least annually in large or small numbers) in the study area. The list of regularly occurring birds and mammals in the study area was generated by first compiling a comprehensive list of birds and mammals for GAAR, using a bird species list for GAAR (NPS 2016), and a wildlife habitat-use matrix developed for birds and mammals in northwestern Alaska (Marcot et al. 2015). The list of regularly occurring species was then shortened to include only those species for which suitable habitat (e.g., for foraging, breeding, denning, migration) was available in the study area corridors mapped for wetlands by DOWL HKM (2014). Lastly, if a species was at the limit of its range in the study area (the northern or western range edges, for example) and was known to be relatively uncommon and patchy in distribution throughout Alaska, we assumed that species was unlikely to regularly occur in the study area.

For each species expected to occur regularly in the study area, the habitats mapped in this study were then assessed as important (regularly used at any point in the life cycle) or not important (infrequently used or avoided). To determine the importance of the mapped habitats to wildlife species, we reviewed the scientific literature noted above, emphasizing Alaskan and boreal forest studies that documented habitat use by birds and mammals. Information from the literature was applied to the assessment in a study-area-specific manner. First, the distribution of habitats throughout the study area was an important consideration. For example, some species require habitats that occur in proximity to each other to meet different life-history requirements. This consideration is especially important for waterfowl, for example, because many species prefer or require nesting habitats that occur near appropriate brood-rearing habitat. Second, we assumed that habitats occurring only in small (<1 acre) and widely scattered patches would be infrequently used or avoided in comparison to habitats that occurred in large, contiguous patches. This consideration is more important for large-bodied species such as waterbirds and some raptors, and species with larger territory sizes (shorebirds), than it is for many of the smaller landbird species.

WETLAND FUNCTIONAL CLASSES

Wetland functional classes, or groups of wetland and lentic waters types that are expected to provide similar ecological services, were derived by integrating 5 variables from the ITU mapping: NWI type and HGM class (provided by DOWL HKM 2014), physiography, macrotopography, and AVC Level IV vegetation class. The resulting multivariate concatenations of those 5 variables, which resulted in 379 unique ITU code combinations, were then aggregated into a smaller set of 15 wetland functional classes (plus Flow Paths, see Riverine Functional Classes below) that were developed to encompass the range of wetland functions expected to occur in the study area.

WETLAND FUNCTIONAL ASSESSMENT

The AFRS was used to evaluate each wetland functional class for 12 wetland functions: (1) flood flow regulation (storage); (2) sediment, nutrient, and toxicant removal; (3) erosion control and shoreline stabilization; (4) organic matter production and export; (5) maintenance of soil thermal regime (in permafrost wetlands); (6) threatened and endangered species support (documenting consideration of threatened and endangered species even though none are expect to occur in GAAR); (7) bird and mammal habitat suitability; (8) fish habitat suitability; (9) rare plant habitat and native plant diversity; (10) subsistence use; (11) groundwater discharge; and (12) groundwater recharge.

EXISTING CONDITIONS

For each wetland function, a suite of functional indicators, tailored specifically to subarctic wetlands, was evaluated. The extent to which each of the indicators was met or detected determined the level of performance of a wetland functional class. Indicators that were met or detected were assigned a value of 1 and indicators that were not met or detected were assigned a value of 0. Indicator values then were summed for each function and divided by the maximum possible score to generate a score ranging from 0.0 to 1.0 for each function. If a functional indicator was not expected to occur in the AMDIAP study area, it was marked as not applicable (N/A), and was not included in the maximum possible score (i.e., existing function scores were not reduced for indicators that were not applicable). A text section was included in each wetland function scoring sheet to describe the rationale used to determine the scores for each indicator.

The exceptions to assigning a functional indicator value as 0, 1, or N/A were for 2 of the indicators in the bird and mammal habitat suitability function. For these 2 indicators (mammal diversity and bird diversity), the indicators were not assessed as presence (1) or absence (0). Instead, the diversity rankings relied on the numerical results of the wildlife habitat-use evaluation and were defined as the ratio of the number of species expected to occur regularly within each functional class relative to the total number of species expected to occur regularly within the study area as a whole. For example, a wetland functional class that could be expected to support 25 out of the 89 bird species expected to occur across the full study area would receive a bird diversity functional indicator score of 0.28. Functional indicators were evaluated primarily using data in the literature for the study area (Jorgenson et al. 2009) and site-specific field data collected by DOWL HKM (2014), but additional literature was reviewed specifically for the mammal diversity and bird diversity indicators (see Wildlife Habitat-Use Evaluation above).

Not all wetland functional classes will perform all potential functions. Wetland functional classes likely to have either a deep active layer or no permafrost were not assessed for the maintenance of soil thermal regime function, which was developed to assess permafrost maintenance. Wetland functional classes that were likely to have a shallow active layer (i.e., permafrost wetlands) were not assessed for groundwater discharge or groundwater recharge functions because a shallow active layer will inhibit groundwater connectivity. Wetland functional classes without at least a seasonal connection to fish-bearing waters were not assessed for fish habitat suitability. No wetland functional classes were assessed for threatened and endangered species support because no threatened or endangered species are likely to occur in the project area (USFWS 2014).

To generate an overall functional capacity index score for each wetland functional class for existing conditions, the individual function scores were summed for each functional class and then divided by the total number of applicable and assessed functions. Averaging evenly across all functions does not weight any of the 12 functions assessed to a greater degree, and only including applicable and assessed functions in the denominator ensures that functions not anticipated to occur in a particular functional class do not downwardly bias the average. For example, permafrost wetlands are not anticipated to perform either groundwater recharge or discharge functions, so these 2 functions were not included in the denominator for permafrost wetlands.

FUNCTIONAL CHANGE

To predict the effects of the proposed AMDIAP road on wetland functions, both direct and indirect impacts were considered. Direct impacts would involve gravel fill within the road footprint and gravel extraction from the material site development. To predict functional change associated with the indirect effects of road construction and operations, we first evaluated the likelihood of potential indirect impacts to each wetland functional class within a 328-ft buffer zone from the toe of the proposed road (see Predicted Direct and Indirect Impacts below). These potential indirect impacts were then considered when evaluating the functional performance of wetland functional classes that would be affected by construction and operation of the AMDIAP road. The process of assessing changes in functional performance involved reevaluating the presence or absence of functional indicators in light of the information on likely indirect impacts. Potential changes in those functional indicators for which there was greater uncertainty, or for which the spatial extent was likely to be much less than in the 328-ft buffer, were acknowledged by giving those indicators a partial change (loss) score of 0.5 (i.e., halfway between presence [1] and absence [0]). In this process, we sought not to explicitly quantify functional changes or the spatial extent of those changes but to classify functional indicators simply as still present, absent, or partially changed. As with the assessment of existing functional conditions, the indicator values then were summed for each function and divided by the maximum possible score to generate a functional capacity index ranging from 0.0 to 1.0 for each function.

Each wetland function in each wetland functional class was evaluated for existing conditions and the predicted conditions resulting from direct and indirect effects, and these values were averaged for each functional class across all applicable functions, as described under Existing Conditions above. Functional change scores (Δ) were then calculated for both the direct and indirect effects per USACE (2016) as:

Δ = existing condition score - predicted condition score

The Δ values were then multiplied by the number of acres for each wetland functional class expected to be affected in the 2 possible road alignment corridors to determine the wetland debits associated with direct effects and the estimated wetland debits associated with indirect effects. While wetland debits do not correspond directly to acres of wetlands in the study area, they do incorporate the acreage of each wetland functional class and therefore provide a more complete evaluation of total functional change. Wetland debits can be envisioned as the expected loss in functional capacity across all the acreage for a wetland functional class or across all the wetland acreage in the AMDIAP study area depending on how the data are summarized. Comparing debits among wetlands also illustrates that filling a small, high-performing wetland (low acreage, but high Δ) may have a loss in functional capacity equivalent to filling a larger, lower performing wetland (high acreage, but low Δ).

The wetland debits (Δ × acres) can be compared between the 2 proposed road alignments to gauge the expected loss in wetland functional capacity from construction and operation of the AMDIAP road along either alignment. Debits were presented for each of the 16 wetland functional classes, while incorporating (averaging) the variable number of wetland functions expected to be performed in each functional class, as described above. Debits were also summed across all wetland functional classes for each road alignment to evaluate the total loss in functional capacity predicted for each alignment. Averaging function and functional change scores across wetland functions and summing wetland debits evenly across functional classes places no greater value on any of the 12 wetland functions or 16 functional classes (e.g., a debit for flood flow regulation is equivalent to a debit for bird and mammal habitat suitability, and a debit for Riverine Wet Sedge-Shrub Meadow is the same as a debit for Slope Saturated Spruce Forest). However, a weighting procedure for the averaging of functional change scores and/or the summation of wetland debits could be used to emphasize the predicted loss in functional capacity for the functions and/or functional classes considered to be of higher value.

RIVERINE FUNCTIONAL CLASSES

Riverine functional classes were developed following procedures similar to those used to define the functional classes for wetlands and lentic waters. For riverine systems, however, we aggregated stream waters into functionally similar groups based on Strahler stream order and slope (stream gradient).

All rivers and streams in the mapping provided by DOWL HKM (2014) were attributed as Permanently Flooded Upper Perennial Streams (R3UBH). Review of the high-resolution imagery for the project and available data (Johnson and Litchfield 2016, ABR 2014c, Lemke et al. 2014), however, indicated that a diversity of stream types, each functioning differently in the landscape, were present within the AMDIAP study area. There were also stream lines in the mapping that were found to be completely vegetated on the imagery and did not appear to represent riverine features. Because of this, a combination of modeling and individual review of the map polygons and imagery was used to parse the R3UBH polygons into subsets of ecologically similar lotic waters, and to distinguish what appeared to be ephemeral flow paths that lacked the characteristic bed and bank morphology of riverine systems, and thus, were best assessed as a non-riverine wetland functional class.

A high-resolution digital elevation model (DEM, 5-m IFSAR DTM available at http://maps.dggs.alaska.gov/elevationdata/#-16788524:9545298:5) was used with *ArcGIS* hydrology tools to model a stream network within the eastern portion of the Kobuk River headwaters (Upper Kobuk River, HUC 19050302). This watershed encompassed all rivers and streams digitized by DOWL HKM (2014) within GAAR. *ArcGIS* hydrology tools were used to model a stream network using 4 different flow accumulation thresholds, corresponding to upstream drainage areas of 250, 125, 25, and 12.5 thousand m². Each modeled stream network was reviewed in conjunction with the available imagery, the National Hydrography Dataset (NHD), and DOWL HKM (2014) wetlands mapping. The flow accumulation threshold of 125 thousand m² was determined to provide a reasonable distinction between ephemeral/intermittent and perennial waters. Strahler stream orders were then assigned to all rivers and streams mapped by DOWL HKM (2014). Strahler stream order identifies the hierarchical relationship between streams. Headwaters are first order streams, becoming a second order stream at the confluence of two first order streams. An n^{th} order stream is always located downstream from the confluence of two (n^{th} - 1) order streams. We used Strahler stream order 0 for what were likely ephemeral, non-riverine waters. *ArcGIS 3D Analyst* tools were used to assign the mean, maximum, and minimum slopes to each mapped stream segment.

Riverine functional classes, or ecologically similar lotic waters, were then derived by combining Strahler stream order and gradient (slope). Those initial bivariate combinations resulted in 13 classes, which were then aggregated into 4 riverine functional classes. What were classified as ephemeral, non-riverine waters (Strahler stream order 0) were assessed separately as a wetland functional class (see Wetland Functional Classes above).

RIVERINE FUNCTIONAL ASSESSMENT

The riverine functional assessment for this project relied on the hierarchical approach developed by Harman et al. (2012) for assessing functions in lotic waters, which builds on earlier work by Fischenich (2006). This approach acknowledges the interdependencies between various riverine functions, from the requirement of sufficient flow to maintain stream channels to providing suitable conditions to support a diversity of aquatic life. For use in this study, we modified a rapid approach for assessing stream functions developed by Starr et al. (2015). The Starr et al. (2015) assessment technique was based on the Stream Functions Pyramid Framework (Harman et al. 2012) and was developed to provide regulators a function-based assessment of existing stream conditions and likely conditions following proposed restoration projects. In this study, 5 riverine functions were assessed: (1) hydrology, (2) hydraulics, (3) geomorphology, (4) physicochemical, and (5) biology.

EXISTING CONDITIONS

The stream assessment portion of Starr et al. (2015) was modified for use in this office-based evaluation of riverine functions. A numerical scoring system allows the calculation of functional change scores per USACE (2016), so we used numerical values (3, 2, or 1) instead of the categorical rankings (functioning, functioning at risk, or not functioning, respectively) that were described by Starr et al. (2015). As with the wetland functional assessment, the numerical scores for each riverine functional indicator were summed for each function and divided by the maximum possible score to generate a functional capacity index ranging from 0.0 to 1.0 for each function. A text section was included in each riverine function scoring sheet to describe the rationale used to determine the scores for each indicator.

As with wetland functional classes, an overall functional capacity index score was generated for each riverine functional class for existing conditions by summing the individual function scores and then dividing by the total number of applicable and assessed functions. Averaging evenly across all functions places no higher weight or value on any one of the 5 functions assessed.

Riverine functional indicators described by Starr et al. (2015) that could not be determined without field observations were modified for use in this desktop study; this included replacing measurements of bank height ratio and entrenchment with a general assessment of floodplain engagement (hydraulics), and removing bank erosion measurements (geomorphology). Similarly, bedform diversity measurements (geomorphology) were replaced with an evaluation of the number of habitat types within the stream reaches assessed. Modifications were also made to better reflect riverine conditions within the study area; this included altering water quality indicators (physicochemical) to be more reflective of cold-water systems lacking nutrient loading, and altering the riparian vegetation indicator (geomorphology) so that it did not require the presence of trees for a high score.

FUNCTIONAL CHANGE

For riverine functions, the assessment of functional change involved evaluating short-term effects, which would occur primarily during the construction phase of the project, and long-term effects, which would occur primarily during the operations phase. Both short- and long-term impacts to riverine functions from construction and operation of the proposed road were predicted by assuming material site use, and gravel, culvert, and bridge placement as indicated in the project application materials (GIS data and construction typicals provided by DOWL). A review of the scientific literature also was conducted to determine the type, extent, and magnitude of likely riverine impacts. For both short-term and long-term impacts, predicted effects were assessed within both the project footprint and the 328-ft buffer used to assess indirect effects on wetland functional classes (see Predicted Direct and Indirect Impacts below), as neither short- nor long-term effects were likely to be confined to the project footprint.

Each riverine function in each riverine functional class was evaluated for existing conditions and the predicted conditions resulting from short- and long-term effects, and these values were averaged for each functional class across all applicable functions, as described under Existing Conditions above. Riverine functional change scores (Δ) were then calculated for both short- and long-term effects per USACE (2016) as:

Δ = existing condition score - predicted condition score

The Δ values were then multiplied by the number of acres for each riverine functional class likely to be affected in the 2 possible road alignment corridors to determine riverine debits associated with short- and long-term effects. Debits were calculated using the acreage of the combined direct and indirect effects areas, as neither short- nor long-term effects are likely to be constrained to the project footprint. Debits were presented for each of the 4 riverine functional classes, while incorporating (averaging) the variable number of riverine functions expected to be performed in each functional class, as described above. Debits were also summed across all riverine functional classes for each road alignment to evaluate the total loss in functional capacity predicted for each alignment.

PREDICTED DIRECT AND INDIRECT IMPACTS

Direct impacts to wetland functions for each wetland functional class occurring within the footprint of the proposed road were assessed by assuming material site use, and gravel, culvert, and bridge placement as indicated in the project application materials (GIS data and construction typicals provided by DOWL). Indirect impacts for each functional class were assessed as described below and included an assessment of changes in plant community composition, changes in soil physical and chemical characteristics, degradation of permafrost, dust fallout, hydrologic alteration, impounded water, introduction of invasive plant species, and the alteration of wildlife habitat use. Impacts were assessed based on the specific locations of the occurrences of each wetland functional class within the 328-ft indirect-effects buffer zone. The results of the indirect impacts analysis were used to predict wetland functional change for each wetland functional class and are discussed in the Wetland Functional Assessment section in Results and Discussion.

Potential indirect impacts to wetland functions from construction and operation of the AMDIAP road are likely to be primarily associated with changes in vegetation and soil characteristics, and alterations to wetland hydrology (Raynolds et al. 2014, Myers-Smith et al. 2006, Forman et al. 2003, Trombulak and Frissell 1999, Auerback et al. 1997, Webber et al. 1982). The magnitude of effects will depend on the extent to which best management practices (BMPs) are employed during road construction, the level of road traffic, and the degree to which water management control structures such as bridges and culverts are designed and maintained to preserve natural watershed flow patterns. Data collected along the Dalton Highway that showed changes in plant community composition, soil characteristics, and depth of the active layer were most significant in the first 328 ft from the road (Myers-Smith et al. 2006, Auerback et al. 1997), although changes were detected at distances >328 ft. Dust fall was identified as one of the leading vectors of potential impacts from road construction and operations. Given these results and the potential similarity of the Dalton Highway and the proposed AMDIAP road, we assessed the magnitude of potential indirect impacts for this study by reviewing the frequency and spatial distribution of the wetland functional classes within a 328-ft buffer on either side of the northern and southern alignments. The spatial extent of indirect impacts is important to carefully consider, however, because a given wetland functional class is likely to be variably influenced by indirect effects of the proposed road. For example, wetlands and waters that are concentrated within the outer boundary of the buffer are less likely to be exposed (or not exposed at all) to some of the impacts evaluated in this functional assessment. While we acknowledge that indirect effects are not likely to be evenly distributed throughout the 328-ft buffer, the buffer zone nevertheless provides a framework for assessing the possible wetland acreage that could be affected by the AMDIAP road. Determining individual buffer zone widths for each indirect effect and assessing how they might vary throughout the corridor would be a challenging and somewhat speculative exercise without more specific information on road traffic volumes, for example. In the Wetland Functional Assessment section in Results and Discussion, we note where differences in the spatial extent of indirect effects from those predicted in the 328-ft buffer are likely to occur.

When assessing dust effects on wetland functions, we assumed that traffic levels on the AMDIAP road would be similar to those on the Dalton Highway. The Dalton Highway is a heavily trafficked industrial road, however, and if the AMDIAP road has more moderate traffic levels, dust effects may be less extensive. The effect of inadequate cross drainage was another important potential indirect impact that could affect wetland function. Both proposed road alignments for the AMDIAP largely run perpendicular to the prevailing slope of the surrounding terrain, with many inconspicuous cross drainages (referred to as Flow Paths) delineated as part of the wetlands map prepared by DOWL HKM (2014). The paths of these drainages are difficult to predict in some cases and although culvert locations have been mapped to accommodate these drainages, it is possible some drainages will be missed or that culvert installation and/or maintenance would be inadequate, thereby potentially impounding waters on the upstream side of the road. In general, we assumed that impoundment impacts would be localized and rather small in spatial extent, but some impoundments could become fairly large permanently to semi-permanently flooded waters if individual drainages are missed during the planning and installation of culverts. The Nutuvukti Lake Fen, which occurs along the western portion of the northern road alignment, appears to be recharged by drainage through glacial outwash soils to the north; inadequate drainage structures and subsequent impoundments in this area have the potential to disrupt the recharge of the fen (Speeter 2015, Swanson 1995). Impoundments also have the potential to hasten permafrost thaw. Speeter (2015) observed the after-effects of a wildfire at Jim Creek, which occurred along the northern alignment approximately 100 miles east of GAAR. Removal of the organic mat in this area by fire led to a rapid thawing of permafrost. Surface water accelerated the permafrost thaw and increased erosion, leading to structural instabilities and widespread landslides near Jim Creek. These observations corroborate the understanding that frozen soils at this latitude are thermally unstable when landscapes are disturbed. Disturbance of the organic mat (compression, removal, or burning) can result in permafrost thaw and structural failure and, as noted by Speeter (2015), surface water can accelerate permafrost melting and erosion.

RESULTS AND DISCUSSION

The recent, fine-scale mapping of wetlands and waters in the AMDIAP study area, provided by DOWL HKM (2014), identified fewer wetlands and waters that would be directly affected by the northern road alignment than were identified on the older and coarser scale NWI mapping (130.63 and 225.46 acres, respectively). In contrast, the DOWL HKM (2014) mapping identified more wetlands and waters that would be directly affected by the southern road alignment than were identified in the NWI mapping (193.60 and 174.81 acres, respectively). We expect that the smaller number of acres of wetlands mapped by DOWL HKM (2014) for the longer northern road alignment, when compared to the NWI mapping, is due to the presence of naturally well-drained and forest-fire disturbed spruce forest areas along the northern alignment that were misclassified as wetlands in the earlier NWI mapping. DOWL HKM (2014) also mapped 544 river and stream crossings in the longer northern road alignment, and 319 river and stream crossings in the shorter southern alignment.

WILDLIFE HABITAT TYPES

Twenty wildlife habitat types were identified in the study area (Figure 2). The aggregation scheme used to derive the set of 20 wildlife habitat types is presented in Appendix A. The area (acres) of each wildlife habitat type expected to occur within the footprint of the proposed project (road surface and embankments, pullouts, and material sites) and the area expected to be influenced by indirect effects (328-ft buffer from the toe of the project footprint) for both the northern and southern road alignments is presented in Table 2. Appendix B provides a crosswalk between the wildlife habitat types, wetland functional classes, and analogous ecotypes developed by Jorgenson et al. (2009). The 20 wildlife habitat types are described below.

Lakes and Ponds: Lacustrine waterbodies in upland, lowland, and riverine terrain; characterized by deep and shallow open water and variable occurrences of emergent sedge marsh vegetation in shallow water shorelines.

Lacustrine Sedge Meadow: Poorly drained wet sedge and sedge-moss meadows associated with Lakes and Ponds; floating mats are included in this type.

Table 2. Impact areas for wildlife habitat types in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska. Direct effects areas are based on the road footprint data provided in the project application and indirect effects areas on a 328-ft buffer zone for the northern and southern road alignments.

	Northern Alignment		Southern Alignment	
Wildlife Habitat Type	Direct Effects Area (acres)	Indirect Effects Area (acres)	Direct Effects Area (acres)	Indirect Effects Area (acres)
Lakes and Ponds	0.01	5.50	0.07	4.03
Lacustrine Sedge Meadow		0.67		0.56
Rivers and Streams	0.60	11.74	1.21	19.52
Riverine Sedge-Shrub Meadow	0.06	0.07	0.05	<0.01
Riverine Grass-Shrub Meadow	0.05	2.78		2.10
Riverine Low Birch-Ericaceous Scrub	1.38	8.70		
Riverine Low Willow Scrub		4.67	0.13	2.30
Riverine Tall Alder-Willow Scrub	2.85	23.39	2.34	18.95
Riverine Mixed Forest			1.04	3.69
Riverine Spruce Forest	3.33	18.85	3.03	24.37
Flow Paths[1]	1.34	9.77	1.03	7.84
Upland and Lowland Sedge-Shrub Meadow	0.54	11.96	0.88	22.73
Upland and Lowland Grass-Shrub Meadow	0.79	7.99	0.97	7.67
Upland and Lowland Low Birch-Ericaceous Scrub	18.71	130.51	3.46	29.10
Tussock Tundra	5.07	47.52		
Upland and Lowland Low Willow Scrub	10.43	106.68	5.28	25.53
Upland and Lowland Tall Alder-Willow Scrub	22.96	201.06	13.40	98.72
Upland and Lowland Seral Spruce Woodland-Tall Scrub	54.64	219.18		
Upland and Lowland Spruce Forest	195.66	1,201.47	246.88	1,120.47
Upland and Lowland Mixed Forest	10.95	44.95	62.22	128.25
Upland Broadleaf Forest	2.35	8.78	1.04	10.37
Outside of Map Area[2]		97.66		134.56
Total	331.74	2,163.90	343.01	1,660.76

1 Flow Paths are parallel ephemeral water tracks that were assessed as part of each habitat type in which they occurred.
2 Lands listed as outside of the map area are those portions of the 328-ft indirect-effects buffers that occur outside of the 2,000-ft corridors in which wetlands were mapped by DOWL HKM (2014); this occurs because the road alignments are not always centered within the 2,000-ft mapping corridors (see Figure 2).

Riverine Grass-Shrub Meadow: Tall grass meadows dominated by bluejoint (*Calamagrostis canadensis*) in riverine corridors; some occurrences of this type have a prominent shrub component.

Riverine Low Birch-Ericaceous Scrub: Moderately well-drained areas dominated by open and closed low shrub birch (*Betula nana*) and ericaceous shrubs; post-burn successional low-scrub areas also are included in this type.

Riverine Low Willow Scrub: Open and closed low (<1.5 m) willow shrub (*Salix* spp.) communities in riverine corridors.

Riverine Mixed Forest: Open mixed spruce (*Picea* spp.)-balsam poplar (*Populus balsamifera*) forests in riverine corridors.

Riverine Sedge-Shrub Meadow: Wet sedge-dominated meadow areas in riverine corridors.

Riverine Spruce Forest: Open black and white spruce (*Picea mariana* and *P. glauca*) forests in riverine corridors; also occurs in a woodland form (<20% cover of trees); understory typically dominated by low willow shrubs.

Riverine Tall Alder-Willow Scrub: Open and closed tall (>1.5 m) shrub thickets characterized by alder (*Alnus* spp.)-willow stands in riverine corridors.

Rivers and Streams: Includes the Kobuk and Reed rivers and their tributaries.

Tussock Tundra: Tussock sedge meadows dominated by tussock cottongrass (*Eriophorum vaginatum*) with associated dwarf and low (<1.5 m) shrubs.

Upland and Lowland Grass-Shrub Meadow: Tall grass meadows dominated by bluejoint in upland and lowland terrain; some occurrences have a prominent shrub component.

Upland and Lowland Low Birch-Ericaceous Scrub: Low shrub birch stands in upland and lowland terrain; understory is typically dominated by low (<1.5 m) and dwarf ericaceous shrubs.

Upland and Lowland Low Willow Scrub: Open and closed low (<1.5 m) willow and birch-willow stands in upland and lowland terrain; includes low shrub types dominated by sweetgale (*Myrica gale*), which cannot be separated from willow on aerial imagery.

Upland and Lowland Mixed Forest: Open mixed spruce-Alaska paper birch (*Betula neoalaskana*) forests, spruce-balsam poplar forests, and spruce-quaking aspen (*Populus tremuloides*) forests in upland and lowland terrain.

Upland and Lowland Sedge-Shrub Meadow: Moist and wet sedge-dominated meadow areas, often with dwarf shrub associates, in upland and lowland terrain.

Upland and Lowland Spruce Forest: Open black spruce and white spruce forests in upland and lowland areas.

Upland and Lowland Seral Spruce Woodland-Tall Scrub: Post-fire, successional tall (>1.5 m) shrub communities with scattered standing dead spruce trees among sapling spruce and birch and tall shrubs.

Upland and Lowland Tall Alder-Willow Scrub: Open and closed tall (>1.5 m) willow and alder dominated stands in upland and lowland terrain.

Upland Broadleaf Forest: Open broadleaf forests dominated by aspen, birch, and balsam poplar in well-drained upland areas.

WILDLIFE HABITAT-USE EVALUATION

Results of the wildlife habitat-use evaluation are presented in Table 3. This information was prepared to assess the importance of each mapped wildlife habitat type for the bird and mammal species expected to occur regularly in the study area, and was used to inform the assessment of the bird and mammal habitat suitability function in the wetland functional assessment (see below).

The forested habitats (Riverine Mixed Forest, Riverine Spruce Forest, Upland and Lowland Mixed Forest, and Upland and Lowland Spruce Forest) are expected to support the greatest numbers of bird species (Table 3), due in large part to the greater diversity in vegetation structure (providing habitat primarily for landbirds) as well as the variation in hydrology and adjacency to surface water (providing habitat for some waterbirds and shorebirds). Conversely, the relatively simple vegetation structure found in the tall-grass types (Riverine Grass-Shrub Meadow and Upland and Lowland Grass-Shrub Meadow) is expected to support fewer numbers of bird species (Table 3). The wetter and lower-stature sedge-dominated meadow habitat, Upland and Lowland Sedge-Shrub Meadow, however, is expected to support a similar number of bird species as the forested habitats, largely because of the use of those wet sedge-shrub meadows by waterbirds and shorebirds. The similar wet meadow habitat, Riverine Sedge-Shrub Meadow, could be used by a comparable number of bird species except that the occurrences of this type in the study area are quite small and scattered (isolated), which will result in less use by those waterbirds and shorebirds that have large territory sizes.

Similar to birds, the forested habitats are expected to support a large number of mammal species because of the variation in vegetation structure, which will provide cover and foraging habitat for rodents, carnivores, and herbivores. Tall and low scrub habitats, which will similarly provide cover and foraging habitat, also are expected to support a relatively large number of mammal species. In general, use of open meadow habitats by mammal species is expected to be noticeably lower than their use of forest and scrub habitats, with the notable exception of Tussock Tundra, which is expected to be regularly used by rodents, carnivores, and caribou.

Table 3. Wildlife habitat-use evaluation for birds and mammals likely to occur regularly, in large or small numbers, in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska. An x indicates a habitat considered important for that species during the life-history stage(s) that occur in the study area.

	Wildlife Habitat (acres)[1]																			
Species	Lakes and Ponds (26.7 acres)	Lacustrine Sedge Meadow (4.4 acres)	Riverine Grass-Shrub Meadow (8.8 acres)	Riverine Low Birch-Ericaceous Scrub (18.1 acres)	Riverine Low Willow Scrub (24.3 acres)	Riverine Mixed Forest (10.2 acres)	Riverine Sedge-Shrub Meadow (1.6 acres)	Riverine Spruce Forest (134.8 acres)	Riverine Tall Alder-Willow Scrub (144.4 acres)	Rivers and Streams (123.0 acres)	Upland and Lowland Grass-Shrub Meadow (45.4 acres)	Upland and Lowland Low Birch-Ericaceous Scrub (652.6 acres)	Tussock Tundra (134.8 acres)	Upland and Lowland Low Willow Scrub (525.8 acres)	Upland and Lowland Mixed Forest (406.4 acres)	Upland and Lowland Sedge-Shrub Meadow (143.5 acres)	Upland and Lowland Seral Spruce Woodland-Tall Scrub (535.9 acres)	Upland and Lowland Spruce Forest (6,892.7 acres)	Upland and Lowland Tall Alder-Willow Scrub (1,110.0 acres)	Upland Broadleaf Forest (66.7 acres)
BIRDS																				
Greater White-fronted Goose	x	x								x			x			x				
Canada Goose	x	x											x			x				
Trumpeter Swan	x	x														x				
Tundra Swan	x	x														x				
American Wigeon	x	x								x				x		x				
Mallard	x	x								x			x	x		x				
Northern Shoveler	x	x														x				
Northern Pintail	x	x								x			x	x		x				
Green-winged Teal	x	x												x		x				
Greater Scaup	x	x																		
Lesser Scaup	x	x												x		x				
White-winged Scoter	x									x								x[2]		
Common Merganser	x					x				x					x					
Red-breasted Merganser	x	x	x	x	x	x			x	x					x					
Ruffed Grouse						x									x					x

Table 3. Continued.

Species	Wildlife Habitat (acres)[1]																			
	Lakes and Ponds (26.7 acres)	Lacustrine Sedge Meadow (4.4 acres)	Riverine Grass-Shrub Meadow (8.8 acres)	Riverine Low Birch-Ericaceous Scrub (18.1 acres)	Riverine Low Willow Scrub (24.3 acres)	Riverine Mixed Forest (10.2 acres)	Riverine Sedge-Shrub Meadow (1.6 acres)	Riverine Spruce Forest (134.8 acres)	Riverine Tall Alder-Willow Scrub (144.4 acres)	Rivers and Streams (123.0 acres)	Upland and Lowland Grass-Shrub Meadow (45.4 acres)	Upland and Lowland Low Birch-Ericaceous Scrub (652.6 acres)	Tussock Tundra (134.8 acres)	Upland and Lowland Low Willow Scrub (525.8 acres)	Upland and Lowland Mixed Forest (406.4 acres)	Upland and Lowland Sedge-Shrub Meadow (143.5 acres)	Upland and Lowland Seral Spruce Woodland-Tall Scrub (535.9 acres)	Upland and Lowland Spruce Forest (6,892.7 acres)	Upland and Lowland Tall Alder-Willow Scrub (1,110.0 acres)	Upland Broadleaf Forest (66.7 acres)
Spruce Grouse						x		x							x			x		
Willow Ptarmigan					x				x			x		x					x	
Sandhill Crane		x														x				
American Golden-Plover													x			x				
Semipalmated Plover										x										
Upland Sandpiper					x								x	x		x				
Whimbrel													x			x				
Least Sandpiper	x	x											x			x				
Pectoral Sandpiper	x	x														x				
Semipalmated Sandpiper	x	x											x			x				
Western Sandpiper	x	x											x			x				
Long-billed Dowitcher	x	x														x				
Wilson's Snipe		x			x							x[3]		x		x		x[4]		
Spotted Sandpiper					x					x										
Solitary Sandpiper	x	x										x[3]				x		x[4]		
Lesser Yellowlegs	x			x	x					x		x[3]		x		x		x[4]		
Red-necked Phalarope	x	x																		
Long-tailed Jaeger				x	x							x	x	x		x				
Bonaparte's Gull	x																	x[2]		
Mew Gull	x				x					x				x		x				

Table 3. Continued.

Species	Wildlife Habitat (acres)[1]																			
	Lakes and Ponds (26.7 acres)	Lacustrine Sedge Meadow (4.4 acres)	Riverine Grass-Shrub Meadow (8.8 acres)	Riverine Low Birch-Ericaceous Scrub (18.1 acres)	Riverine Low Willow Scrub (24.3 acres)	Riverine Mixed Forest (10.2 acres)	Riverine Sedge-Shrub Meadow (1.6 acres)	Riverine Spruce Forest (134.8 acres)	Riverine Tall Alder-Willow Scrub (144.4 acres)	Rivers and Streams (123.0 acres)	Upland and Lowland Grass-Shrub Meadow (45.4 acres)	Upland and Lowland Low Birch-Ericaceous Scrub (652.6 acres)	Tussock Tundra (134.8 acres)	Upland and Lowland Low Willow Scrub (525.8 acres)	Upland and Lowland Mixed Forest (406.4 acres)	Upland and Lowland Sedge-Shrub Meadow (143.5 acres)	Upland and Lowland Seral Spruce Woodland-Tall Scrub (535.9 acres)	Upland and Lowland Spruce Forest (6,892.7 acres)	Upland and Lowland Tall Alder-Willow Scrub (1,110.0 acres)	Upland Broadleaf Forest (66.7 acres)
Arctic Tern	x	x								x										
Pacific Loon	x	x												x[2]		x[2]				
Osprey						x		x							x					
Bald Eagle						x		x							x					
Northern Harrier		x	x		x		x				x		x	x		x				
Sharp-shinned Hawk						x		x							x			x		
Northern Goshawk						x		x							x			x		x
Red-tailed Hawk			x			x					x				x					x
Great Horned Owl		x	x			x	x	x			x				x	x		x		x
Northern Hawk Owl			x			x		x			x				x		x	x		x
Great Gray Owl			x			x		x			x				x			x		
Short-eared Owl			x	x	x		x				x	x	x	x		x				
Boreal Owl						x									x					x
Belted Kingfisher										x										
American Three-toed Woodpecker						x		x							x		x	x		
Northern Flicker						x		x							x			x		x
Merlin						x		x							x		x	x		
Olive-sided Flycatcher						x		x							x		x	x		x
Alder Flycatcher						x			x						x		x		x	
Northern Shrike						x		x	x						x		x	x	x	
Gray Jay						x		x							x		x	x		

Table 3. Continued.

Species	Wildlife Habitat (acres)[1]																			
	Lakes and Ponds (26.7 acres)	Lacustrine Sedge Meadow (4.4 acres)	Riverine Grass-Shrub Meadow (8.8 acres)	Riverine Low Birch-Ericaceous Scrub (18.1 acres)	Riverine Low Willow Scrub (24.3 acres)	Riverine Mixed Forest (10.2 acres)	Riverine Sedge-Shrub Meadow (1.6 acres)	Riverine Spruce Forest (134.8 acres)	Riverine Tall Alder-Willow Scrub (144.4 acres)	Rivers and Streams (123.0 acres)	Upland and Lowland Grass-Shrub Meadow (45.4 acres)	Upland and Lowland Low Birch-Ericaceous Scrub (652.6 acres)	Tussock Tundra (134.8 acres)	Upland and Lowland Low Willow Scrub (525.8 acres)	Upland and Lowland Mixed Forest (406.4 acres)	Upland and Lowland Sedge-Shrub Meadow (143.5 acres)	Upland and Lowland Seral Spruce Woodland-Tall Scrub (535.9 acres)	Upland and Lowland Spruce Forest (6,892.7 acres)	Upland and Lowland Tall Alder-Willow Scrub (1,110.0 acres)	Upland Broadleaf Forest (66.7 acres)
Common Raven			x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
Tree Swallow	x		x			x	x	x		x	x				x	x		x		
Black-capped Chickadee						x		x							x			x		x
Boreal Chickadee						x		x							x			x		x
Gray-headed Chickadee						x		x	x						x		x	x	x	
American Dipper										x										
Ruby-crowned Kinglet						x		x							x			x		x
Arctic Warbler				x	x				x			x		x			x		x	
Bluethroat				x	x				x			x		x			x		x	
Gray-cheeked Thrush						x		x	x						x		x	x	x	
Swainson's Thrush						x		x							x		x			x
American Robin						x	x	x	x						x	x	x	x	x	x
Varied Thrush						x		x	x						x		x	x	x	x
Bohemian Waxwing						x		x							x			x		x
Eastern Yellow Wagtail					x		x						x	x		x				
Pine Grosbeak						x		x							x			x		
White-winged Crossbill						x		x							x			x		
Common Redpoll				x	x	x		x	x			x		x	x		x	x	x	x
Hoary Redpoll				x	x	x		x	x			x		x	x		x	x	x	x

Table 3. Continued.

Species	Wildlife Habitat (acres)[1]																			
	Lakes and Ponds (26.7 acres)	Lacustrine Sedge Meadow (4.4 acres)	Riverine Grass-Shrub Meadow (8.8 acres)	Riverine Low Birch-Ericaceous Scrub (18.1 acres)	Riverine Low Willow Scrub (24.3 acres)	Riverine Mixed Forest (10.2 acres)	Riverine Sedge-Shrub Meadow (1.6 acres)	Riverine Spruce Forest (134.8 acres)	Riverine Tall Alder-Willow Scrub (144.4 acres)	Rivers and Streams (123.0 acres)	Upland and Lowland Grass-Shrub Meadow (45.4 acres)	Upland and Lowland Low Birch-Ericaceous Scrub (652.6 acres)	Tussock Tundra (134.8 acres)	Upland and Lowland Low Willow Scrub (525.8 acres)	Upland and Lowland Mixed Forest (406.4 acres)	Upland and Lowland Sedge-Shrub Meadow (143.5 acres)	Upland and Lowland Seral Spruce Woodland-Tall Scrub (535.9 acres)	Upland and Lowland Spruce Forest (6,892.7 acres)	Upland and Lowland Tall Alder-Willow Scrub (1,110.0 acres)	Upland Broadleaf Forest (66.7 acres)
Lapland Longspur							x						x			x				
Northern Waterthrush						x		x	x	x										
Orange-crowned Warbler						x		x	x						x		x	x	x	x
Yellow Warbler									x								x		x	
Blackpoll Warbler						x		x	x						x		x	x	x	
Yellow-rumped Warbler						x		x	x						x			x	x	x
Wilson's Warbler						x		x	x						x		x	x	x	
American Tree Sparrow				x	x		x		x			x		x		x	x		x	
Savannah Sparrow		x	x	x	x		x				x	x	x	x		x				
Fox Sparrow					x	x		x	x					x	x		x	x	x	
White-crowned Sparrow				x	x			x	x			x		x			x	x	x	
Golden-crowned Sparrow				x	x				x											
Dark-eyed Junco						x		x							x			x		x
Rusty Blackbird	x													x^2		x		x^2	x^2	
MAMMALS																				
American Red Squirrel						x		x							x			x		

Table 3. Continued.

Species	Wildlife Habitat (acres)[1]																			
	Lakes and Ponds (26.7 acres)	Lacustrine Sedge Meadow (4.4 acres)	Riverine Grass-Shrub Meadow (8.8 acres)	Riverine Low Birch-Ericaceous Scrub (18.1 acres)	Riverine Low Willow Scrub (24.3 acres)	Riverine Mixed Forest (10.2 acres)	Riverine Sedge-Shrub Meadow (1.6 acres)	Riverine Spruce Forest (134.8 acres)	Riverine Tall Alder-Willow Scrub (144.4 acres)	Rivers and Streams (123.0 acres)	Upland and Lowland Grass-Shrub Meadow (45.4 acres)	Upland and Lowland Low Birch-Ericaceous Scrub (652.6 acres)	Tussock Tundra (134.8 acres)	Upland and Lowland Low Willow Scrub (525.8 acres)	Upland and Lowland Mixed Forest (406.4 acres)	Upland and Lowland Sedge-Shrub Meadow (143.5 acres)	Upland and Lowland Seral Spruce Woodland-Tall Scrub (535.9 acres)	Upland and Lowland Spruce Forest (6,892.7 acres)	Upland and Lowland Tall Alder-Willow Scrub (1,110.0 acres)	Upland Broadleaf Forest (66.7 acres)
Arctic Ground Squirrel					x							x	x	x						
Beaver									x	x										
Collared Lemming					x							x	x	x					x	
Brown Lemming		x	x	x			x					x	x	x					x	
Singing Vole				x	x				x			x		x			x		x	
Tundra Vole				x	x	x						x	x	x			x		x	
Taiga Vole						x		x	x						x		x	x	x	
Northern Red-backed Vole						x		x	x				x		x		x	x	x	
Northern Bog Lemming		x			x	x	x					x		x	x					
Porcupine						x		x							x		x	x		x
Snowshoe Hare				x	x	x		x	x					x	x		x	x	x	
Cinereus Shrew					x	x		x	x			x	x	x	x		x		x	x
American Pygmy Shrew				x	x	x		x				x	x	x	x		x	x	x	x
Dusky Shrew				x	x	x		x	x			x	x	x	x		x		x	
Tundra Shrew				x		x		x	x			x	x		x		x	x	x	
Lynx						x		x	x			x			x		x	x	x	
Wolf	x[5]	x	x	x	x	x		x	x	x[5]	x	x	x	x	x	x	x	x	x	x
Red Fox		x	x	x	x	x		x			x	x	x	x	x	x		x		x
Black Bear				x	x	x		x	x	x					x					

Table 3. Continued.

Species	Wildlife Habitat (acres)[1]																			
	Lakes and Ponds (26.7 acres)	Lacustrine Sedge Meadow (4.4 acres)	Riverine Grass-Shrub Meadow (8.8 acres)	Riverine Low Birch-Ericaceous Scrub (18.1 acres)	Riverine Low Willow Scrub (24.3 acres)	Riverine Mixed Forest (10.2 acres)	Riverine Sedge-Shrub Meadow (1.6 acres)	Riverine Spruce Forest (134.8 acres)	Riverine Tall Alder-Willow Scrub (144.4 acres)	Rivers and Streams (123.0 acres)	Upland and Lowland Grass-Shrub Meadow (45.4 acres)	Upland and Lowland Low Birch-Ericaceous Scrub (652.6 acres)	Tussock Tundra (134.8 acres)	Upland and Lowland Low Willow Scrub (525.8 acres)	Upland and Lowland Mixed Forest (406.4 acres)	Upland and Lowland Sedge-Shrub Meadow (143.5 acres)	Upland and Lowland Seral Spruce Woodland-Tall Scrub (535.9 acres)	Upland and Lowland Spruce Forest (6,892.7 acres)	Upland and Lowland Tall Alder-Willow Scrub (1,110.0 acres)	Upland Broadleaf Forest (66.7 acres)
Brown Bear				x	x	x		x	x	x		x	x	x	x	x	x	x	x	x
River Otter										x										
Wolverine				x	x	x		x	x	x[5]		x	x	x	x	x	x	x	x	
American Marten						x		x							x		x	x		x
Short-tailed Weasel						x		x	x			x	x	x	x		x	x	x	
Least Weasel						x		x	x						x		x	x	x	
Moose	x	x	x	x	x	x		x	x		x			x			x	x	x	x
Caribou				x	x							x	x	x		x		x		

[1] Use of 64.8 acres of Flow Paths (narrow ephemeral water tracks) were assessed as part of each habitat type they occurred in.
[2] Regularly-used where adjacent to Lakes and Ponds.
[3] Wet scrub bog component of this habitat only.
[4] Wet dwarf black spruce woodland component of this habitat only.
[5] Frozen surface used for travel during winter.

WETLAND FUNCTIONAL CLASSES

Sixteen wetland functional classes (groupings of wetland types that share similar wetland functions) were identified from the ITU data for the study area (Figure 2). The ITU code combinations and the aggregation of those 379 composite codes into the final set of 16 wetland functional classes is outlined in Appendix C. Analogous local scale ecosystems, or ecotypes (from Jorgenson et al. 2009), which were crosswalked to each wetland functional class, and the common vascular plant species likely to occur in each functional class are presented in Table 4. Lastly, a crosswalk between the wetland functional classes, the analogous ecotypes (from Jorgenson et al. 2009), and the wildlife habitat types mapped in this study is presented in Appendix B.

The area (acres) of each wetland functional class expected to occur within the footprint of the proposed project (direct effects of the road, pullouts, and material sites) and the area expected to be influenced by indirect effects (328-ft buffer zone from the toe of the project footprint) for both the northern and southern road alignments is presented in Table 5. Although the northern alignment (26.0 miles) is over 8 miles longer than the southern alignment (17.8 miles), it would directly affect less acreage of wetlands and waters than the southern alignment (130.03 and 192.38 acres, respectively). This relationship holds for indirect effects also, in which the northern alignment would affect less wetland and waters acreage than the southern alignment (1,071.23 and 1,215.06 acres, respectively). Note that the acreage values for indirect effects are overestimates in some cases because all indirect impacts are not likely to occur uniformly throughout the entire width of the 328-ft buffer; some effects may be localized and restricted to the upslope side of the road (e.g., small impoundments), and others would occur along a gradient of effects according to distance from the road (e.g., dust effects).

Two wetland functional classes, Lacustrine Fringe Wet Sedge Meadow and Depressional Saturated Deciduous Shrub, were not located within the direct-effects footprint of either the northern or southern road alignment, and comprised <1.0 acre within each alignment's indirect-effects buffer. Some portions of the indirect-effects buffer in each alignment also were outside of the 2,000-ft mapping corridor used by DOWL HKM (2014); nearly 100 and 135 acres within the northern and southern road alignments, respectively, were located outside of the mapping

Table 4. Wetland functional classes, analogous ecotypes, and common plant species expected to occur in each functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

Wetland Functional Class	Analogous Ecotypes (Jorgenson et al. 2009)	Common Plant Species (Jorgenson et al. 2009)
Flow Paths	various	
Lakes and Ponds	Lowland Lake Riverine Lake	*Potamageton* spp., *Utricularia vulgaris*
Lacustrine Fringe Wet Sedge Meadow	Lacustrine Wet Sedge Meadow	*Eriophorum angustifolium, Carex chordorrhiza*
Depressional Wet Sedge-Shrub Meadow	Lacustrine Wet Sedge Meadow	*Eriophorum angustifolium, Carex chordorrhiza*
Depressional Saturated Graminoid-Shrub Meadow	Lacustrine Bluejoint Meadow	*Calamagrostis canadensis, Polemonium acutiflorum, Eriophorum angustifolium*
Depressional Saturated Deciduous Shrub	Lacustrine Willow Shrub	*Salix pulchra, Betula nana, Arctagrostis latifolia, Carex aquatilis*
Slope Wet Sedge-Shrub Meadow	Lowland Sedge Fen Lowland Sedge-Willow Fen	*Salix pulchra, Carex chordorrhiza, Carex aquatilis, Eriophorum angustifolium, Potentilla palustris*
Slope Saturated Graminoid-Shrub Meadow	Upland Bluejoint Meadow	*Calamagrostis canadensis*
Slope Wet Deciduous Shrub	Lowland Willow Low Shrub	*Alnus viridis* ssp. *crispa, Salix richardsonii, Salix pulchra,*
Slope Saturated Deciduous Shrub	Upland Birch-Ericaceous Low Shrub Upland Birch-Willow Low Shrub Upland Dwarf Birch-Tussock Shrub Upland Willow Low Shrub Upland Alder-Willow Tall Shrub	*Alnus viridis* ssp. *crispa, Salix richardsonii, Betula nana, Salix pulchra, Equisetum arvense, Eriophorum vaginatum*
Slope Saturated Shrub Peatland	Lowland Ericaceous Shrub Bog	*Sphagnum* spp, *Andromeda polifolia, Betula nana, Carex aquatilis, Carex rotundata*
Slope Saturated Spruce Forest	Lowland Black Spruce Forest	*Picea mariana, Ledum decumbens, Vaccinium uliginosum, Carex bigelowii*
Riverine Wet Sedge-Shrub Meadow	Riverine Wet Sedge Meadow	*Carex aquatilis, Eriophorum angustifolium*
Riverine Seasonally Flooded Graminoid-Shrub Meadow	Riverine Bluejoint Meadow	*Calamagrostis canadensis*

Table 4. Continued.

Wetland Functional Class	Analogous Ecotypes (Jorgenson et al. 2009)	Common Plant Species (Jorgenson et al. 2009)
Riverine Seasonally Flooded Deciduous Shrub	Riverine Birch-Willow Low Shrub Riverine Willow Low Shrub Riverine Moist Willow Tall Shrub Riverine Wet Willow Tall Shrub	*Betula nana, Salix alaxensis, Salix pulchra, Salix richardsonii, Salix reticulata, Potentilla palustris*
Riverine Seasonally Flooded Spruce Forest	Riverine White Spruce-Willow Forest	*Picea glauca, Salix richardsonii*

Table 5. Impact areas for riverine and wetland functional classes in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska. Direct effects areas are based on the road footprint data provided in the project application and indirect effects areas on a 328-ft buffer zone for the northern and southern road alignments.

Functional Class	Northern Alignment		Southern Alignment	
	Direct Effects Area (acres)	Indirect Effects Area (acres)[1]	Direct Effects Area (acres)	Indirect Effects Area (acres)[1]
Riverine[2]				
Major Rivers	0.14	5.33	0.33	13.73
Large Streams	0.06	3.38	0.08	0.33
Low-gradient Small Streams	0.35	2.63	0.81	5.46
High-Gradient Small Streams	0.05	0.39		<0.01
Riverine Class Total	0.60	11.73	1.22	19.52
Wetlands				
Flow Paths	1.34	9.77	1.03	7.84
Lakes and Ponds	0.01	5.50	0.07	4.03
Lacustrine Fringe Wet Sedge Meadow		0.67		0.56
Depressional Wet Sedge-Shrub Meadow			0.13	2.35
Depressional Saturated Graminoid-Shrub Meadow	0.76	6.25	0.34	0.38
Depressional Saturated Deciduous Shrub		0.55		0.24
Slope Wet Sedge-Shrub Meadow	0.54	11.96	0.75	20.38
Slope Wet Deciduous Shrub	14.43	131.55	12.73	98.50
Slope Saturated Graminoid-Shrub Meadow	0.03	0.89	0.63	7.29
Slope Saturated Deciduous Shrub	36.05	309.72	5.88	25.30
Slope Saturated Shrub Peatland	1.80	13.47	3.46	27.59
Slope Saturated Spruce Forest	67.92	523.12	162.52	981.87
Riverine Wet Sedge-Shrub Meadow	0.06	0.07	0.05	<0.01
Riverine Seasonally Flooded Graminoid-Shrub Meadow	0.05	2.78		2.10
Riverine Seasonally Flooded Deciduous Shrub	4.23	36.73	2.46	21.14
Riverine Seasonally Flooded Spruce Forest	2.81	18.20	2.33	15.49
Wetlands Class Total	130.03	1,071.23	192.38	1,215.06

Table 5. Continued.

Functional Class	Northern Alignment: Direct Effects Area (acres)	Northern Alignment: Indirect Effects Area (acres)[1]	Southern Alignment: Direct Effects Area (acres)	Southern Alignment: Indirect Effects Area (acres)[1]
Other Lands				
Uplands	201.11	983.28	149.41	291.62
Outside of Map Area[3]		97.66		134.56
Other Lands Total	201.12	1,080.96	149.42	426.18
Grand Total	331.74	2,163.90	343.01	1,660.76

1 Acreage figures for indirect effects may be overestimates in some cases because indirect impacts are not likely to occur uniformly throughout the 328-ft buffer zone (see text for additional discussion).
2 Direct impacts to riverine functions should not involve gravel fill assuming that bridges and culverts are installed as outlined in the project application.
3 Lands listed as outside of the map area are those portions of the 328-ft indirect-effects buffers that occur outside of the 2,000-ft corridors in which wetlands were mapped by DOWL HKM (2014); this occurs because the road alignments are not always centered within the 2,000-ft mapping corridors (see Figure 2).

corridor because the road alignments are not always centered within the 2,000-ft mapping corridors used by DOWL HKM (2014, see Figure 2). Descriptions of each functional class are presented below.

Flow Paths: Mapped by DOWL HKM (2014) as permanently flooded upper perennial streams (R3UBH). A combination of GIS modeling and a review of the existing map polygons, as described in Methods above, was used to distinguish ephemeral Flow Paths from perennial and intermittent streams. Because these small, narrow features do not possess characteristic riverine morphology (bed and banks), they were assessed as a separate (non-riverine) wetland functional class. Flow Paths are often located within water tracks, which are drainage-related features in poorly-defined, shallow depressions or swales. The high soil moisture content in water tracks allows for more robust vegetation growth, which can make them easier to distinguish from the air than on the ground (Woo 2012). McNamara et al. (1999) describe water tracks as occupying a transitional flow regime between hillslope flow paths and fluvial channels at valley bottoms. Near-surface permafrost is suggested to control erosion in water tracks, preventing the development of a channel network (McNamara et al. 1999). This aligns with the description of parallel, linear surface water features in GAAR that convey water ephemerally, but that do not aggrade through the organic mat or coalesce into a dendritic stream network (Swanson 1995). Flow Paths in the study area are located in upland, lowland, and riverine terrain within both the northern and southern road alignments (Figure 2). Minor culverts are planned where Flow Paths would cross the possible road alignments; this includes 219 crossings in the northern alignment and 211 crossings in the southern alignment (Figure 2).

Lakes and Ponds: Permanently flooded waterbodies occur in both the northern and southern road alignment corridors (Figure 2). Most are small (<20 acres) waterbodies, although the margins of two larger lakes (Nutuvukti Lake and an unnamed lake, >20 acres each) occur on the edge of the northern road alignment corridor. While the majority of Lakes and Ponds are either lacustrine waters in depressions or small, shallow ponds in fens, this functional class also includes abandoned oxbows and flood basins in the floodplains of the Kobuk and Reed rivers. Only a very small area of Lakes and Ponds (<0.10 acres, Table 5) is located within the direct-effects footprint of either the northern or southern road alignments.

Lacustrine Fringe Wet Sedge Meadow: Permanently to seasonally flooded sedge and sedge-moss meadows, including floating mats, where the hydrology is assumed to be controlled primarily by adjacent lacustrine waterbodies. Lacustrine Fringe Wet Sedge Meadow is associated with 4 waterbodies in the Lakes and Ponds functional class: the 2 larger lakes (Nutuvukti Lake and an unnamed lake, >20 acres each), which occur on the edge of the northern road alignment corridor; a lacustrine depressional waterbody in the northern road alignment corridor; and a lacustrine depressional waterbody in the southern road alignment corridor (Figure 2). No Lacustrine Fringe Wet Sedge Meadow is located within the direct-effects footprint of either the northern or southern road alignments (Table 5).

Depressional Wet Sedge-Shrub Meadow: Permanently to seasonally flooded sedge and willow meadows located in basins; this type was treated as a depressional HGM class because it occurs in water-collecting basins. The majority of this functional class is located in the coarse morainal deposits north of Nutuvukti Lake, in the western-most 2 miles of the northern road alignment corridor (Figure 2). Because of the coarse moraine deposits, we have high confidence (see Table 1) that this wetland functional class either lacks permafrost entirely or has a deep active layer (i.e., no near-surface permafrost). No occurrences of Depressional Wet Sedge-Shrub Meadow are located within either the direct-effects footprint or the indirect-effects buffer of the northern road alignment (Table 5).

Depressional Saturated Graminoid-Shrub Meadow: Saturated bluejoint meadows associated with drained basins. The majority of this functional class is located in the coarse morainal deposits north of Nutuvukti Lake, in the western-most 2 miles of the northern road alignment corridor (Figure 2). Because of the coarse moraine deposits, we have high confidence (see Table 1) that this wetland functional class either lacks permafrost entirely or has a deep active layer (i.e., no near-surface permafrost).

Depressional Saturated Deciduous Shrub: Saturated willow shrub communities in depressions; primarily characterized by low (<1.5 m) willows. The majority of this functional class is located in the coarse morainal deposits north of Nutuvukti Lake, in the western-most 2 miles of the northern road alignment corridor (Figure 2). Because of the coarse moraine deposits, we have high confidence (see Table 1) that this wetland functional class either lacks permafrost entirely or has a deep active layer (i.e., no near-surface permafrost). No occurrences of Depressional Wet Sedge-Shrub Meadow are located within either the direct-effects footprint or the indirect-effects buffer of the northern road alignment (Table 5).

Slope Wet Sedge-Shrub Meadow: Poorly drained sedge and sedge-willow communities occur throughout both the northern and southern road alignments (Figure 2). These non-patterned wetlands occur on lower slopes, toe slopes, and across valley bottoms.

Slope Saturated Graminoid-Shrub Meadow: Saturated bluejoint meadows in both the northern and southern road alignment corridors (Figure 2). Landscape position distinguishes this functional class, which is located in level to gently sloping terrain, from the ecologically similar Depressional Saturated Graminoid-Shrub Meadow, which is typically located in depressional basins in areas of morainal deposits.

Slope Wet Deciduous Shrub: Seasonally to semi-permanently flooded, low (<1.5 m) and tall (>1.5 m) willow and alder-willow communities. Found in drainage swales, this functional class is located throughout both the northern and southern road alignment corridors (Figure 2).

Slope Saturated Shrub Peatland: Saturated to seasonally flooded, low (<1.5 m) shrub and moss wetlands located in the northern road alignment corridor (Figure 2). DOWL HKM (2014) does not report pH or EC values, and the species composition of these wetlands (frequently dominated by ericaceous shrubs and *Eriophorum vaginatum*) suggests they could be either bogs or poor fens. This functional class was treated as a slope HGM class due to its occurrence on lower slopes and toe slopes.

Slope Saturated Deciduous Shrub: Saturated low (<1.5 m) and tall (>1.5 m) shrub communities, frequently in lower slope and toe slope positions. While occurring in both the northern and southern road alignment corridors, this wetland functional class occurs predominantly in the northern road alignment corridor (Figure 2, Table 5).

Slope Saturated Spruce Forest: Saturated black spruce forested wetlands are prevalent throughout both the northern and southern road alignment corridors (Figure 2, Table 5). This wetland functional class typically has a shallow active layer and thick surface organics and it is located in a variety of landscape positions.

Riverine Wet Sedge-Shrub Meadow: Poorly drained sedge and sedge-willow meadows primarily associated with the Major Rivers and Large Streams riverine functional classes in both the northern and southern road alignment corridors; this functional class also occurs along a stretch of the Low-gradient Small Streams riverine functional class in the northern road alignment corridor (Figure 2). As Major Rivers and Large Streams are likely to have thaw bulbs (taliks), we have high confidence (see Table 1) that this wetland functional class either lacks permafrost entirely or has a deep active layer (i.e., no near-surface permafrost).

Riverine Seasonally Flooded Graminoid-Shrub Meadow: Seasonally flooded-saturated bluejoint meadows in riverine corridors, primarily associated with Major Rivers and Large Streams (Figure 2). This functional class is associated with the Reed River (Major Rivers) in the southern road alignment corridor, the Kobuk River (Major Rivers) in the northern road alignment corridor, and Large Streams and Low-gradient Small Streams in the northern road alignment corridor. As Major Rivers and Large Streams are likely to have thaw bulbs (taliks), we have high confidence (see Table 1) that most occurrences of this wetland functional class either lack permafrost entirely or have deep active layers (i.e., no near-surface permafrost).

Riverine Seasonally Flooded Deciduous Shrub: Seasonally flooded low (<1.5 m) to tall (>1.5 m) deciduous shrub stands, typically willow. This class is primarily associated with Major Rivers and Large Streams, but also occurs along Low-gradient Small Streams in both the northern and southern road alignment corridors (Figure 2). As Major Rivers and Large Streams are likely to have thaw bulbs (taliks), we have high confidence (see Table 1) that most occurrences of this wetland functional class either lack permafrost entirely or have deep active layers (i.e., no near-surface permafrost).

Riverine Seasonally Flooded Spruce Forest: Seasonally flooded white spruce forests, often with a willow understory. This class is associated with Major Rivers and Large Streams in both the northern and southern road alignment corridors (Figure 2). As Major Rivers and Large Streams are likely to have thaw bulbs (taliks), we have high confidence (see Table 1) that this wetland functional class either lacks permafrost entirely or has a deep active layer (i.e., no near-surface permafrost).

WETLAND FUNCTIONAL ASSESSMENT

Wetland functional scores were calculated for existing conditions and for the predicted change in functional conditions after construction of the proposed road (Table 6, Appendix D).

Table 6. Wetland functional scores for existing conditions and predicted direct and indirect effects by wetland functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

Wetland Functional Class		Flood Flow Regulation	Sediment, Nutrient, and Toxicant Removal	Erosion Control and Shoreline Stabilization	Organic Matter Production and Export	Maintenance of Soil Thermal Regime	Threatened and Endangered Species Support	Bird and Mammal Habitat Suitability	Fish Habitat Suitability	Rare Plant Habitat and Native Plant Diversity	Subsistence Use	Groundwater Discharge	Groundwater Recharge
Flow Paths	Existing conditions	0.25	0.67	1.00	1.00	0.80	N/A	0.40	N/A	0.00	0.00	N/A	N/A
	Direct effects	0.00	0.00	0.00	0.00	0.00	N/A	0.00	N/A	0.00	0.00	N/A	N/A
	Indirect effects	0.13	0.50	0.50	0.67	0.50	N/A	0.30	N/A	0.00	0.00	N/A	N/A
Lakes and Ponds	Existing conditions	0.50	1.00	N/A	0.50	0.20	N/A	0.60	0.50	0.00	0.33	N/A	N/A
	Direct effects	0.00	0.00	N/A	0.00	0.00	N/A	0.00	0.00	0.00	0.00	N/A	N/A
	Indirect effects	0.50	1.00	N/A	0.50	0.20	N/A	0.47	0.50	0.00	0.33	N/A	N/A
Lacustrine Fringe Wet Sedge Meadow	Existing conditions	0.25	0.40	N/A	1.00	0.40	N/A	0.49	0.25	0.33	0.33	N/A	N/A
	Direct effects	0.00	0.00	N/A	0.00	0.00	N/A	0.00	0.00	0.00	0.00	N/A	N/A
	Indirect effects	0.25	0.40	N/A	1.00	0.40	N/A	0.39	0.25	0.17	0.33	N/A	N/A
Depressional Wet Sedge-Shrub Meadow	Existing conditions	0.50	0.60	N/A	1.00	N/A	N/A	0.49	N/A	0.33	0.33	0.00	0.33
	Direct effects	0.00	0.00	N/A	0.00	N/A	N/A	0.00	N/A	0.00	0.00	0.00	0.00
	Indirect effects	0.50	0.60	N/A	1.00	N/A	N/A	0.39	N/A	0.17	0.33	0.00	0.33
Depressional Saturated Graminoid-Shrub Meadow	Existing conditions	0.75	0.40	N/A	0.67	N/A	N/A	0.44	N/A	0.00	0.33	0.00	0.33
	Direct effects	0.00	0.00	N/A	0.00	N/A	N/A	0.00	N/A	0.00	0.00	0.00	0.00
	Indirect effects	0.75	0.40	N/A	0.67	N/A	N/A	0.34	N/A	0.00	0.33	0.00	0.33
Depressional Saturated Deciduous Shrub	Existing conditions	1.00	0.40	N/A	0.33	N/A	N/A	0.78	N/A	0.00	0.33	0.00	0.33
	Direct effects	0.00	0.00	N/A	0.00	N/A	N/A	0.00	N/A	0.00	0.00	0.00	0.00
	Indirect effects	1.00	0.40	N/A	0.33	N/A	N/A	0.58	N/A	0.00	0.33	0.00	0.33
Slope Wet Sedge-Shrub Meadow	Existing conditions	0.50	0.40	1.00	1.00	0.60	N/A	0.52	0.25	0.33	0.33	N/A	N/A
	Direct effects	0.00	0.00	0.00	0.00	0.00	N/A	0.00	0.00	0.00	0.00	N/A	N/A
	Indirect effects	0.50	0.40	0.75	0.50	0.50	N/A	0.42	0.25	0.17	0.33	N/A	N/A
Slope Wet Deciduous Shrub	Existing conditions	0.50	0.40	1.00	1.00	0.60	N/A	0.78	0.25	0.00	0.33	N/A	N/A
	Direct effects	0.00	0.00	0.00	0.00	0.00	N/A	0.00	0.00	0.00	0.00	N/A	N/A
	Indirect effects	0.38	0.30	0.75	0.67	0.40	N/A	0.68	0.25	0.00	0.33	N/A	N/A
Slope Saturated Graminoid-Shrub Meadow	Existing conditions	0.25	0.00	1.00	0.67	0.60	N/A	0.24	0.25	0.67	0.33	N/A	N/A
	Direct effects	0.00	0.00	0.00	0.00	0.00	N/A	0.00	0.00	0.00	0.00	N/A	N/A
	Indirect effects	0.25	0.00	1.00	0.67	0.50	N/A	0.14	0.25	0.50	0.33	N/A	N/A
Slope Saturated Deciduous Shrub	Existing conditions	0.50	0.20	1.00	0.67	0.60	N/A	0.57	0.25	0.33	0.33	N/A	N/A
	Direct effects	0.00	0.00	0.00	0.00	0.00	N/A	0.00	0.00	0.00	0.00	N/A	N/A
	Indirect effects	0.38	0.10	0.75	0.50	0.20	N/A	0.37	0.25	0.33	0.33	N/A	N/A
Slope Saturated Shrub Peatland	Existing conditions	0.50	0.40	N/A	0.67	0.80	N/A	0.58	N/A	0.33	0.33	N/A	N/A
	Direct effects	0.00	0.00	N/A	0.00	0.00	N/A	0.00	N/A	0.00	0.00	N/A	N/A
	Indirect effects	0.38	0.30	N/A	0.50	0.70	N/A	0.38	N/A	0.17	0.33	N/A	N/A
Slope Saturated Spruce Forest	Existing conditions	0.50	0.40	1.00	0.33	0.80	N/A	0.61	0.25	0.33	0.67	N/A	N/A
	Direct effects	0.00	0.00	0.00	0.00	0.00	N/A	0.00	0.00	0.00	0.00	N/A	N/A
	Indirect effects	0.50	0.40	1.00	0.33	0.70	N/A	0.51	0.25	0.33	0.67	N/A	N/A

Table 6. Continued.

Wetland Functional Class		Flood Flow Regulation	Sediment, Nutrient, and Toxicant Removal	Erosion Control and Shoreline Stabilization	Organic Matter Production and Export	Maintenance of Soil Thermal Regime	Threatened and Endangered Species Support	Bird and Mammal Habitat Suitability	Fish Habitat Suitability	Rare Plant Habitat and Native Plant Diversity	Subsistence Use	Groundwater Discharge	Groundwater Recharge
Riverine Wet Sedge-Shrub Meadow	Existing conditions	0.25	0.40	1.00	1.00	N/A	N/A	0.24	0.25	0.00	0.00	0.00	0.00
	Direct effects	0.00	0.00	0.00	0.00	N/A	N/A	0.00	0.00	0.00	0.00	0.00	0.00
	Indirect effects	0.25	0.40	1.00	1.00	N/A	N/A	0.14	0.25	0.00	0.00	0.00	0.00
Riverine Seasonally Flooded Graminoid-Shrub Meadow	Existing conditions	0.50	0.60	1.00	1.00	N/A	N/A	0.45	0.25	0.00	0.33	0.00	0.00
	Direct effects	0.00	0.00	0.00	0.00	N/A	N/A	0.00	0.00	0.00	0.00	0.00	0.00
	Indirect effects	0.50	0.60	1.00	1.00	N/A	N/A	0.35	0.25	0.00	0.33	0.00	0.00
Riverine Seasonally Flooded Deciduous Shrub	Existing conditions	0.50	0.40	1.00	1.00	N/A	N/A	0.55	0.25	0.33	0.33	0.00	0.00
	Direct effects	0.00	0.00	0.00	0.00	N/A	N/A	0.00	0.00	0.00	0.00	0.00	0.00
	Indirect effects	0.50	0.40	1.00	1.00	N/A	N/A	0.45	0.25	0.17	0.33	0.00	0.00
Riverine Seasonally Flooded Spruce Forest	Existing conditions	0.50	0.40	0.67	1.00	N/A	N/A	0.62	0.25	0.33	0.33	0.00	0.00
	Direct effects	0.00	0.00	0.00	0.00	N/A	N/A	0.00	0.00	0.00	0.00	0.00	0.00
	Indirect effects	0.50	0.40	0.67	1.00	N/A	N/A	0.52	0.25	0.17	0.33	0.00	0.00

All wetland functional classes occurring within the road footprint would be filled or used as material sites (direct effects), and would lose the capacity to perform any of the ecological services assessed in this study. Wetland functional classes in the 328-ft buffer were assessed for indirect effects by first evaluating the type and likelihood of indirect impacts to wetlands in the study area (Table 7); these predicted impacts include changes in plant community composition, changes in soil physical and chemical characteristics, degradation of permafrost, dust fallout, hydrologic alteration, impounded water, introduction of invasive plant species, and altered use of wetlands by wildlife. This information was then used to assess the likely changes in functional indicators and develop functional scores due to indirect effects for each wetland function and wetland functional class (Table 6, Appendix D). Wetland function scores for existing conditions, and scores assessed after consideration of direct and predicted indirect effects are discussed for each individual wetland function below.

Flood flow regulation: Existing condition scores for flood flow regulation ranged from 0.25 to 1.0 (Table 6, Appendix D). Scores were lowest in those functional classes lacking depressional (water storage) features and/or surface roughness (which slows the rate of sheet flow); this includes Flow Paths, Lacustrine Fringe Wet Sedge Meadow, Saturated Graminoid-Shrub Meadow, and Riverine Wet Sedge-Shrub Meadow. The highest scoring functional classes were Depressional Saturated Graminoid-Shrub Meadow and Depressional Saturated Deciduous Shrub (0.75 and 1.0, respectively), both of which have depressional features and documented indications of water storage; Depressional Saturated Deciduous Shrub also supports dense willow shrub cover, which provides surface roughness (Appendix D).

All wetland functional classes within the direct-effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus eliminating their capacity to provide flood flow regulation; this is represented by a score of 0.0 (no functional capacity) for direct effects (Table 6). For indirect effects, which may not result in full reductions in function, function scores for the 16 functional classes ranged from 0.13 to 1.0 (Table 6).

A reduction in the capacity to perform flood flow regulation is predicted for those wetland functional classes that could undergo a change in plant community composition that would reduce surface roughness; this includes Flow Paths, Slope Wet Deciduous Shrub, Slope

Saturated Deciduous Shrub, and Slope Saturated Shrub Peatland (Table 7, Appendix D). While the existing conditions for each of these functional classes includes substantial cover of low shrubs, providing surface roughness, the community composition for all but Slope Saturated Shrub Peatland is likely to change to one dominated by graminoids in impoundments that are likely to occur at the road/wetland interface (Table 7, Appendix D). Slope Saturated Shrub Peatland may experience reduced shrub cover through soil calcification from dust fallout, which, over time, may result in a greater cover of grasses, resulting in a similar reduction in surface roughness (Table 7, Appendix D). We caution that the spatial extent of indirect effects may be overestimated in some cases. For flood flow regulation, impoundments in particular will only occur on the upslope side of the proposed road.

Sediment, nutrient, and toxicant removal: Existing condition scores for sediment, nutrient, and toxicant removal ranged from 0.0 to 1.0 (Table 6, Appendix D). Scores were highest in 4 functional classes: Lakes and Ponds (1.0), Flow Paths (0.67), Depressional Wet Sedge-Shrub Meadow (0.60), and Riverine Seasonally Flooded Graminoid-Shrub Meadow (0.60). Lakes and Ponds are depressional features, some of which were formed by depositional processes (Appendix D); these waterbodies should be effective at retaining sediments. Flow Paths scored relatively high due to their assumed woody vegetation (provide surface roughness) and vegetation/surface water interspersion (which facilitates the uptake of nutrients and toxicants by plants). As no field ground-reference data were collected for Flow Paths, the presence of sediment deposits and surface organics could not be assessed (Appendix D). Depressional Wet Sedge-Shrub Meadow and Riverine Seasonally Flooded Graminoid-Shrub Meadow scored slightly higher than other wetland functional classes because of their combination of depressional features, vegetation/surface water interspersion, thick surface organics, and/or evidence of deposition during natural flood events (Appendix D). Slope Saturated Graminoid-Shrub Meadow had the lowest existing condition score (0.0) because it lacked all indicators for sediment, nutrient, and toxicant removal (Appendix D).

All wetland functional classes within the direct-effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus eliminating their capacity to provide sediment, nutrient, and toxicant removal; this is represented by a score of 0.0 (no functional capacity) for

Table 7. Indirect impacts assessed by wetland functional class for both the northern and southern road alignments in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska. Impacts were assessed based on the specific locations of the occurrences of each wetland functional class in the 328-ft indirect-effects buffer zone.

Wetland Functional Class	Changes in Plant Community Composition	Changes in Soil Physical / Chemical Characteristics	Permafrost Degradation	Dust	Hydrologic Alteration[1]	Impoundments	Invasive Plant Species	Altered Habitat Use
Flow Paths	Some localized changes in plant community composition are possible at road-vegetation interface. Plant community composition will likely shift to one dominated by graminoids over time due to impoundments, although overall cover and biomass may decrease (Auerbach et al. 1997, Myers-Smith et al. 2006).	Ephemeral flow paths are unlikely to accumulate sufficient sediment from dust loading to alter sediment pH, texture.	Influenced by extent to which impoundments develop next to road. Waterbodies serve as heat sinks for thawing underlying permafrost.	Ephemeral flow paths unlikely to be affected by dust fall, although probably some modest sediment load where flow paths come close to the road (shrub/forest canopy in many areas probably retains some of the dust fall).	If drainages are blocked by poor culvert placement, areas where flow paths channels are close together could coalesce at the road, creating additional impoundments.	Potential for poor placement of culverts to manage cross drainage due to difficulty in determining exact location of flow path (channels are small and may be obscured by vegetation). Thus, water may impound on upslope side of road during spring flooding, and concentrated flow at culvert outlets may aggrade through organic mat.	Some risk for wetlands near road. Dust effects could encourage colonization by invasives.	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Lakes and Ponds	Not applicable to these generally unvegetated communities.	Aquatic systems are unlikely to accumulate sufficient sediment from dust loading to alter sediment pH or texture.		Probably modest sediment load where waterbodies come close to the road, although the shrub/forest canopy present in many areas between the road and waterbody captures some of the dust fall (Forman et al. 2003) and sediment tends to dissipate and be diluted when it lands on a waterbody.	Low frequency near road, hydrology not likely to be notably altered by road.	Low frequency near road, impoundments unlikely.	Invasive species risk is most likely to be restricted to terrestrial plant species in this region.	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Lacustrine Fringe Wet Sedge Meadow	Level of sediment deposition not likely to be sufficient to change plant community. Potential for some decrease in moss cover over time.	Risk is negligible, as majority of this habitat is more than 50 m from road; dust accumulation unlikely to substantively change soil characteristics. Modest risk for one occurrence that is close to road footprint. Could see a slight increase in soil pH from dust deposition, although the likely seasonal flooding (flushing) of these areas may ameliorate this effect.	Active layer is probably deep or habitat may even part of talik (thaw bulb) associated with waterbody.	One occurrence within 50 m of road; potentially some sediment deposition, although impacts ameliorated with likely annual spring flooding (flushing). For wetlands further than 50 m from road, probably some slight sediment load although shrub/forest canopy is present in most areas between habitat and road that likely retains much of the dust fall.	Low frequency near road, hydrology not likely to be notably altered by road.	Low frequency near road, impoundments unlikely.	Risk is negligible as this habitat is more than 50 m from road. Risk is also limited as habitat is not suitable for the invasive species that would have the potential to establish along the road (they are typically more attracted to mesic to dry habitats, while these soils are wet and organic rich).	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.

Table 7. Continued.

Wetland Functional Class	Changes in Plant Community Composition	Changes in Soil Physical / Chemical Characteristics	Permafrost Degradation	Dust	Hydrologic Alteration[1]	Impoundments	Invasive Plant Species	Altered Habitat Use
Depressional Wet Sedge-Shrub Meadow	One occurrence next to road so some potential for shift to more deciduous shrub-dominated community over time if site were to become drier (from dust loading). Since these areas are depressional, however, they may be seasonally flooded, which would help flush sediment into adjacent waterbody.	Potential for some increase in pH for occurrence next to road, but seasonal flushing may ameliorate this effect.	These are depressional wetlands underlain by glacial till, unlikely to have a shallow active layer.	Dust impacts are expected to be minimal because of seasonal flushing of water.	Depressional wetlands underlain by glacial till are unlikely to experience altered hydrology.	One occurrence, with an ephemeral outlet that doesn't cross the road, directly abuts the road and thus a low potential for impoundments.	Risk is negligible as habitat is not suitable for the invasive species that would have the potential to establish along the road (they are typically more attracted to mesic to dry habitats, while these soils are wet and organic rich).	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Depressional Saturated Graminoid-Shrub Meadow	Numerous occurrences near road (within first 50 m), overall cover and biomass may decrease (Auerbach et al. 1997, Myers-Smith et al. 2006), substantial shift in community composition is not anticipated.	Soils are likely acidic (underlain by glacial till), if gravel sources are from abandoned floodplain deposits, an increase in soil pH is likely over time.	These are depressional wetlands underlain by glacial till, unlikely to have a shallow active layer.	see Changes in Plant Community Composition.	Depressional wetlands underlain by glacial till are unlikely to experience altered hydrology.	Few instances where these habitats intersect the road edge and they do not appear to be associated with drainage features, thus low likelihood of impoundments.	Some risk for wetlands near road. Dust effects could encourage colonization by invasives.	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Depressional Saturated Deciduous Shrub	Numerous occurrences near road (within first 50 m), overall cover and biomass may decrease (Auerbach et al. 1997, Myers-Smith et al. 2006), substantial shift in community composition is not anticipated.	Soils are likely acidic (underlain by glacial till), if gravel sources are from abandoned floodplain deposits, an increase in soil pH is likely over time.	These are depressional wetlands underlain by glacial till, unlikely to have a shallow active layer.	see Changes in Plant Community Composition.	Depressional wetlands underlain by glacial till, unlikely to experience altered hydrology.	Not applicable, as this wetland functional class does not directly abut the road.	Some risk for wetlands near road. Dust effects could encourage colonization by invasives.	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Slope Wet Sedge-Shrub Meadow	Changes in plant community composition would mostly be associated with changes in wetland hydrology from impoundments (i.e., conversion from seasonally flooded to semipermanently or permanently flooded). Dust impacts are expected to be minimal because of seasonal flushing of water.	Based on limited field data, soils tend to have thick organic horizons, which suggest that changes in soil characteristics would be limited. Perhaps some development of a local thin mineral layer near the road from dust fall over time, but probably not resulting in substantive changes.	Likely to be some localized deepening of the active layer near wetland/road interface but probably fairly localized. Could be more extensive when associated with low-gradient streams that back up on upstream side of road.	Dust impacts are expected to be minimal because of seasonal flushing of water.	Wetlands could become wetter (upstream from road) from impounded water or drier (downstream of road), as culvert forces stream to more confined channel.	Small drainage channels are often associated with these communities. Potential for poor placement of culverts to manage cross drainage due to difficulty in determining exact location of drainages (may be obscured by vegetation). Thus, water may impound on upslope side of road during spring flooding. Snow dams and aufeis could create at least temporary impoundments on the upstream side of road.	Risk is negligible as habitat is not suitable for the invasive species that would have the potential to establish along the road (they are typically more attracted to mesic to dry habitats, while these soils are wet and organic rich).	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.

Table 7. Continued.

Wetland Functional Class	Changes in Plant Community Composition	Changes in Soil Physical / Chemical Characteristics	Permafrost Degradation	Dust	Hydrologic Alteration[1]	Impoundments	Invasive Plant Species	Altered Habitat Use
Slope Wet Deciduous Shrub	Changes, if any, would be confined to the road edge where impoundments form (i.e. conversion from seasonally flooded to semipermanently or permanently flooded); thus localized shift to graminoid vegetation possible. Dust impacts are expected to be minimal because of seasonal flushing of water.	Hydrologic regime and plant community composition not expected to notable change as a result of road construction, due to seasonal flushing of sediments (mitigates impacts of dust fall and habitats remain productive).	Influenced by development of roadside impoundments. Waterbodies serve as heat sinks for thawing underlying permafrost. Likely some localized deepening of the active layer near wetland/road interface, could be more extensive when associated with low-gradient streams that back up on upstream side of road.	Expect that effect will be minimal because this habitat is regularly flooded, which will limit the impact of dust deposition.	If closely-associated drainages are blocked by poor culvert placement, areas where flow paths channels are close together could coalesce at the road, creating additional impoundments. These communities may expand as drainages coalesce or become more dominated by emergent graminoids if impoundments form.	Small drainage channels are often associated with these communities. Potential for poor placement of culverts to manage cross drainage due to difficulty in determining exact location of drainages (may be obscured by vegetation). Thus, water may impound on upslope side of road during spring flooding.	Risk is negligible as habitat is not suitable for the invasive species that would have the potential to establish along the road (they are typically more attracted to mesic to dry habitats, while these soils are wet).	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Slope Saturated Graminoid-Shrub Meadow	Some localized changes in plant community composition are possible at road-vegetation interface, but changes are expected to be limited, as deciduous shrubs will help mitigate the impact of dust deposition by capturing dust in shrub canopy. Potentially more robust growth of existing species due to warmer soil temperature next to the road.	Potentially some changes in soil characteristics from dust deposition, namely lower organic content and higher pH.	Limited, due to lack of formation of impoundments, although may occur near road where the active layer has been shown to deepen as a result of the accumulation of dust fall.	See Changes in Plant Community Composition	No mechanism for hydrologic alteration (wetland hydrology expected to be maintained). Few instances where these habitats intersect the road edge and they do not appear to be associated with drainage features.	Few instances where these habitats intersect the road edge and they do not appear to be associated with drainage features.	Some risk for wetlands near road. Dust effects could encourage colonization by invasives.	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Slope Saturated Deciduous Shrub	Some localized changes in plant community composition are possible at road-vegetation interface, mostly associated with changes in wetland hydrology from impoundments (i.e., conversion from saturated to semipermanently or permanently flooded), leading to localized shift to graminoids. Potentially more robust growth of existing species due to warmer soil temperature next to the road. Dust impacts expected to be limited, as deciduous shrubs will help mitigate the impact of dust deposition.	Expected to be limited from dust fall but could be altered locally if impoundments develop, which could shift hydrology to a more permanent or at least seasonally flooded regime, thereby influencing decomposition and nutrient mineralization.	Influenced by extent to which impoundments develop next to road. Waterbodies serve as heat sinks for thawing underlying permafrost.	See Changes in Plant Community Composition	If closely-associated drainages are blocked by poor culvert placement, areas where flow paths channels are close together could coalesce at the road, creating additional impoundments. These communities may expand as drainages coalesce or become more dominated by emergent graminoids if impoundments form.	For areas where small drainage channels are often associated with these communities, potential for poor placement of culverts to manage cross drainage due to difficulty in determining exact location of drainages (may be obscured by vegetation). Thus, water may impound on upslope side of road during spring flooding.	Limited risk, as habitat is not favorable to invasive species colonization (shrub canopy and layer of leaf litter).	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.

Table 7. Continued.

Wetland Functional Class	Changes in Plant Community Composition	Changes in Soil Physical / Chemical Characteristics	Permafrost Degradation	Dust	Hydrologic Alteration[1]	Impoundments	Invasive Plant Species	Altered Habitat Use
Slope Saturated Shrub Peatland	Assuming heavy traffic, dust accumulation can reduce moss cover (through soil calcification) and evergreen (ericaceous) shrubs, which may result in higher cover of grasses over time.	Expected to be limited, although perhaps some thinning of the organic horizon near the road from dust fall.	May be some local deepening of the active layer near the road from dust accumulation.	See Changes in Plant Community Composition	Expected to be limited, as these wetlands are more precipitation driven than maintained by surface or groundwater recharge and are not associated with drainages.	Impoundments expected to be limited, as these habitats are in low-gradient areas not associated with drainage features.	Risk is negligible as habitat is not suitable for the invasive species that would have the potential to establish along the road (they are typically more attracted to mesic to dry habitats, while these soils are wet and organic rich).	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Slope Saturated Spruce Forest	Some localized changes in plant community composition are possible at road-vegetation interface. Dust impacts expected to be limited, forest and shrub canopy help capture dust fall. Potentially a slightly higher cover of graminoids over time near road.	Based on limited field data, soils tend to have thick organic horizons, which suggest that changes in soil characteristics would be limited. Perhaps some development of a local thin mineral layer near the road from dust fall over time, but probably not resulting in substantive changes.	Influenced by extent to which impoundments develop next to road. Waterbodies serve as heat sinks for thawing underlying permafrost.	See Changes in Plant Community Composition	If closely-associated drainages are blocked by poor culvert placement, areas where flow paths channels are close together could coalesce at the road, creating additional impoundments. This would likely result in loss of tree canopy and shift to more graminoid/shrub-dominated community.	This habitat is extensive within the immediate confines of the road. For areas where small drainage channels are often associated with these communities, potential for poor placement of culverts to manage cross drainage due to difficulty in determining exact location of drainages (may be obscured by vegetation). Thus, water may impound on upslope side of road during spring flooding.	Risk is negligible as habitat is not suitable for the invasive species that would have the potential to establish along the road (they are typically more attracted to mesic to dry habitats, while these soils are wet and organic rich).	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Riverine Wet Sedge-Shrub Meadow	Associated with a range of stream crossing structures (minor culverts to large bridges). Majority associated with Major Rivers or Large streams, with little apparent opportunity for impoundments (see Impoundments). Localized changes in plant community composition are likely in vicinity of culverts at few Low-gradient Small Stream crossings, extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Likely limited to the vicinity of culvert outlet (one location), as hydrologic regime is expected to be maintained. Main concern would be associated with poor culvert installation and maintenance (snow/ice dams).	This functional class is associated with Major Rivers and Large Streams, which are unlikely to have a shallow active layer.	Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Hydrologic changes may occur in vicinity of culvert if flow is more channelized, thereby restricting the size of the floodplain. These areas are depressions within the floodplain, however, so changes are likely to be limited.	Within the indirect effects buffer, this wetland functional class is associated with overbank flooding by Major Rivers and Large Streams, with little apparent opportunity for impoundments.	Risk is negligible as habitat is not suitable for the invasive species that would have the potential to establish along the road (they are typically more attracted to mesic to dry habitats, while these soils are wet).	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.

Table 7. Continued.

Wetland Functional Class	Changes in Plant Community Composition	Changes in Soil Physical / Chemical Characteristics	Permafrost Degradation	Dust	Hydrologic Alteration[1]	Impoundments	Invasive Plant Species	Altered Habitat Use
Riverine Seasonally Flooded Graminoid-Shrub Meadow	Associated with a range of stream crossing structures (minor culverts to large bridges). Majority associated with Major Rivers or Large streams, with little apparent opportunity for impoundments (see Impoundments). Localized changes in plant community composition are likely in vicinity of culverts at few Low-gradient Small Stream crossings, extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Associated with a range of stream crossing structures, from minor culverts to large bridges. Likely to limited to vicinity of culvert, as hydrologic regime is expected to be maintained. Main concern would be associated with poor culvert installation and maintenance (snow/ice dams). Seasonal flooding expected to ameliorate the effects of any dust outfall from the road on soil characteristics.	This functional class is primarily associated with Major Rivers and Large Streams, which are unlikely to have a shallow active layer.	Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Associated with a range of stream crossing structures, from minor culverts to large bridges. Hydrologic changes that may occur in vicinity of culvert is more channelized flow, thereby restricting the size of the floodplain. Thus, floodplain may shrink.	Associated with a range of stream crossing structures, from minor culverts to large bridges. Some potential for at least temporary impoundments if culverts not properly installed and maintained. Majority of this wetland functional class is associated with overbank flooding by Major Rivers and Large Streams, with little apparent opportunity for impoundments.	Risk is negligible as habitat is not suitable for the invasive species that would have the potential to establish along the road (they are typically more attracted to mesic to dry habitats, while these soils are wet).	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.
Riverine Seasonally Flooded Deciduous Shrub	Associated with a range of stream crossing structures (minor culverts to large bridges). Majority associated with Major Rivers or Large streams, with little apparent opportunity for impoundments (see Impoundments). Localized changes in plant community composition are likely in vicinity of culverts at few Low-gradient Small Stream crossings, extent of change will depend on degree to which culvert effectively manages stream flow.	Associated with a range of stream crossing structures, from minor culverts to large bridges. Likely to limited to vicinity of culvert, as hydrologic regime is expected to be maintained. Main concern would be associated with poor culvert installation and maintenance (snow/ice dams).	This functional class is primarily associated with Major Rivers and Large Streams, which are unlikely to have a shallow active layer.	Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Associated with a range of stream crossing structures, from minor culverts to large bridges. Hydrologic changes that may occur in vicinity of culvert is more channelized flow, thereby restricting the size of the floodplain. Thus, floodplain may shrink.	Associated with a range of stream crossing structures, from minor culverts to large bridges. Some potential for at least temporary impoundments if culverts not properly installed and maintained, although some of these habitats are not adjacent to an active channel. Majority of this wetland functional class is associated with overbank flooding by Major Rivers and Large Streams, with little apparent opportunity for impoundments.	Could be a concern as substrate is likely better drained that other wetlands, attracting species such as Sweet Clover (*Melilotus* spp.). Lack of barren substrate, however, would make it more difficult for invasives to establish.	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.

Table 7. Continued.

Wetland Functional Class	Changes in Plant Community Composition	Changes in Soil Physical / Chemical Characteristics	Permafrost Degradation	Dust	Hydrologic Alteration[1]	Impoundments	Invasive Plant Species	Altered Habitat Use
Riverine Seasonally Flooded Spruce Forest	Associated with a range of stream crossing structures (minor culverts to large bridges). Majority associated with Major Rivers or Large streams, with little apparent opportunity for impoundments (see Impoundments). Localized changes in plant community composition are likely in vicinity of culverts at few Low-gradient Small Stream crossings, extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Associated with a range of stream crossing structures, from minor culverts to large bridges. Likely to limited to vicinity of culvert, as hydrologic regime is expected to be maintained. Main concern would be associated with poor culvert installation and maintenance (snow/ice dams).	This functional class is associated with Major Rivers and Large Streams, which are unlikely to have a shallow active layer.	Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Associated with a range of stream crossing structures, from minor culverts to large bridges. Hydrologic changes that may occur in vicinity of culvert is more channelized flow, thereby reducing the size of the floodplain. Many of these habitats, however, are not associated with drainages that would be culverted.	Associated with a range of stream crossing structures, from minor culverts to large bridges. Some potential for at least temporary impoundments if culverts not properly installed and maintained, although some of these habitats are not adjacent to an active channel. Majority of this wetland functional class is associated with overbank flooding by Major Rivers and Large Streams, with little apparent opportunity for impoundments.	Could be a concern as substrate is likely better drained that other wetlands, attracting species such as Sweet Clover (*Melilotus* spp.). Extent of risk depends on whether forest becomes more shrubby over time due to hydrologic changes associated with poor culvert installation and maintenance. Lack of barren substrate, however, would make it more difficult for invasives to establish.	Some impact, namely avoidance, is likely (although limited) for most wildlife species, as a result of construction of the road.

[1] Examples are changes in flow patterns, increase in surface waters, loss of wetland hydrology.

direct effects (Table 6). For indirect effects, which may not result in full reductions in function, function scores for the 16 functional classes ranged from 0.0 to 1.0 (Table 6).

A reduction in the capacity to perform sediment, nutrient, and toxicant removal is predicted for those wetland functional classes that could undergo a change in plant community composition that would reduce surface roughness; this includes Flow Paths, Slope Wet Deciduous Shrub, Slope Saturated Deciduous Shrub, and Slope Saturated Shrub Peatland (Table 7, Appendix D). While the existing conditions for each of these functional classes includes substantial cover of low shrubs, providing surface roughness, the community composition for all but Slope Saturated Shrub Peatland is likely to change to one dominated by graminoids in impoundments that are likely to occur at the road/wetland interface (Table 7, Appendix D). Slope Saturated Shrub Peatland may experience reduced shrub cover through soil calcification from dust fallout, which, over time, may result in a greater cover of grasses, resulting in a similar reduction in surface roughness (Table 7, Appendix D). As we could not assess potential future conditions for the functional indicator, "sediment deposits are present, providing evidence of deposition during natural flood events," we retained the existing condition scores for this indicator for all wetland functional classes. Again, we caution that the spatial extent of indirect effects may be overestimated in some cases. For sediment, nutrient, and toxicant removal, some indirect effects could be due to impoundments, which will only occur on the upslope side of the proposed road.

Erosion control and shoreline stabilization: This function was assessed only for those wetland functional classes directly abutting a relatively permanent channelized water; this includes Flow Paths, Slope Wet Sedge-Shrub Meadow, Slope Wet Deciduous Shrub, Slope Saturated Graminoid-Shrub Meadow, Slope Saturated Deciduous Shrub, Slope Saturated Spruce Forest, Riverine Wet Sedge-Shrub Meadow, Riverine Seasonally Flooded Graminoid-Shrub, Riverine Seasonally Flooded Deciduous Shrub, and Riverine Seasonally Flooded Spruce Forest. All of these functional classes except Riverine Seasonally Flooded Spruce Forest scored high (1.0) for existing conditions (Table 6, Appendix D). Sandy (erodible) soils in Riverine Seasonally Flooded Spruce Forest precluded an existing condition score of 1.0 for erosion control and shoreline stabilization (Appendix D).

All wetland functional classes within the direct-effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus eliminating their capacity to provide erosion control and shoreline stabilization; this is represented by a score of 0.0 (no functional capacity) for direct effects (Table 6). For indirect effects, which may not result in full reductions in function, function scores for the 10 functional classes that will perform this function ranged from 0.50 to 1.0 (Table 6).

A reduction in the capacity to perform erosion control and shoreline stabilization is predicted for those wetland functional classes that could undergo a change in plant community composition that would reduce the soil binding characteristics of plant roots and reduce surface roughness; this includes Flow Paths, Slope Wet Deciduous Shrub, Slope Saturated Deciduous Shrub, and Slope Saturated Shrub Peatland (Table 7, Appendix D). Expected plant community changes in these functional classes, due largely to impoundments expected to occur at the road edge, are likely to involve shifts to graminoid vegetation and an overall loss of plant cover and biomass. As we could not assess potential future conditions for the functional indicator, “historical aerial photography indicates stable shoreline features,” we retained existing condition scores for this indicator for all wetland functional classes. Again, we caution that the spatial extent of indirect effects may be overestimated in some cases. For erosion control and shoreline stabilization, some indirect effects could be due to impoundments, which will only occur on the upslope side of the proposed road.

Organic matter production and export: Existing condition scores for organic matter production and export ranged from 0.33 to 1.0 (Table 6, Appendix D). Scores were highest in those functional classes with productive vegetation that produces high-quality (herbaceous and deciduous shrub) litter, and that have at least seasonal surface water and surface water outflow that occurs outside of spring flooding; this includes Flow Paths, Lacustrine Fringe Wet Sedge Meadow, Depressional Wet Sedge-Shrub Meadow, Slope Wet Sedge-Shrub Meadow, Slope Wet Deciduous Shrub, Riverine Wet Sedge-Shrub Meadow, Riverine Seasonally Flooded Graminoid-Shrub, Riverine Seasonally Flooded Deciduous Shrub, and Riverine Seasonally Flooded Spruce Forest (Appendix D).

All wetland functional classes within the direct-effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus eliminating their capacity to provide organic matter production and export; this is represented by a score of 0.0 (no functional capacity) for direct effects (Table 6). For indirect effects, which may not result in full reductions in function, function scores for the 16 functional classes ranged from 0.33 to 1.0 (Table 6).

A reduction in the capacity to perform organic matter production and export is predicted for those wetland functional classes that could undergo a change in plant community composition that would reduce overall production of high-quality organic matter (herbaceous and deciduous shrub vegetation); this includes Flow Paths, Slope Wet Sedge-Shrub Meadow, Slope Wet Deciduous Shrub, Slope Saturated Deciduous Shrub, and Slope Saturated Shrub Peatland (Table 7, Appendix D). Expected plant community changes in these functional classes, due largely to impoundments expected to occur at the road edge, are likely to involve shifts to higher quality graminoid vegetation but an overall loss of plant cover and biomass. Again, we caution that the spatial extent of indirect effects may be overestimated in some cases. For organic matter production and export, some indirect effects could be due to impoundments, which will only occur on the upslope side of the proposed road.

Maintenance of soil thermal regime: This wetland function, which focuses on the maintenance of permafrost, was not assessed for those wetland functional classes likely to lack permafrost or to have relatively deep active layers (see Table 1); this includes Depressional Wet Sedge-Shrub Meadow, Depressional Saturated Graminoid-Shrub, Depressional Saturated Deciduous Shrub, Riverine Wet Sedge-Shrub Meadow, Riverine Seasonally Flooded Graminoid-Shrub, Riverine Seasonally Flooded Deciduous Shrub, and Riverine Seasonally Flooded Spruce Forest (Table 6, Appendix D). For the functional classes likely to have permafrost, the existing condition scores for maintenance of soil thermal regime scores ranged from 0.20 to 0.80 (Table 6, Appendix D). Scores were highest for those functional classes that have a continuous (insulating) layer of vegetation; lack a permanently flooded hydrologic regime and/or are not located within riverine, lacustrine fringe, or estuarine fringe HGM classes (less potential for thaw bulbs); and have thick (insulating) surface organics (histosol or histel); these classes include Flow Paths, Slope Saturated Shrub Peatland, and Slope Saturated Spruce Forest.

All wetland functional classes within the direct-effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus eliminating their capacity to provide maintenance of soil thermal regime; this is represented by a score of 0.0 (no functional capacity) for direct effects (Table 6). For indirect effects, which may not result in full reductions in function, function scores for the 9 functional classes that will perform this function ranged from 0.20 to 0.70 (Table 6).

A reduction in the capacity to maintain the soil thermal regime is predicted for those wetland functional classes that could undergo a change in plant community composition (reduction of the insulating layer), be affected by impoundments that could result in a shift to a semi-permanently to permanently flooded water regime, and/or experience concentrated flows aggrading through the organic mat; these functional classes include Flow Paths, Slope Wet Sedge-Shrub Meadow, Slope Wet Deciduous Shrub, Slope Saturated Graminoid-Shrub Meadow, Slope Saturated Deciduous Shrub, Slope Saturated Shrub Peatland, and Slope Saturated Spruce Forest (Table 7, Appendix D). Again, we caution that the spatial extent of indirect effects may be overestimated in some cases. For maintenance of soil thermal regime, some indirect effects could be due to impoundments, which will only occur on the upslope side of the proposed road.

Threatened and endangered species support: This function was not assessed for any wetland functional class (Table 6), because no species listed under the Endangered Species Act or occurring on the State of Alaska list of threatened or endangered species have ranges that include the study area.

Bird and mammal habitat suitability: Existing condition scores for bird and mammal habitat suitability ranged from 0.24 to 0.78 (Table 6, Appendix D). Scores were highest in those functional classes with greater habitat complexity (vegetation/surface water interspersion and vegetation structure diversity) and that are expected to support greater numbers of bird and mammal species; this includes Depressional Saturated Deciduous Shrub, Slope Wet Deciduous Shrub, Slope Saturated Spruce Forest, and Riverine Seasonally Flooded Spruce Forest (Table 6, Appendix D).

All wetland functional classes within the direct-effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus the capacity for those functional classes to provide bird and mammal habitat would be eliminated; this is represented by a score of 0.0 (no functional capacity) for direct effects (Table 6). All functional classes within the 328-ft indirect-effects buffer would have a reduced capacity to provide bird and mammal habitat because development of the road would result in some disturbance displacement of wildlife (Table 7, Appendix D). Unless traffic levels are very high, however, complete and consistent displacement from disturbance is unlikely and we expect wildlife use in the indirect-effects buffer during periods of low human activity along the road. We accounted for what is likely to be partial displacement of wildlife by reducing the score (for the undisturbed conditions functional indicator) from 1 to 0.5 for indirect effects (Appendix D). For indirect effects, functional scores for the 16 function classes ranged from 0.14 to 0.68 (Table 6).

Changes in bird and mammal habitats from development of the proposed road are expected to occur from both road disturbance and through changes to plant community composition, which could result in reduced diversity in vegetation structure (Appendix D). We caution once again that the spatial extent of indirect effects may be overestimated in some cases. For bird and mammal habitat suitability, most indirect effects are likely to be the result of disturbance displacement, which will almost certainly be greater at distances close to the proposed road (e.g., within the first 50 m). Some of the larger-bodied and sensitive waterfowl species and shorebirds with large territory sizes, however, may be displaced (from nesting) at greater distances from the road.

Fish habitat suitability: The fish habitat suitability function was not assessed for those wetland functional classes that lacked a perennial or intermittent surface water connection to a fish-bearing water; these classes include Flow Paths, Depressional Wet Sedge-Shrub Meadow, Depressional Saturated Graminoid-Shrub, Depressional Saturated Deciduous Shrub, and Slope Saturated Shrub Peatland. For the functional classes that have connections to fish-bearing waters, the existing condition scores for fish habitat suitability ranged from 0.25 to 0.50 (Table 6, Appendix D). Lakes and Ponds scored highest for fish habitat suitability (0.50), based on the observed connections to the Kobuk River and the presence of surrounding vegetation that can provide cover, shade, and/or detrital matter to enhance fish habitat.

All wetland functional classes within the direct effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus eliminating the capacity to provide fish habitat; this is represented by a score of 0.0 (no functional capacity) for direct effects (Table 6). The likely changes in plant community composition associated with indirect effects were not considered substantial enough to result in reductions in the surrounding herbaceous and/or woody vegetation that would enhance fish habitat. Thus, for indirect effects, no reductions in the capacity to provide fish habitat were predicted for the 11 functional classes that will perform this function, and the indirect effects function scores were the same as those for existing conditions (Table 6, Appendix D).

Rare plant habitat and native plant diversity: Existing condition scores for rare plant habitat and native plant diversity ranged from 0.0 to 0.67 (Table 6, Appendix D). Scores were highest in the functional class, Slope Saturated Graminoid-Shrub Meadow (0.67). This functional class encompasses habitats for plants ranked S1–S3 or G1–G3 by the Alaska Center for Conservation Science (Appendix D). *Schizachne purpurascens* was documented by Jorgenson et al. (2009) in the ecotype crosswalked to Slope Saturated Graminoid-Shrub Meadow, and Parker (2009) noted 2 species (*Schizachne purpurascens* and *Viola selkirkii*) that could occur in the GAAR habitats associated with this wetland functional class. The Jorgenson et al. (2009) ecotype crosswalked to this functional class also supported a high diversity of plant species (Appendix D).

All wetland functional classes within the direct effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus eliminating the capacity to provide rare plant habitat and native plant diversity; this is represented by score of 0.0 (no functional capacity) for direct effects (Table 6). For indirect effects, which may not result in full reductions in function, function scores for the 16 functional classes ranged from 0.0 to 0.50 (Table 6).

A reduction in the capacity to provide rare plant habitat and native plant diversity is possible in those functional classes that support rare plants more sensitive to disturbance, and/or for wetland functional classes that have both a high diversity of species and a risk of colonization by invasive species; this includes Lacustrine Fringe Wet Sedge Meadow, Depressional Wet Sedge-Shrub Meadow, Slope Wet Sedge-Shrub Meadow, Slope Saturated Graminoid-Shrub Meadow, Slope Saturated Shrub Peatland, Riverine Seasonally Flooded Deciduous Shrub, and Riverine Seasonally Flooded Spruce Forest (Table 7, Appendix D). We caution once again that the spatial extent of indirect effects may be overestimated in some cases. For rare plant habitat and native plant diversity, some indirect effects could be due to increases in soil pH from dust fallout, which will be more pronounced near the proposed road but could, if traffic levels are high, extend to 100 m or beyond (Auerback et al. 1997; Myers-Smith et al. 2006).

Subsistence use: Existing condition scores for subsistence use ranged from 0.0 to 0.67 (Table 6, Appendix D). Scores were highest in the Slope Saturated Spruce Forest functional class, which had both >25% cover of berry-yielding species (*Vaccinium uliginosum*, *V. vitis-idaea*, *V. microcarpus*, and *Rubus chamaemorus*) and encompassed habitats expected to be regularly used by important subsistence species (moose and caribou) (Appendix D).

All wetland functional classes within the direct effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus eliminating their capacity to provide habitat for subsistence use; this is represented by a score of 0.0 (no functional capacity) for direct effects (Table 6). For indirect effects, no reductions in functional performance in the habitats used for subsistence were predicted. Hence, the function scores for indirect effects for the 16 functional classes were the same as the existing condition scores (Table 6).

Under the functional indicator, "visible trails or known access points," the presence of the proposed AMDIAP road was not envisioned to increase subsistence use scores because the road is planned for industrial access only, and because recent literature suggests that subsistence harvests may diminish if the road eventually opens to the public (Guettabi et al. 2016). Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited, however, and we assume that habitats will be available for use when traffic is not present (see also bird and mammal habitat suitability above). For these reasons, no wetland functional class was expected to have losses in important habitat for subsistence species within the indirect-effects buffer (Appendix D).

Groundwater discharge and groundwater recharge: These 2 functions were not assessed for those wetland functional classes likely to have near-surface permafrost (i.e., a shallow active layer) (Table 7, Appendix D). None of the 7 functional classes assessed for these 2 functions had indicators of groundwater discharge and all were scored 0.0 for that function (Table 6). Depressional Wet Sedge-Shrub Meadow, Depressional Saturated Graminoid-Shrub, and Depressional Saturated Deciduous Shrub had indicators of groundwater recharge, as those depressional features often lacked outlets. While Riverine Wet Sedge-Shrub Meadow, Riverine Seasonally Flooded Graminoid-Shrub, Riverine Seasonally Flooded Deciduous Shrub, and Riverine Seasonally Flooded Spruce Forest were evaluated for groundwater recharge, no functional indicators were present. The AFRS is not designed to assess hyporheic exchange, which is a likely shallow surface water-groundwater interaction in riverine wetland functional classes in the study area.

All wetland functional classes within the direct effects footprint of the AMDIAP road would be filled or used for gravel extraction, thus eliminating their capacity for groundwater discharge or groundwater recharge; this is represented by a score of 0.0 (no functional capacity) for direct effects (Table 6). Function scores for indirect effects were not altered from those for existing conditions because the likely changes induced by indirect effects of the AMDIAP road would not affect the functional indicators assessed for groundwater discharge or recharge.

WETLAND FUNCTIONAL CHANGE AND WETLAND DEBITS

Using the wetland function scores for existing conditions and scores assessed after consideration of direct and predicted indirect effects, wetland functional change scores (Δ) were calculated for each wetland functional class for both direct and indirect effects (Table 8). Those Δ values were then multiplied by the number of potentially affected acres of each wetland functional class occurring in each of the 2 proposed road alignment corridors to determine the estimated wetland debits associated with direct and predicted indirect effects (Table 9).

Using the wetland debit calculations (functional change scores × affected acreage) and calculations of existing functional capacity (existing functional scores × acreage; Table 10), both of which incorporate the estimated spatial extent of wetland function, we can compare the overall expected loss in functional capacity between the 2 proposed road alignments (Table 11). Although the northern alignment (26.0 miles) is over 8 miles longer than the southern alignment (17.8 miles), when considering all wetland functions and all wetland functional classes, there are fewer wetland debits associated with the northern than the southern alignment for direct effects

Table 8. Standardization of wetland functional scores for existing conditions, predicted direct and indirect effects, and the predicted change in functional scores from existing conditions (Δ[1]) by wetland functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

Wetland Functional Class		Sum of Individual Function Scores	Number of Assessed Functions	Average Score (Sum/Number of Functions)	Δ
Flow Paths	Existing Conditions	4.12	8	0.52	
	Direct Effects	0.00	8	0.00	0.52
	Predicted Indirect Effects	2.59	8	0.32	0.20
Lakes and Ponds	Existing Conditions	3.63	8	0.45	
	Direct Effects	0.00	8	0.00	0.45
	Predicted Indirect Effects	3.50	8	0.44	0.01
Lacustrine Fringe Wet Sedge Meadow	Existing Conditions	3.46	8	0.43	
	Direct Effects	0.00	8	0.00	0.43
	Predicted Indirect Effects	3.19	8	0.40	0.03
Depressional Wet Sedge-Shrub Meadow	Existing Conditions	3.59	8	0.45	
	Direct Effects	0.00	8	0.00	0.45
	Predicted Indirect Effects	3.33	8	0.42	0.03
Depressional Saturated Graminoid-Shrub Meadow	Existing Conditions	2.92	8	0.37	
	Direct Effects	0.00	8	0.00	0.37
	Predicted Indirect Effects	2.82	8	0.35	0.02
Depressional Saturated Deciduous Shrub	Existing Conditions	3.18	8	0.40	
	Direct Effects	0.00	8	0.00	0.40
	Predicted Indirect Effects	2.98	8	0.37	0.03
Slope Wet Sedge-Shrub Meadow	Existing Conditions	4.93	9	0.55	
	Direct Effects	0.00	9	0.00	0.55
	Predicted Indirect Effects	3.82	9	0.42	0.13
Slope Wet Deciduous Shrub	Existing Conditions	4.86	9	0.54	
	Direct Effects	0.00	9	0.00	0.54
	Predicted Indirect Effects	3.75	9	0.42	0.12
Slope Saturated Graminoid-Shrub Meadow	Existing Conditions	4.01	9	0.45	
	Direct Effects	0.00	9	0.00	0.45
	Predicted Indirect Effects	3.64	9	0.40	0.05
Slope Saturated Deciduous Shrub	Existing Conditions	4.45	9	0.49	
	Direct Effects	0.00	9	0.00	0.49
	Predicted Indirect Effects	3.21	9	0.36	0.13
Slope Saturated Shrub Peatland	Existing Conditions	3.61	7	0.52	
	Direct Effects	0.00	7	0.00	0.52
	Predicted Indirect Effects	2.75	7	0.39	0.13

Table 8. Continued.

Wetland Functional Class		Sum of Individual Function Scores	Number of Assessed Functions	Average Score (Sum/Number of Functions)	Δ
Slope Saturated Spruce Forest	Existing Conditions	4.89	9	0.54	
	Direct Effects	0.00	9	0.00	0.54
	Predicted Indirect Effects	4.69	9	0.52	0.02
Riverine Wet Sedge-Shrub Meadow	Existing Conditions	3.14	10	0.31	
	Direct Effects	0.00	10	0.00	0.31
	Predicted Indirect Effects	3.04	10	0.30	0.01
Riverine Seasonally Flooded Graminoid-Shrub Meadow	Existing Conditions	4.13	10	0.41	
	Direct Effects	0.00	10	0.00	0.41
	Predicted Indirect Effects	4.03	10	0.40	0.01
Riverine Seasonally Flooded Deciduous Shrub	Existing Conditions	4.37	10	0.44	
	Direct Effects	0.00	10	0.00	0.44
	Predicted Indirect Effects	4.10	10	0.41	0.03
Riverine Seasonally Flooded Spruce Forest	Existing Conditions	4.10	10	0.41	
	Direct Effects	0.00	10	0.00	0.41
	Predicted Indirect Effects	3.84	10	0.38	0.03

[1] Δ = existing condition score - predicted condition score.

Table 9. Calculation of wetland debits (average functional change scores [Δ[1]] × affected acres) for direct and predicted indirect[2] effects by wetland functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

Wetland Functional Class		Northern Alignment Δ	Northern Alignment Acres	Northern Alignment Debits	Southern Alignment Δ	Southern Alignment Acres	Southern Alignment Debits
Flow Paths	Direct Effects	0.52	1.34	0.70	0.52	1.03	0.54
	Indirect Effects	0.20	9.77	1.95	0.20	7.84	1.57
Lakes and Ponds	Direct Effects	0.45	0.01	<0.01	0.45	0.07	0.03
	Indirect Effects	0.01	5.50	0.06	0.01	4.03	0.04
Lacustrine Fringe Wet Sedge Meadow	Direct Effects	0.43		0.00	0.43		0.00
	Indirect Effects	0.03	0.67	0.02	0.03	0.56	0.02
Depressional Wet Sedge-Shrub Meadow	Direct Effects	0.45		0.00	0.45	0.13	0.06
	Indirect Effects	0.03		0.00	0.03	2.35	0.07
Depressional Saturated Graminoid-Shrub Meadow	Direct Effects	0.37	0.76	0.28	0.37	0.34	0.13
	Indirect Effects	0.02	6.25	0.13	0.02	0.38	0.01
Depressional Saturated Deciduous Shrub	Direct Effects	0.40		0.00	0.40		0.00
	Indirect Effects	0.03	0.55	0.02	0.03	0.24	0.01
Slope Wet Sedge-Shrub Meadow	Direct Effects	0.55	0.54	0.30	0.55	0.75	0.41
	Indirect Effects	0.13	11.96	1.55	0.13	20.38	2.65
Slope Wet Deciduous Shrub	Direct Effects	0.54	14.43	7.79	0.54	12.73	6.87
	Indirect Effects	0.12	131.55	15.79	0.12	98.50	11.82
Slope Saturated Graminoid-Shrub Meadow	Direct Effects	0.45	0.03	0.01	0.45	0.63	0.28
	Indirect Effects	0.05	0.89	0.04	0.05	7.29	0.36
Slope Saturated Deciduous Shrub	Direct Effects	0.49	36.05	17.66	0.49	5.88	2.88
	Indirect Effects	0.13	309.72	40.26	0.13	25.30	3.29
Slope Saturated Shrub Peatland	Direct Effects	0.52	1.80	0.94	0.52	3.46	1.80
	Indirect Effects	0.13	13.47	1.75	0.13	27.59	3.59
Slope Saturated Spruce Forest	Direct Effects	0.54	67.92	36.68	0.54	162.52	87.76
	Indirect Effects	0.02	523.12	10.46	0.02	981.87	19.64
Riverine Wet Sedge-Shrub Meadow	Direct Effects	0.31	0.06	0.02	0.31	0.05	0.02
	Indirect Effects	0.01	0.07	0.00	0.01	<0.01	<0.01
Riverine Seasonally Flooded Graminoid-Shrub Meadow	Direct Effects	0.41	0.05	0.02	0.41		0.00
	Indirect Effects	0.01	2.78	0.03	0.01	2.10	0.02
Riverine Seasonally Flooded Deciduous Shrub	Direct Effects	0.44	4.23	1.86	0.44	2.46	1.08
	Indirect Effects	0.03	36.73	1.10	0.03	21.14	0.63
Riverine Seasonally Flooded Spruce Forest	Direct Effects	0.41	2.81	1.15	0.41	2.33	0.96
	Indirect Effects	0.03	18.20	0.55	0.03	15.49	0.46

1 Δ = existing condition score - predicted condition score; see Table 6 for calculation of functional change scores.

2 Debits were calculated for predicted indirect effects throughout the 328-ft indirect-effects buffer; those acreage figures, however, may be overestimates in some cases because indirect impacts are not likely to occur uniformly throughout the 328-ft buffer zone (see text for additional discussion).

Table 10. Calculation of existing wetland functional capacity (average existing functional score × affected acres) in direct and indirect effects areas by wetland functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

			Northern Alignment		Southern Alignment	
Wetland Functional Class		Existing Functional Score	Acres	Existing Functional Capacity	Acres	Existing Functional Capacity
Flow Paths	Direct Effects	0.52	1.34	0.70	1.03	0.54
	Indirect Effects	0.52	9.77	5.08	7.84	4.08
Lakes and Ponds	Direct Effects	0.45	0.01	<0.01	0.07	0.03
	Indirect Effects	0.45	5.50	2.48	4.03	1.81
Lacustrine Fringe Wet Sedge Meadow	Direct Effects	0.43		0.00		0.00
	Indirect Effects	0.43	0.67	0.29	0.56	0.24
Depressional Wet Sedge-Shrub Meadow	Direct Effects	0.45		0.00	0.13	0.06
	Indirect Effects	0.45		0.00	2.35	1.06
Depressional Saturated Graminoid-Shrub Meadow	Direct Effects	0.37	0.76	0.28	0.34	0.13
	Indirect Effects	0.37	6.25	2.31	0.38	0.14
Depressional Saturated Deciduous Shrub	Direct Effects	0.40		0.00		0.00
	Indirect Effects	0.40	0.55	0.22	0.24	0.10
Slope Wet Sedge-Shrub Meadow	Direct Effects	0.55	0.54	0.30	0.75	0.41
	Indirect Effects	0.55	11.96	6.58	20.38	11.21
Slope Wet Deciduous Shrub	Direct Effects	0.54	14.43	7.79	12.73	6.87
	Indirect Effects	0.54	131.55	71.04	98.50	53.19
Slope Saturated Graminoid-Shrub Meadow	Direct Effects	0.45	0.03	0.01	0.63	0.28
	Indirect Effects	0.45	0.89	0.40	7.29	3.28
Slope Saturated Deciduous Shrub	Direct Effects	0.49	36.05	17.66	5.88	2.88
	Indirect Effects	0.49	309.72	151.76	25.30	12.40
Slope Saturated Shrub Peatland	Direct Effects	0.52	1.80	0.94	3.46	1.80
	Indirect Effects	0.52	13.47	7.00	27.59	14.35
Slope Saturated Spruce Forest	Direct Effects	0.54	67.92	36.68	162.52	87.76
	Indirect Effects	0.54	523.12	282.48	981.87	530.21
Riverine Wet Sedge-Shrub Meadow	Direct Effects	0.31	0.06	0.02	0.05	0.02
	Indirect Effects	0.31	0.07	0.02	<0.01	<0.01
Riverine Seasonally Flooded Graminoid-Shrub Meadow	Direct Effects	0.41	0.05	0.02		0.00
	Indirect Effects	0.41	2.78	1.14	2.10	0.86
Riverine Seasonally Flooded Deciduous Shrub	Direct Effects	0.44	4.23	1.86	2.46	1.08
	Indirect Effects	0.44	36.73	16.16	21.14	9.30
Riverine Seasonally Flooded Spruce Forest	Direct Effects	0.41	2.81	1.15	2.33	0.96
	Indirect Effects	0.41	18.20	7.46	15.49	6.35

Table 11. Summary totals for existing functional capacity (average existing functional score × affected acres) and predicted wetland debits[1] (average functional change scores [Δ[2]] × affected acres) for direct and predicted indirect effects by wetland functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

	Northern Alignment						Southern Alignment					
	Direct Effects		Predicted Indirect Effects		Direct and Predicted Indirect Effects		Direct Effects		Predicted Indirect Effects		Direct and Predicted Indirect Effects	
Wetland Functional Class	Existing Functional Capacity	Predicted Wetland Debits	Existing Functional Capacity	Predicted Wetland Debits	Existing Functional Capacity	Predicted Wetland Debits	Existing Functional Capacity	Predicted Wetland Debits	Existing Functional Capacity	Predicted Wetland Debits	Existing Functional Capacity	Predicted Wetland Debits
Flow Paths	0.70	0.70	5.08	1.95	5.78	2.65	0.54	0.54	4.08	1.57	4.62	2.11
Lakes and Ponds	<0.01	<0.01	2.48	0.06	2.49	2.49	0.03	0.03	1.81	0.04	1.84	0.07
Lacustrine Fringe Wet Sedge Meadow	0.00	0.00	0.29	0.02	0.29	0.02	0.00	0.00	0.24	0.02	0.24	0.02
Depressional Wet Sedge-Shrub Meadow	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	1.06	0.07	1.12	0.13
Depressional Saturated Graminoid-Shrub Meadow	0.28	0.28	2.31	0.13	2.59	0.41	0.13	0.13	0.14	0.01	0.27	0.14
Depressional Saturated Deciduous Shrub	0.00	0.00	0.22	0.02	0.22	0.02	0.00	0.00	0.10	0.01	0.10	0.01
Slope Wet Sedge-Shrub Meadow	0.30	0.30	6.58	1.55	6.88	1.85	0.41	0.41	11.21	2.65	11.62	3.06
Slope Wet Deciduous Shrub	7.79	7.79	71.04	15.79	78.83	23.58	6.87	6.87	53.19	11.82	60.06	18.69
Slope Saturated Graminoid-Shrub Meadow	0.01	0.01	0.40	0.04	0.41	0.05	0.28	0.28	3.28	0.36	3.56	0.64
Slope Saturated Deciduous Shrub	17.66	17.66	151.76	40.26	169.42	57.92	2.88	2.88	12.40	3.29	15.28	6.17
Slope Saturated Shrub Peatland	0.94	0.94	7.00	1.75	7.94	2.69	1.80	1.80	14.35	3.59	16.15	5.39
Slope Saturated Spruce Forest	36.68	36.68	282.48	10.46	319.16	47.14	87.76	87.76	530.21	19.64	617.97	107.40
Riverine Wet Sedge-Shrub Meadow	0.02	0.02	0.02	0.00	0.04	0.02	0.02	0.02	<0.01	<0.01	0.02	0.02
Riverine Seasonally Flooded Graminoid-Shrub Meadow	0.02	0.02	1.14	0.03	1.16	0.05	0.00	0.00	0.86	0.02	0.86	0.02
Riverine Seasonally Flooded Deciduous Shrub	1.86	1.86	16.16	1.10	18.02	2.96	1.08	1.08	9.30	0.63	10.38	1.71
Riverine Seasonally Flooded Spruce Forest	1.15	1.15	7.46	0.55	8.61	1.70	0.96	0.96	6.35	0.46	7.31	1.42
Total:	67.41	67.41	554.42	73.71	621.84	143.55	102.82	102.82	648.58	44.18	751.40	147.00

[1] Debits were calculated for predicted indirect effects throughout the 328-ft indirect-effects buffer; those acreage figures, however, may be overestimates in some cases because indirect impacts are not likely to occur uniformly throughout the 328-ft buffer zone (see text for additional discussion).
[2] Δ = existing condition score - predicted condition score; see Table 6 for existing condition scores, predicted condition scores, and functional change scores.

(67.41 and 102.82, respectively; Table 11), This same pattern holds for direct and indirect effects combined although the differences are smaller (143.55 and 147.00, respectively; Table 11). This relationship is reversed, however, when indirect effects are considered separately; in this case the wetland debits are greater for the northern (73.71) than the southern (44.18) alignment. It is important to note that there is a large measure of uncertainty when attempting to quantify indirect effects on functional change. Although we believe this functional assessment provides a framework within which the spatial extent of indirect effects of road construction and operations on functional change can be evaluated, in reality the spatial extent of functional change will depend on factors such as traffic volume, best management construction practices, and the adequacy of culvert installation and maintenance.

When evaluating the estimated wetland debits by individual wetland functional class, it is clear that just a few functional classes account for the overall differences in debits between the 2 proposed road alignments. Of the 16 functional classes evaluated, only 6 were found to have fewer wetland debits for direct effects in the longer northern alignment corridor and the differences in debits between the alignments were usually small (Table 11). However, 1 of those 6 classes, Slope Saturated Spruce Forest, had dramatically fewer debits in the longer northern alignment (36.68) compared to the shorter southern alignment (87.76). This result is due entirely to the substantially smaller areal coverage of Slope Saturated Spruce Forest wetlands in the project footprint for the longer northern alignment (an order of magnitude fewer acres than along the southern alignment; Table 5). This is because the average functional change scores (the other half of the wetland debit equation) were calculated for wetland functional classes in the AMDIAP study area as a whole (Tables 8 and 9) and do not vary by road alignment. Functional change scores were not calculated separately for the 2 road alignments because the effects of the proposed road on wetland functions and wetland functional classes should not differ by alignment.

For indirect effects, 9 of the 16 wetland functional classes evaluated had greater wetland debits in the longer northern road alignment relative to the shorter southern alignment, but the differences in debits between the alignments were relatively small for all but 1 of those 9 functional classes (Table 11). A single functional class, Slope Saturated Deciduous Shrub, had noticeably greater debits for indirect effects in the longer northern alignment (40.26) compared to the shorter southern alignment (3.29). Analogous to Slope Saturated Spruce Forest (noted above), but in the opposite direction, this result occurs because there are substantially more acres of Slope Saturated Deciduous Shrub wetlands in the indirect-effects buffer in the northern alignment (an order of magnitude more acres than in the southern alignment; Table 5). Again, this is because the average functional change scores (the other half of the wetland debit equation) were calculated for wetland functional classes across the entire AMDIAP study area (Tables 8 and 9) and do not vary by road alignment. Functional change scores were not calculated separately for the 2 road alignments because the effects of the proposed road on wetland functions and wetland functional classes should not differ by alignment.

RIVERINE FUNCTIONAL CLASSES

Four riverine functional classes (groupings of stream types that provide similar riverine functions) were identified in the study area based on Strahler stream order and gradient (Figure 2). The area (acres) of each riverine functional class that occurs in the study area is presented in Table 5; area figures are presented for both the footprint of the northern and southern road alignments (road surface and embankments at bridge and culvert sites, as provided in the project application) and for the indirect-effects buffer (328-ft zone from the toe of the project footprint). Although the northern road alignment (26.0 miles) is over 8 miles longer than the southern alignment (17.8 miles), there are fewer acres of riverine functional classes (for direct and indirect effects combined) associated with the northern alignment (12.33) relative to the southern alignment (20.74) (Table 5). This occurs because (1) the southern road alignment crosses 2 Major Rivers (which are of much greater wetted width than other riverine features) whereas the longer northern alignment crosses only 1, and (2) the southern alignment also crosses a larger number of Low-gradient Small Streams (see below). The total number of rivers and streams crossed by the 2 road alignments, however, are roughly similar: 40 for the northern alignment and 43 for the southern. Note that Flow Paths—which will not perform riverine functions but do serve as ephemeral drainage features—are more numerous along the longer northern alignment (219) than the southern (211) (see Wetland Functional Classes above). Flow Paths also comprise more acreage along the northern alignment (Table 5).

Major Rivers within the study area are the low-gradient (<2% slope) Kobuk and Reed rivers. Both are high volume, gravel-bedded rivers that support both resident and anadromous fish (ABR 2014c, Lemke et al. 2014). The northern road alignment crosses the Kobuk River and the southern road alignment crosses both the Kobuk and Reed rivers (Figure 2). In part, because of the 2 Major River crossings in the shorter southern alignment, its overall riverine functional class acreage is greater than in the longer northern alignment (Table 5).

Large Streams within the study area are unnamed, low-gradient (<2% slope), higher order streams that are included in the NHD. Most of the low-gradient Large Streams are also visible in the aerial imagery for the study area. Large Streams are either tributaries to Reed River or Kichaiakalea Creek, both of which drain into the Kobuk River, or are tributaries to the Kobuk River itself. The northern road alignment crosses 4 Large Streams and the southern alignment crosses 1 Large Stream (Figure 2).

Low-gradient Small Streams are first- and second-order waterways with <2% slope; some of these streams are included in the NHD. Some Low-gradient Small Streams are visible in the aerial imagery, but many are not. While the Low-gradient Small Streams that are not visible on the aerial imagery may in some cases be obscured by low to tall shrub canopies, it is also possible that the GIS model used to assign Strahler stream order may have over-estimated the occurrence of Low-gradient Small Streams. We cannot rule out the possibility that some of the Low-gradient Small Streams may be better described as Flow Paths (see Wetland Functional Classes above). Only with additional field studies to better define the type and location of small streams throughout the study area can this be fully resolved. Road crossings are planned for 22 Low-gradient Small Streams in the northern road alignment and 40 Low-gradient Small Streams in the southern alignment (Figure 2).

High-gradient Small Streams are first- and second-order waterways with a slope of 2% or greater; some of these small streams are included in the NHD. This class combines moderate- and high-gradient streams. Many of the moderate- to high-gradient streams are located in willow drainages and are not visible in the aerial imagery for the study area. As with Low-gradient Small Streams, it is also possible that the GIS model used to assign Strahler stream order may have over-estimated the occurrence of these small streams; if so, some of these waters might be better described as Flow Paths (see Wetland Functional Classes above). Only with additional field studies to better define the type and location of small streams throughout the study area can this be fully resolved. Road crossings are planned for 13 High-gradient Small Streams in the northern road alignment; no High-gradient Small Streams are crossed by the southern alignment (Figure 2).

RIVERINE FUNCTIONAL ASSESSMENT

Riverine functional scores were calculated for existing conditions and for the predicted change in functional conditions after construction and operation of the proposed road, for both short- and long-term effects (Table 12, Appendix E). Riverine function scores for existing conditions, short-term effects, and long-term effects are discussed by function below.

Table 12. Riverine functional scores for existing conditions and short- and long-term effects by riverine functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

Riverine Functional Class		Hydrology	Hydraulics	Geomorphology	Physicochemical	Biology
Major Rivers	Existing conditions	1.00	1.00	0.93	1.00	0.83
	Short-term effects	0.83	0.78	0.53	0.83	0.83
	Long-term effects	1.00	0.78	0.73	1.00	0.83
Large Streams	Existing conditions	1.00	1.00	1.00	1.00	0.83
	Short-term effects	0.83	0.89	0.60	0.83	0.83
	Long-term effects	1.00	0.89	0.80	1.00	0.83
Low-gradient Small Streams	Existing conditions	1.00	1.00	1.00	1.00	1.00
	Short-term effects	0.83	0.89	0.67	0.67	0.67
	Long-term effects	1.00	0.89	0.67	1.00	0.83
High-gradient Small Streams	Existing conditions	1.00	1.00	1.00	1.00	0.67
	Short-term effects	1.00	0.89	0.67	0.83	0.67
	Long-term effects	1.00	0.89	0.67	1.00	0.67

Hydrology: Hydrologic functions involve the transport of water from the watershed to the channel. Starr et al. (2015) assess hydrology by focusing on runoff (concentrated flow) and flashiness (deviation in storm flows from base flows). All riverine functional classes scored high (1.0) for existing hydrology conditions (Table 12) because the undisturbed study area has no point-source discharges and low impervious cover (Appendix E). Function scores for short-term effects on hydrology across the 4 functional classes ranged from 0.83 to 1.0; for long-term effects, all hydrology function scores were 1.0 (Table 12). Short-term effects on hydrology were predicted for Major Rivers, Large Streams, and Low-gradient Small Streams due to the potential for point-source discharges (dewatering) that will likely be created with material site development within the Kobuk River Preserve (Appendix E). It is assumed that all discharges will have adequate control measures in place through Storm Water Pollution Protection Plans (SWPPP). No long-term effects were predicted for any riverine functional class (Table 12), under the assumption that the use of material sites and any associated point-source discharges will cease after road construction (Appendix E).

Hydraulics: Hydraulic functions involve the transport of water in the channel, on the floodplain, and through sediments (Harman et al. 2012, Fischenich 2006). Starr et al. (2015) assess hydraulics by focusing on floodplain connectivity. All riverine functional classes scored high (1.0) for existing hydraulic conditions (Table 12) based on the high likelihood of annual floodplain engagement, sheetflow runoff, floodplain hillslopes <10%, and abundant riparian wetlands (Appendix E). Function scores for both short- and long-term effects on hydraulics across the 4 functional classes ranged from 0.78 to 0.89 (Table 12). The short- and long-term effects on hydraulics were expected to be due primarily to anticipated erosion and localized vertical instability associated with stream crossing structures (Appendix E).

Geomorphology: Geomorphological functions involve the transport and storage of wood and sediment to create diverse bed forms and maintain dynamic equilibria (Harman et al. 2012, Fischenich 2006). Starr et al. (2015) assess geomorphology by evaluating functional indicators for riparian vegetation, lateral stability, and bedform diversity. Major Rivers and Large Streams were assessed for each of these indicators, while neither lateral stability nor certain indicators of bedform diversity could be assessed for Low and High-gradient Small Streams. All riverine functional classes except Major Rivers scored high (1.0) for existing geomorphology conditions (Table 12). Major Rivers scored 0.93 for geomorphology because the large and deep rivers generally lacked shallow areas with large rocks for macroinvertebrate colonization, and although cover for fish (e.g., large woody debris, undercut banks) was present it was not abundant (Appendix E). Function scores for short-term effects on geomorphology across the 4 functional classes ranged from 0.53 to 0.67, and for long-term effects. from 0.67 to 0.80 (Table 12). The effects on geomorphology functions were expected to be due to construction-related disturbance (short-term effects), potential localized lateral instability, and the introduction of invasive riparian species (Appendix E).

Physicochemical: Physicochemical functions include the physical and chemical processes that control stream water quality and facilitate nutrient and organic carbon processes (Harman et al. 2012, Fischenich 2006). Starr et al. (2015) assess physicochemical functions by evaluating the quality of both surface water and detritus. All riverine functional classes scored high (1.0) for existing physicochemical conditions (Table 12), as stream waters in the Kobuk River Preserve are known or assumed to meet state surface water quality standards and have available detritus. Function scores for short-term effects on physicochemical functions across the 4 functional classes ranged from 0.67 to 0.83 (Table 12). These effects likely would occur because of short-term decreases in water quality during road construction (Appendix E). No long-term effects on physicochemical functions were predicted for any riverine functional class (all long-term effects function scores were 1.0) (Table 12).

Biology: Biological functions include processes that support the life histories of aquatic and riparian plants and animals (Harman et al. 2012, Fischenich 2006). Starr et al. (2015) assess biological functions by evaluating functional indicators for macroinvertebrate and fish populations. Using these indicators, the biological scores for existing conditions ranged from 0.67 to 1.0 (Table 12). Low-gradient Small Streams are the only riverine functional class to score high (1.0), as they are likely to support both abundant macroinvertebrate and fish populations. Low macroinvertebrate abundance and diversity, which was documented in Major Rivers (Durand et al. 2011) and assumed in Large Streams, precluded a score of 1.0 for these riverine functional classes. Function scores for both short- and long-term effects on biological functions across the 4 functional classes ranged from 0.67 to 0.83 (Table 12). We assume that bridge construction efforts will follow best management practices (e.g., construction during low water events and outside of fish spawning periods) and thus neither short-term nor long-term effects were predicted for Major Rivers or Large Streams (Appendix E). Both Low-gradient and High-gradient Small Streams would be crossed by minor culverts. Typicals for minor culverts show that they will not be embedded, that there will be riprap at culvert inlets and outlets, and that there will be no bed material within culverts. While sufficient for maintaining hydrologic connectivity across the road, even with proper maintenance these culverts have the potential to negatively affect fish passage (e.g., inhibiting the movements of smaller fish during high flow events) (Appendix E).

RIVERINE FUNCTIONAL CHANGE AND RIVERINE DEBITS

Riverine functional change scores (Δ) were calculated for both short- and long-term effects (Table 13), and were then multiplied by the number of potentially affected acres in each road alignment corridor to determine the estimated riverine debits associated with short- and long-

Table 13. Standardization of riverine functional scores for existing conditions, short- and long-effects, and the predicted change in functional scores from existing conditions (Δ[1]) by riverine functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

Riverine Functional Class		Sum of Individual Function Scores	Number of Assessed Functions	Average Score (Sum/Number of Functions)	Δ
Major Rivers	Existing conditions	4.77	5	0.95	
	Short-term effects	3.81	5	0.76	0.19
	Long-term effects	4.34	5	0.87	0.08
Large Streams	Existing conditions	4.83	5	0.97	
	Short-term effects	3.99	5	0.80	0.17
	Long-term effects	4.52	5	0.90	0.07
Low-gradient Small Streams	Existing conditions	5.00	5	1.00	
	Short-term effects	3.72	5	0.74	0.26
	Long-term effects	4.39	5	0.88	0.12
High-gradient Small Streams	Existing conditions	4.67	5	0.93	
	Short-term effects	4.06	5	0.81	0.12
	Long-term effects	4.22	5	0.84	0.09

[1] Δ = existing condition score - predicted condition score.

term effects for each riverine function (Table 14). For comparison with the riverine debits, existing riverine functional capacity was calculated by multiplying existing condition functional scores for each riverine functional class by the potentially affected acreage of each riverine functional class in the 2 road alignments (Table 15). Debits and existing functional capacity were calculated using the acreage of the combined direct-effects footprint and the indirect-effects buffer, as neither short- nor long-term effects are likely to be constrained to the project footprint.

Table 14. Calculation of riverine debits (average functional change scores [Δ[1]] × affected acres[2]) for predicted short- and long-term effects by riverine functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

	Northern Alignment			Southern Alignment		
Riverine Functional Class	Δ	Acres	Debits	Δ	Acres	Debits
Major Rivers						
Short-term effects	0.19	5.47	1.04	0.19	14.06	2.67
Long-term effects	0.08	5.47	0.44	0.08	14.06	1.12
Large Streams						
Short-term effects	0.17	3.44	0.58	0.17	0.41	0.07
Long-term effects	0.07	3.44	0.24	0.07	0.41	0.03
Low-gradient Small Streams						
Short-term effects	0.26	2.98	0.77	0.26	6.27	1.63
Long-term effects	0.12	2.98	0.36	0.12	6.27	0.75
High-gradient Small Streams						
Short-term effects	0.12	0.44	0.05	0.12	<0.01	<0.01
Long-term effects	0.09	0.44	0.04	0.09	<0.01	<0.01

[1] Δ = existing condition score - predicted condition score.
[2] Riverine debits calculated for the combined direct and indirect effects acreage, as neither short- nor long-term effects are likely to be confined to the project footprint.

Table 15. Calculation of existing riverine functional capacity (average existing functional score × affected acres [1]) by riverine functional class for the northern and southern road alignments in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

	Northern Alignment			Southern Alignment		
Riverine Functional Class	Existing Functional Score	Acres	Existing Functional Capacity	Existing Functional Score	Acres	Existing Functional Capacity
Major Rivers	0.95	5.47	5.20	0.95	14.06	13.36
Large Streams	0.97	3.44	3.34	0.97	0.41	0.40
Low-gradient Small Streams	1.00	2.98	2.98	1.00	6.27	6.27
High-gradient Small Streams	0.93	0.44	0.41	0.93	<0.01	<0.01

[1] Riverine debits calculated for the combined direct and indirect effects acreage, as neither short- nor long-term effects are likely to be confined to the project footprint.

Using the riverine debit calculations (functional change scores × affected acreage) and calculations of existing functional capacity (existing functional scores × acreage), both of which incorporate the estimated spatial extent of riverine function, we can compare the overall expected loss in functional capacity between the 2 proposed road alignments (Table 16). Although the northern road alignment (26.0 miles) is over 8 miles longer than the southern alignment (17.8 miles), there are fewer riverine debits associated with the northern alignment (11.93) compared to the southern alignment (20.03) (Table 16). This counter-intuitive result mirrors the relationship for wetland debits discussed in Wetland Functional Change and Wetland Debits above, in which fewer wetland debits also were associated with the longer northern road alignment. As noted above for the acreage of riverine functional classes in the study area, the greater riverine debits associated with the shorter southern road alignment occurs because (1) the southern road alignment crosses 2 Major Rivers (which are of much greater wetted width than other riverine features) whereas the longer northern alignment crosses only 1, and (2) the southern alignment also crosses a larger number of Low-gradient Small Streams.

Table 16. Summary of existing riverine functional capacity (average existing functional score × affected acres [1]) and riverine debits (average functional change values [Δ^2] × affected acres[1]) by riverine functional class in the Ambler Mining District Industrial Access Project study area, Kobuk River Preserve, Gates of the Arctic National Park, Alaska.

	Northern Alignment			Southern Alignment		
Riverine Functional Class	Existing Functional Capacity	Short-term Effects Debits	Long-term Effects Debits	Existing Functional Capacity	Short-term Effects Debits	Long-term Effects Debits
Major Rivers	5.20	1.04	0.44	13.36	2.67	1.12
Large Streams	3.34	0.58	0.24	0.40	0.07	0.03
Low-gradient Small Streams	2.98	0.77	0.36	6.27	1.63	0.75
High-gradient Small Streams	0.41	0.05	0.04			
Total:	11.93	2.44	1.08	20.03	4.37	1.90

1 Riverine debits calculated for the combined direct and indirect effects acreage, as neither short- nor long-term effects are likely to be confined to the project footprint.
2 Δ = existing condition score - predicted condition score.

LITERATURE CITED

ABR (ABR, Inc.—Environmental Research & Services). 2016a. Wetland mapping review, aquatic site assessment, and wildlife habitat evaluation for Richardson Highway MP 115–148, Alaska, 2015. Prepared for Alaska Department of Transportation and Public Facilities, Fairbanks, AK.

——. 2016b. Aquatic site assessment for the Quintillion Subsea Operations, LLC Nome fiber optic cable corridor, Alaska, 2015. Prepared for Umiaq, Anchorage, AK.

——. 2015. Wetland mapping review, aquatic site assessment, and wildlife habitat evaluation at the Wiley Post/Will Rogers Memorial Airport, Barrow, Alaska, 2014. Prepared for PDC Inc. Engineers, Anchorage, AK.

——. 2014a. Aquatic site assessment for the Greater Mooses Tooth One development project—2014. Prepared for ConocoPhillips Alaska, Inc, Anchorage, AK.

——. 2014b. Wetlands determination, wetland functional assessment, and habitat evaluation for proposed Dalton Highway material sites 65-9-042-2 and 65-9-026-2, and stockpile and staging area at MP 398. Prepared for Alaska Department of Transportation and Public Facilities, Fairbanks, AK.

——. 2014c. Stream habitat surveys of proposed bridge crossings on the Brooks East Corridor. Prepared for DOWL HKM, Anchorage, AK.

Abramov, A. V. 2016. *Gulo gulo*. The IUCN Red List of Threatened Species 2016: e.T9561A45198537. Online at: http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T9561A45198537.en (accessed November 2016).

Adamus, P. R. 2013. Manual for wetland ecosystem services protocol for southeast Alaska (WESPAK-SE). Online at: http://southeastalaskalandtrust.org/wp-content/uploads45yI789N/2012/02/Manual_WESPAKse_10Jan2014.pdf (accessed November 2016).

Adamus, P. R., L. T. Stockwell, E. J. Clairain, Jr., M. E. Morrow, L. P. Rozas, and R. D. Smith. 1991. Wetland evaluation technique (WET); Vol. I: literature review and evaluation rationale. Technical Report WRP-DE-2. U. S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Arp, C. D., M. S. Whitman, B. M. Jones, R. Kemnitz, G. Grosse, and F. E. Urban. 2012. Drainage network structure and hydrologic behavior of three lake-rich watersheds on the Arctic Coastal Plain, Alaska. Arctic, Antarctic, and Alpine Research 44:385–398.

Auerback, N. A., M. D. Walker, and D. A. Walker. 1997. Effects of roadside disturbance on substrate and vegetation properties in arctic tundra. Ecological Applications 7: 218–235.

Baltensperger, A. P. 2009. Behavior and distribution of American marten (*Martes americana*) in relation to snow and forest cover on the Kenai Peninsula, Alaska. M.S. thesis. Colorado State University, Fort Collins, CO.

Banci, V. 1981. Ecology and behavior of wolverine in Yukon. M.S. thesis. Simon Fraser University, Burnaby, BC.

Bayley, S. E., and R L. Mewhort. 2004. Plant community structure and functional differences between marshes and fens in the southern boreal region of Alberta, Canada. Wetlands 2: 277–294.

Bellrose, F. C., editor. 1978. Ducks, geese, and swans of North America. Second, revised edition. Stackpole Books, Harrisburg, PA.

Blok, D., M. M. P. D. Heijmans, G. Schaepman-Strub, A. V. Kononov, T. C. Maximov, and F. Berendse. 2010. Shrub expansion may reduce summer permafrost thaw in Siberian tundra. Global Change Biology 16: 1296–1305.

Blok, D., M. M. P. D. Heijmans, G. Schaepman-Strub, J. van Ruijven, F. J. W. Parmentier, T. C. Maximov, and F. Berendse. 2011. The cooling capacity of mosses: controls on water and energy fluxes in a Siberian tundra site. Ecosystems 14: 1055–1065.

Brabets, T. P. 2001. Hydrologic data and a proposed water-quality monitoring network for the Kobuk River basin, Gates of the Arctic National Park and Preserve, and Kobuk Valley National Park, Alaska. U.S. Geological Survey Water Resources Investigations Report 01-4141. 23 pp.

Brosten, T. R., J. H. Bradford, J. P. McNamara, J. P. Zametske, M. N. Gooseff, and W. Breck Bowden. 2006. Profiles of temporal thaw depths beneath two arctic stream types using ground-penetrating radar. Permafrost and Periglacial Processes 17: 341–355.

Brown, J., O. J. Ferrians, J. A. Heginbottom, and E. S. Melnikov. 2001. Circum-Arctic map of permafrost and ground-ice conditions, version 2. National Snow and Ice Data Center, Boulder, CO. Digital media. Online at: http://nsidc.org/data/GGD318 (accessed October 2016).

Coltrane, J. A., and R. Sinnott. 2012. Winter home range and habitat use by porcupines in Alaska. Journal of Wildlife Management 77: 505–513.

Cook, J. A., and S. O. MacDonald. 2006. Mammal inventory of Alaska's national parks and preserves: Arctic Network—Bering Land Bridge National Park, Cape Krusenstern National Monument, Kobuk Valley National Park, Noatak National Park, and Gates of the Arctic National Park and Preserve. National Park Service Arctic Network National Park Service Alaska Region, Inventory and Monitoring Program, Fairbanks, AK. Final Report 2006 NPS/AKRARCN/NRTR-2004/01.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Northern Prairie Publication 0421. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Cramer, M., K. Bates, D. Miller, K. Boyd, L. Fotherby, P. Skidmore, and T. Hoitsma. 2003. Integrated Streambank Protection Guidelines. Co-published by the Washington departments of Fish & Wildlife, Ecology, and Transportation, Olympia, Washington. 435 pp. Online at: http://www.wdfw.wa.gov/hab/ahg/strmbank.htm (accessed October 2016).

Dean, F., and D. L. Chesemore. 1974. Studies of birds and mammals in the Baird and Schwatka Mountains, Alaska. Biological Papers of the University of Alaska No. 15.

DeGroot, K., and J. McMillan. 2012. Landbird monitoring in the Arctic Network, Gates of the Arctic National Park and Preserve and Noatak National Preserve (2010 Report). U.S. Department of the Interior, National Park Service, Fairbanks, AK. Natural Resource Data Series NPS/ARCN/NRDS—2012/315.

DiFolco, D. L. 1996. 1996 Neotropical Migratory Bird Surveys, Gates of the Arctic National Park and Preserve. U.S. National Park Service, Fairbanks, AK. GAAR 96-01.

DOWL HKM. 2014. Ambler Mining District Industrial Access Road, preliminary wetland delineation and functions and values assessment. Prepared for the Alaska Industrial Development and Export Authority (AIDEA), Anchorage, AK.

Durand, J. R., R. A. Lusardi, D. M. Nover, R. J. Sudeth. G. Carmona-Catot, C. R. Connell-Buck, S. E. Gatzke, J. V. Katz, J. F. Mount, P. B. Moyle, and J. H. Viers. 2011. Environmental heterogeneity and community structure of the Kobuk River, Alaska, in response to climate change. Ecosphere 2(4): art44.

Durand, J. R., R. A. Lusardi, R. Suddeth, G. Carmona-Catot, C. Connell, S. Gatzke, J. V. E. Katz, D. Nover, J. F. Mount, P. Moyle. 2009. Conceptual ecosystem model of the sub-arctic river response to climate change: Kobuk River, Alaska. University of California Davis Center for Watershed Sciences, Davis, CA. Online at: https://watershed.ucdavis.edu/library/conceptual-ecosystem-model-sub-arctic-river-response-climate-change-kobuk-river-alaska (accessed October 2016).

Fischenich, J. C. 2006. Functional objectives for stream restoration, EMRRP technical notes collection.. U.S. Army Engineer Research and Development Center, Vicksburg, MS. ERDC TN-EMRRP-SR-52.

Forman, R. T. T., and L. E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29: 207–231.

Forman, R. T. T., D. Sperling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L. Fahrig, R. France, C. R. Goldman, K. Heanue, J. A. Jones, F. J. Swanson, T. Turrentine, and T. C. Winter. 2003. Road ecology: science and solutions. Island Press, Washington, DC.

Gabrielson, I. N., and F. C. Lincoln. 1959. The Birds of Alaska. The Stackpole Company, Harrisburg, Pennsylvania, and the Wildlife Management Institute, Washington, DC.

Gibson, D. D. 2011. Nesting shorebirds and landbirds of interior Alaska. Unpublished report by AVESALASKA, for U.S. Geological Survey.

Guettabi, M., J. Greenberg, J. Little, and K. Joly. 2016. Evaluating potential economic effects of an industrial road on subsistence in north-central Alaska. Arctic 69: 305–317.

Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, and C. Miller. 2012. A function-based framework for stream assessment and restoration projects. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, DC. EPA 843-K-12-006.

Helmers, M. J.; Isenhart, T. M.; Dosskey, M. G.; Dabney, S. M.; and S. Jeffrey. 2008. Buffers and vegetative filter strips. Agricultural and Biosystems Engineering Publications. Paper 298. Online at: http://lib.dr.iastate.edu/abe_eng_pubs/298/ (accessed October 2016).

Hunt, R. J., J. F. Walker, and D. P. Krabbenhoft. 1999. Characterizing hydrology and the importance of ground-water discharge in natural and constructed wetlands. Wetlands 19: 458–472.

Joly, K. 2011. Modeling influences on winter distribution of caribou in northwestern Alaska through use of satellite telemetry. Rangifer 31: 75–85.

Joly, K., and M. D. Cameron. 2015. Caribou vital sign annual report for the Arctic Network Inventory and Monitoring Program: September 2014–August 2015. Arctic Network Inventory and Monitoring Program, Gates of the Arctic National Park and Preserve, Fairbanks, AK. Natural Resource Report NPS/ARCN/NRR—2015/1090.

Joly, K., F. S. Chapin III, and D. R. Klein. 2010. Winter habitat selection by caribou in relation to lichen abundance, wildfires, grazing, and landscape characteristics in northwest Alaska. Ecoscience 17: 321–333.

Jorgenson, M. T., J. E. Roth, M. Emers, S. F. Schlentner, D. K. Swanson, E. R. Pullman, J. S. Mitchell, and A. A. Stickney. 2003. An ecological land survey in the Northeast Planning Area of the National Petroleum Reserve-Alaska, 2002. Report for CPAI and ARCO Alaska, Inc., Anchorage, AK, by ABR, Inc., Fairbanks, AK.

Jorgenson, M. T., J. E. Roth, P. F. Miller, M. J. Macander, M. S. Duffy, A. F. Wells, G. V. Frost, and E. R. Pullman. 2009. An ecological land survey and landcover map of the Arctic Network. Natural Resource Technical Report NPS/ARCAN/NRTR-2009/270. National Park Service, Fort Collins, CO.

Kessel, B. 1979. Avian habitat classification for Alaska. Murrelet 60: 86–94.

———. 1998. Habitat characteristics of some passerine birds in western North American taiga. University of Alaska Press, Fairbanks, AK.

Khalid, R. A., W. H. Patrick, and R. D. DeLaune. 1977. Phosphorus sorption characteristics of flooded soils. Soil Science Society of America Journal 41: 305–310.

King, J. G., and B. Conant. 1981. The 1980 census of Trumpeter Swans on Alaskan nesting habitats. American Birds 35: 789–793.

Krebs, J., E. C. Lofroth, and I. A. N. Parfitt. 2007. Multiscale habitat use by wolverines in British Columbia, Canada. Journal of Wildlife Management 71: 2180–2192.

Lee, G. F., E. Bentley, R. Amundson. 1975. Effects of marshes on water quality. Pages 105–127 *In* A. D. Hasler, editor. Coupling of Land and Water Systems. Ecological Studies, Volume 10. Springer-Verlag, NY.

Lemke, J. L., J. M. Gottschalk, D. Dissing, R. M. Burgess, and J. C. Seigle. 2014. Anadromous fish surveys within the Brooks East Corridor survey area, Alaska. Report for DOWL HKM, Anchorage, AK, by ABR, Fairbanks, AK.

Lewis, S. B., R. W. Flynn, L. R. Beier, D. P. Gregovich, and N. L. Barten. 2012. Spatial use, habitat selection , and diets of wolverines along the proposed Juneau access improvements road corridor, southeast Alaska. Final Wildlife Research Report. ADF&G/DWC/WRR-2012-05.Alaska Department of Fish and Game, Juneau, AK.

Liljedahl, A. K., L. D. Hinzman, and J. Schulla. 2012. Ice-wedge polygon type controls low-gradient watershed-scale hydrology. Pages 231–236 *in* K. M. Hinkel, editor. Tenth International Conference on Permafrost Vol. 1: International Contributions. The Northern Publisher, Salekhard, Russia.

Lisgo, K. A. 1999. Ecology of the short-tailed weasel (*Mustela erminea*) in the mixedwood boreal forest of Alberta. B.Sc. thesis. University of British Columbia, Vancouver, BC.

Livezey, K. B., E. Fernández-Juricic, and D. T. Blumstein. 2016. Database of bird flight initiation distances to assist in estimating effects from human disturbance and delineating buffer areas. Journal of Fish and Wildlife Management 7: 181–191. Online at: http://dx.doi.org/10.3996/082015-JFWM-078 (accessed November 2016).

Lowrance, R. R., R. L. Todd, and L.E. Asmussen. 1984. Nutrient cycling in an agricultural watershed: II. Streamflow and artificial drainage. Journal of Environmental Quality 13: 27–32.

MacDonald, S. O., and J. A. Cook. 2009. Recent mammals of Alaska. University of Alaska Press, Fairbanks, AK.

Marcot, B. G., M. T. Jorgenson, J. P. Lawler, C. M. Handel, and A. R. DeGange. 2015. Projected changes in wildlife habitats in Arctic natural areas of northwest Alaska. Climatic Change 130: 145–154.

McKee, P. C. 2002. Exotic plants in Alaska National Parks: 2002 field season report. Online at: https://www.nps.gov/gaar/learn/nature/exotic-plants-in-alaska-national-parks.htm (accessed November 2016).

Millar, R. G., and M. C. Quick. 1998. Stable width and depth of gravel-bed rivers with cohesive banks. Journal of Hydraulic Engineering-ASCE 124: 1005–1013.

Myers-Smith, I. H., R. Thompson, and F. S. Chapin III. 2006. Cumulative impacts on Alaskan arctic tundra of a quarter century of road dust. Ecoscience 13: 503–510.

NPS (National Park Service). 2016. Gates of the Arctic bird list. Online at: https://www.nps.gov/gaar/planyourvisit/upload/Birdlist00.pdf (accessed October 2016).

Paragi, T. F., W. N. Johnson, D. D. Katnik, and A. J. Magoun. 1996. Marten selection of postfire seres in the Alaskan taiga. Canadian Journal of Zoology 74: 2226–2237.

Parker, C. L. 2006. Vascular plant inventory of Alaska's Arctic National Parklands: Bering Land Bridge National Preserve, Cape Krusenstern National Monument, Gates of the Arctic National Park and Preserve, Kobuk Valley National Preserve, and Noatak National Preserve. Final Report by ARCN I&M, National Park Service, Alaska Region, Fairbanks, AK. Report no. NPS/AKRARCN/NRTR-2006-01.

Poole, K. G., L. A. Wakelyn, and P. N. Nicklen. 1996. Habitat selection by lynx in the Northwest Territories. Canadian Journal of Zoology 74: 845–850.

Putkonen, J. 1998. Soil thermal properties and heat transfer processes near Ny-Alesund, northwestern Spitsbergen, Svalbard. Polar Research 17: 165–179.

Raynolds, M. K., D. A. Walker, K. J. Ambrosius, J. Brown, K. R. Everett, M. Kanevskiy, G. P. Kofinas, V. E. Romanovsky, Y. Shur, and P. J. Webber. 2014. Cumulative geoecological effects of 62 years of infrastructure and climate change in ice-rich permafrost landscapes, Prudhoe Bay Oilfield, Alaska. Global Change Biology 20: 1211–1224.

Reid, F., M. Schiaffini, and J. Schipper. 2016. *Neovison vison*. The IUCN Red List of Threatened Species 2016: e. T41661A45214988. Online at: http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T41661A45214988.en (accessed October 2016).

Ritchie, R. J. 2013. Raptor surveys along the proposed Brooks East Corridor, Ambler Mining District access project, Alaska, 2013. Report by ABR, Inc.—Environmental Research & Services, Fairbanks, AK, for DOWL KLM, Anchorage, AK.

Robinson, S. R. 1987. Wildlife of the Squirrel River, Alaska. Bureau of Land Management, Fairbanks, AK. Open File Report 20.

Rodewald, P., editor. 2015. The Birds of North America. Cornell Laboratory of Ornithology, Ithaca, NY. Online at: https://birdsna.org/Species-Account/bna/home (accessed November 2016).

Smith, A. C., and J. A. Schaefer. 2002. Home-range size and habitat selection by American marten (*Martes americana*) in Labrador. Canadian Journal of Zoology 80: 1602–1609.

Smith, R. D., A. Ammann, C. Bartoldus, and M. M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. Wetlands Research Program Technical Report WRP-DE-9.

Speeter, G. 2015. Geotechnical investigation, Ambler Mining District Access, Phase 2, Gates of the Arctic National Park and Jim River landslides. AKSAS 63812. Alaska Department of Transportation and Public Facilities, Northern Region, Fairbanks, AK.

Spindler, M. A., and B. Kessel. 1978. Terrestrial bird habitats and their utilization, Upper Tanana River Valley, Alaska, 1977. Report for Northwest Alaskan Pipeline Company, Fairbanks, AK, by University of Alaska Museum, Fairbanks, AK.

Starr, R., W. Harman, and S. Davis. 2015. Function-based rapid stream assessment methodology, final draft. U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, Habitat Restoration Division, Annapolis, MD. CAFE-S15-06.

Swaim, M., and N. Guldager. 2000. 2000 breeding bird surveys off road point counts, Gates of the Arctic National Park and Preserve. National Park Service, Fairbanks, AK. GAAR-00-006. 13 pp.

Swanson, D. K. 1995. Landscape ecosystems of the Kobuk Preserve Unit: Gates of the Arctic National Park, Alaska. U.S. National Park Service. Alaska Regional Office, Anchorage, AK. Technical Report NPS/ARRNR/NRTR-95/22.

Swanson, S. A. 1992. 1991 raptor surveys: Gates of the Arctic National Park and Preserve. National Park Service, Fairbanks, AK. GAAR-91-001.

———. 1996. Small mammal populations in post-fire black spruce (*Picea mariana*) seral communities in the Upper Kobuk River Valley, Alaska: Gates of the Arctic National Park and Preserve. National Park Service, Fairbanks, AK. Technical Report NPS/AFARBR/NRTR-96/30.

———. 2001. 2001 Bird off-road point count surveys. National Park Service, Fairbanks, AK. National Park Service, Fairbanks, AK. GAAR-02-02.

Tibbitts, T. L., D. R. Ruthrauff, R. E. Gill, Jr., and C. M. Handel. 2005. Inventory of montane-nesting birds in the arctic network of national parks, Alaska. Alaska Arctic Network Inventory and Monitoring Program, National Park Service, Anchorage, AK. Final Report NPS/AKARCN/NRTR-2006/02.

Trepline, M., and M. Zimmer. 2012. Drowned or dry: a cross-habitat comparison of detrital breakdown processes. Ecosystems 15:477–491.

Trombulak, S., and C. Frissell, 1999. Review of the ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14: 18–30.

U.S. Army Corps of Engineers (USACE). 2016. Alaska District: credit debit methodology. Version 1.0.

U.S. Fish and Wildlife Service (USFWS). 2014. Endangered, threatened, proposed, candidate, and delisted species in Alaska (Updated May 13, 2014). Online at:

https://www.fws.gov/alaska/fisheries/endangered/pdf/consultation_guide/4_species_list.pdf (accessed November 2016).

Walton, K., T. Gotthardt, and T. Fields. 2013. Alaska species ranking system summary report—American mink. Alaska Natural Heritage Program, University of Alaska, Anchorage, AK.

Wardle, D. A. 2002. Communities and ecosystems—linking the above and belowground components. Princeton University Press, Princeton, NJ.

Washburn, A. L. 1973. Periglacial processes and environments. Edward Arnold, London. 320 pp.

Washington Department of Fish and Wildlife. 2009. Compiled white papers for hydraulic project approval. Online at: http://wdfw.wa.gov/publications/00803/ (accessed October 2016).

Webber, P. J., L. F. Klinger, and D. A. Walker. 1982. The effects of a gravel road on arctic coastal plain tundra. U.S. Army Corps of Engineers, Waterflood Monitoring Program.

Westing, C. 2013. Unit 23 furbearer management report. Pages 319–329 *in* P. Harper and L. A. McCarthy, editors. Furbearer management report of survey-inventory activities, 1 July 2009–30 June 2012. Species Management Report. Alaska Department of Fish and Game, Juneau, AK, ADF&G/DWC/SMR-2013-5.

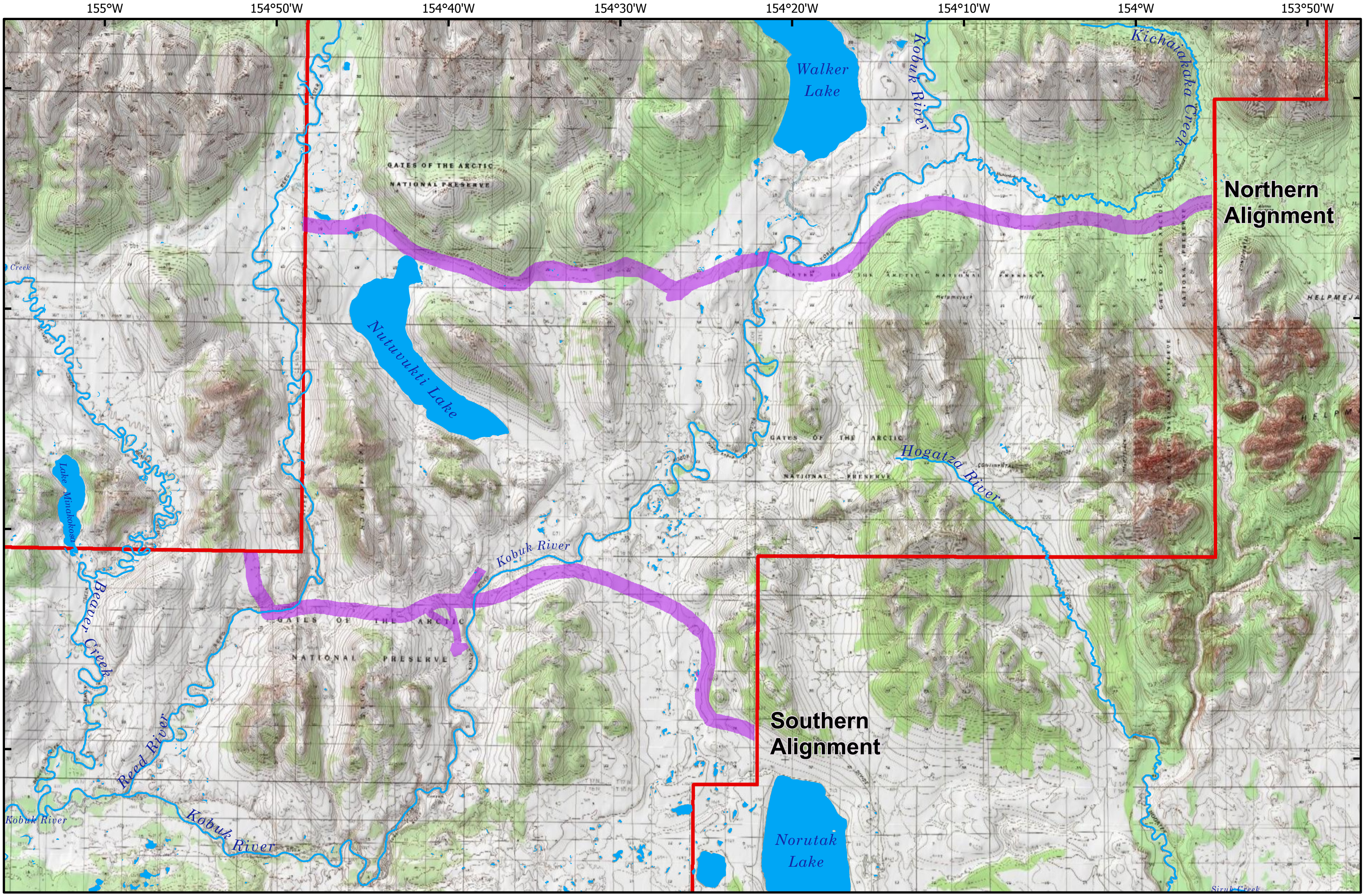
Winter, T. C., J. W. Harvey, O. L. Franke, and W. M. Alley. 1998. Groundwater and surface water: a single resource. U.S. Geological Survey Circular 1139.

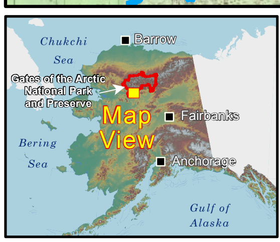
Wolff, J. O. 1978. Food habits of snowshoe hares in interior Alaska. The Journal of Wildlife Management 42: 148–153.

———. 1980. The role of habitat patchiness in the population dynamics of snowshoe hares. Ecological Monographs 50: 111–130.

Woo. M-K. 2012. Permafrost Hydrology. Springer-Verlag, Berlin, Germany. 563 pp.

Yi, S., A. D. McGuire, J. Harden, E. Kasischke, K. Manies, L. Hinzman, A. Liljedahl, J. Randerson, H. Liu, V. Romanovsky, S. Marchenko, and Y. Kim. 2009. Interactions between soil thermal and hydrological dynamics in the response of Alaska ecosystems to fire disturbance. Journal of Geophysical Research 114.





DOWL (2014) Wetlands Mapping Corridor for the Northern and Southern Alignments of the Ambler Mining District Industrial Access Project.

Gates of the Arctic National Park and Preserve Boundary

0 1 2 3 Miles

0 1 2 3 4 5 Kilometers

Notes: Wetlands mapping by DOWL (2014) in a 2000 ft corridor around the Northern and Southern alignments of the Ambler Mining District Industrial Access Project. This study concentrates on the part of the mapping which falls within the boundaries of the Gates of the Arctic National Park and Preserve.

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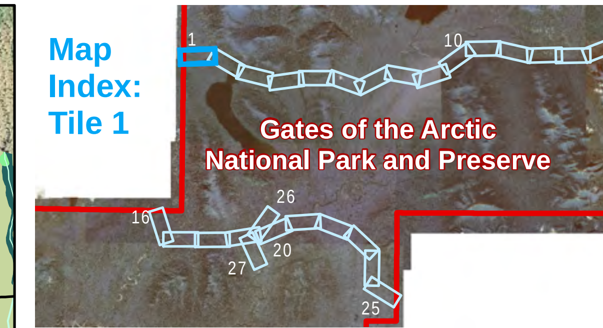
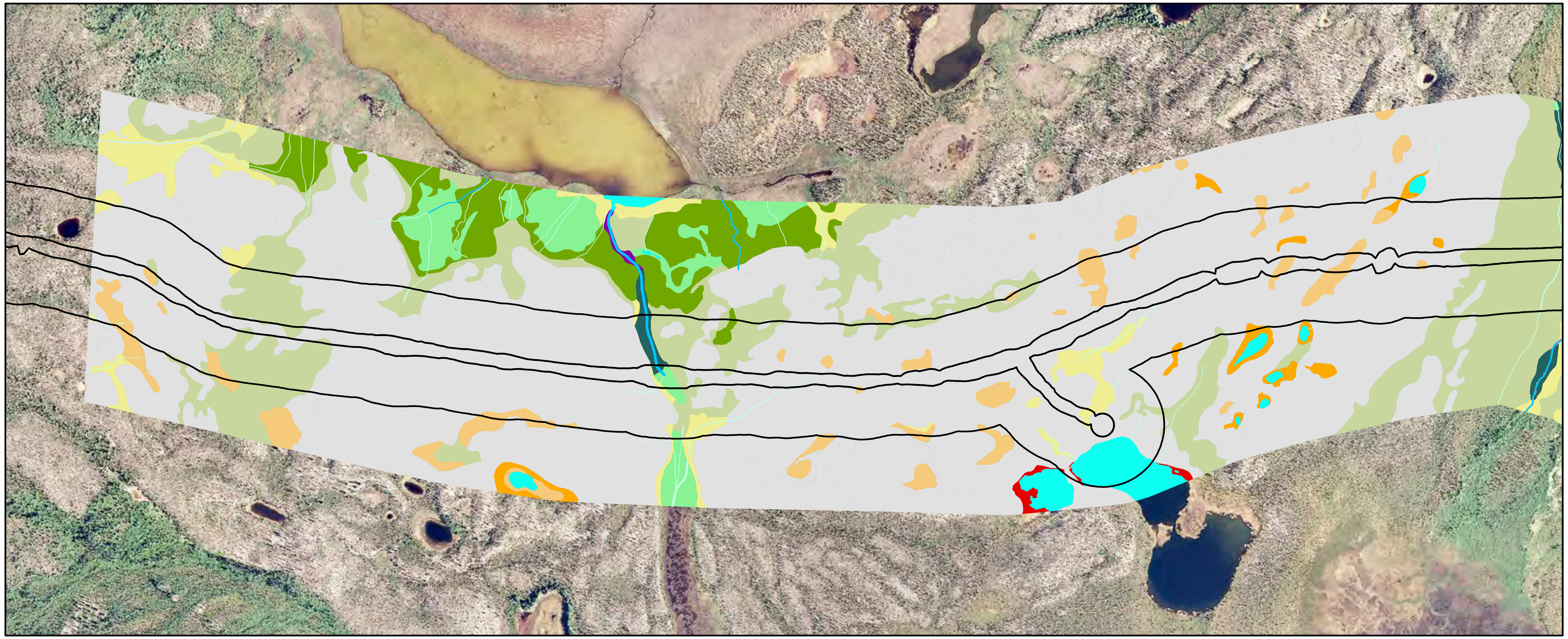
Figure 1.
Study Area Location for the Proposed Ambler Mining District Industrial Access Project, Gates of the Arctic National Park and Preserve, Alaska

Map prepared by:
ABR Inc.–Environmental Research and Services

22 December 2016 | Ambler_Wetlands_StudyArea_16-307.mxd



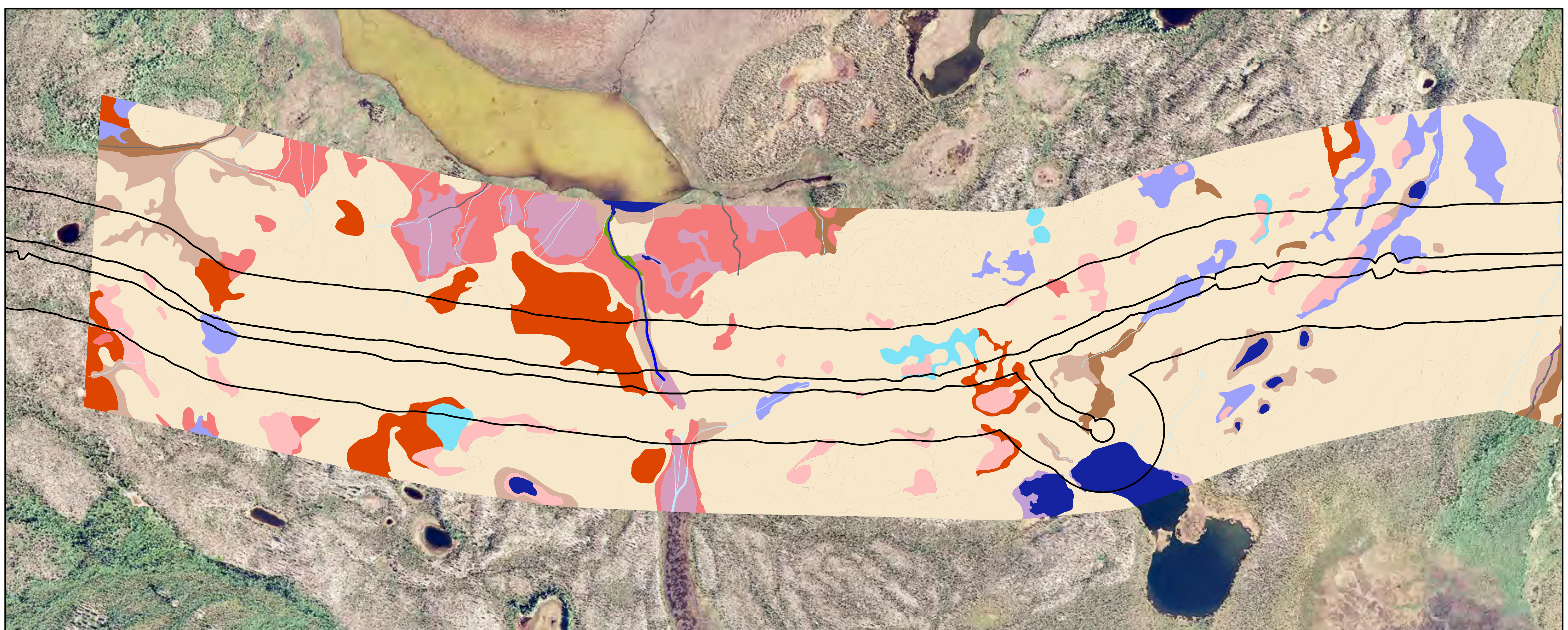


Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream
- High-gradient Small Stream

Wetlands
- Flow Paths
- Lakes and Ponds
- Lacustrine Fringe Wet Sedge Meadow
- Depressional Saturated Graminoid-Shrub Meadow
- Depressional Saturated Deciduous Shrub
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Wet Sedge-Shrub Meadow
- Riverine Seasonally Flooded Deciduous Shrub

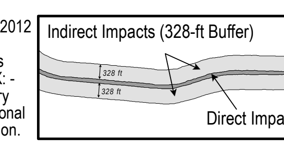
Other Lands
- Upland



Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Lacustrine Sedge Meadow
- Rivers and Streams
- Riverine Sedge-Shrub Meadow
- Riverine Low Willow Scrub
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Upland Broadleaf Forest

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, acq. 2004–2010, at 1 m resolution.



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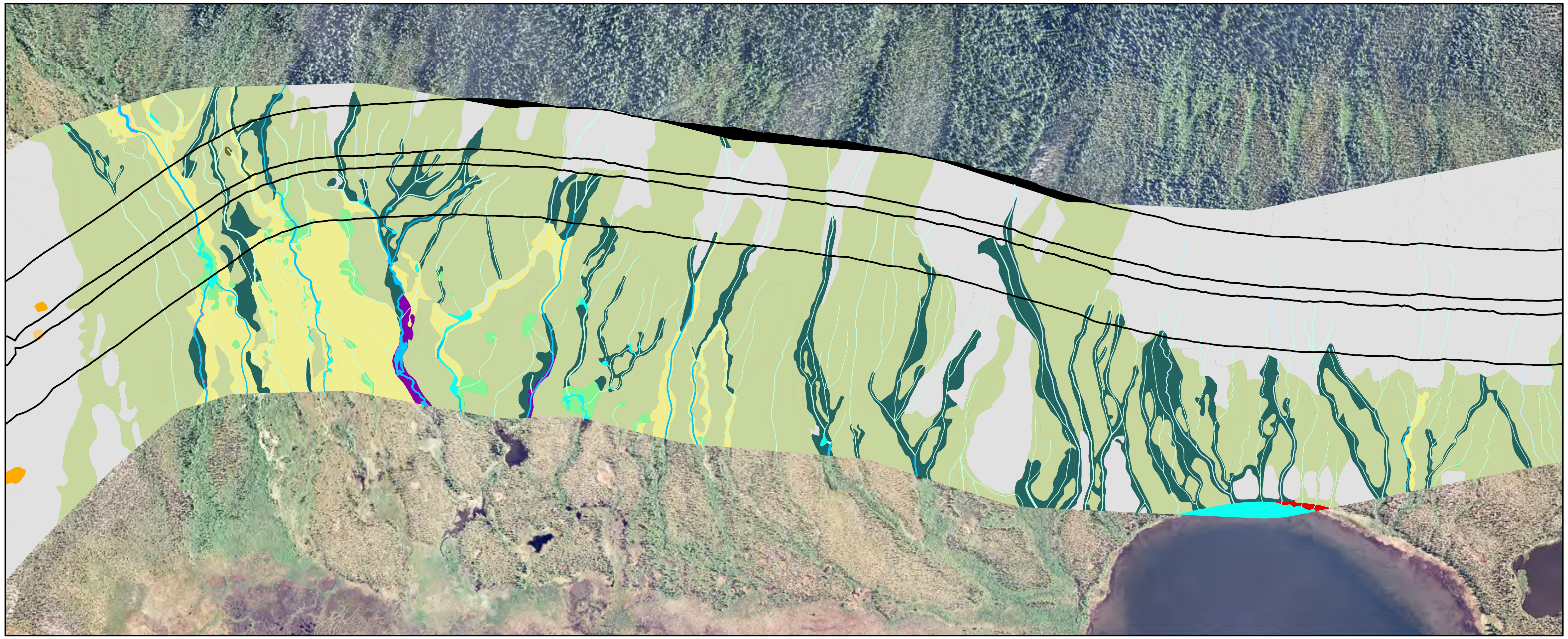
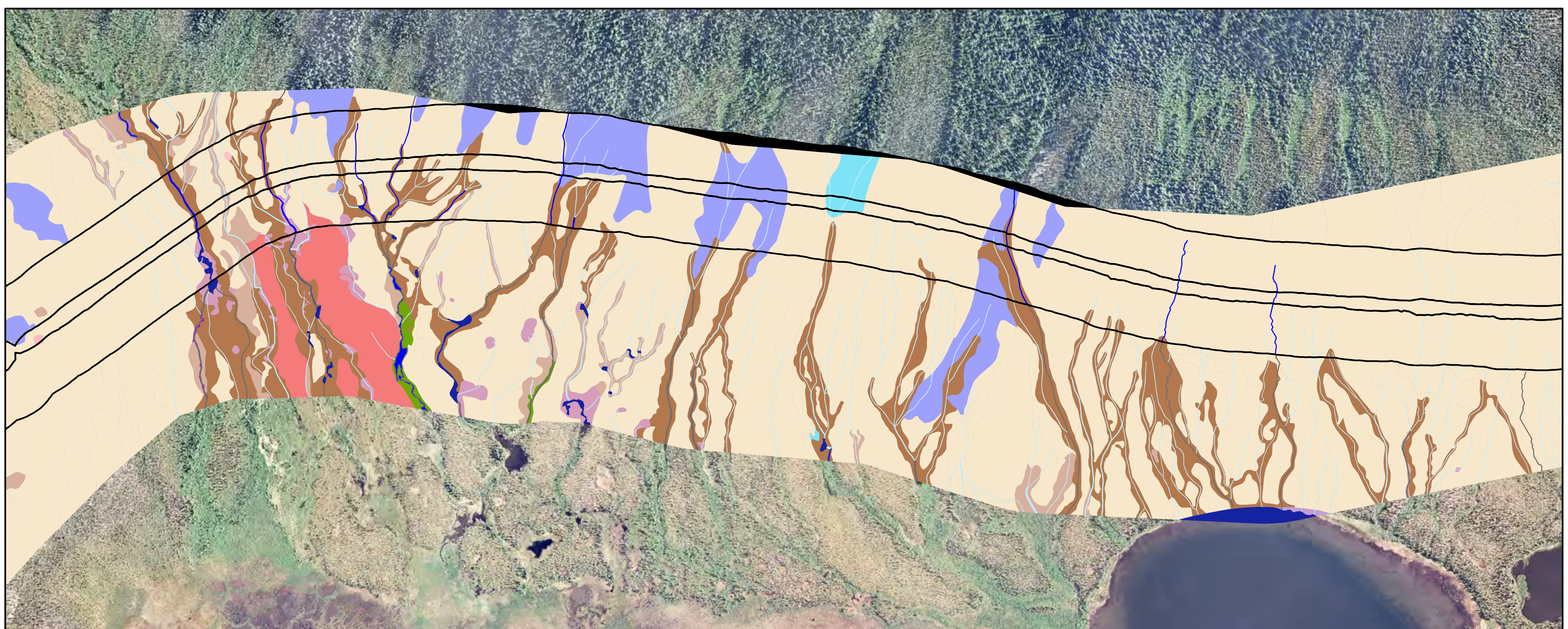
Approximate Scale 1:10,000

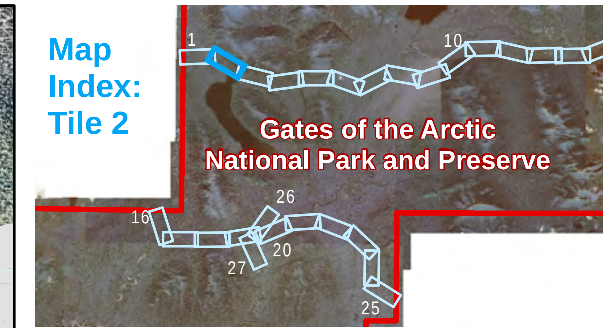
Figure 2, Tile 1
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd







Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream
- High-gradient Small Stream

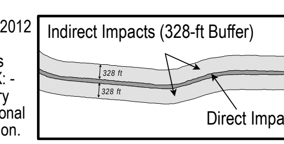
Wetlands
- Flow Paths
- Lakes and Ponds
- Lacustrine Fringe Wet Sedge Meadow
- Depressional Saturated Graminoid-Shrub Meadow
- Depressional Saturated Deciduous Shrub
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Wet Sedge-Shrub Meadow
- Riverine Seasonally Flooded Graminoid-Shrub Meadow
- Riverine Seasonally Flooded Deciduous Shrub

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Lacustrine Sedge Meadow
- Rivers and Streams
- Riverine Sedge-Shrub Meadow
- Riverine Grass-Shrub Meadow
- Riverine Low Willow Scrub
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Upland Broadleaf Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



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Approximate Scale 1:10,000

Figure 2, Tile 2
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd

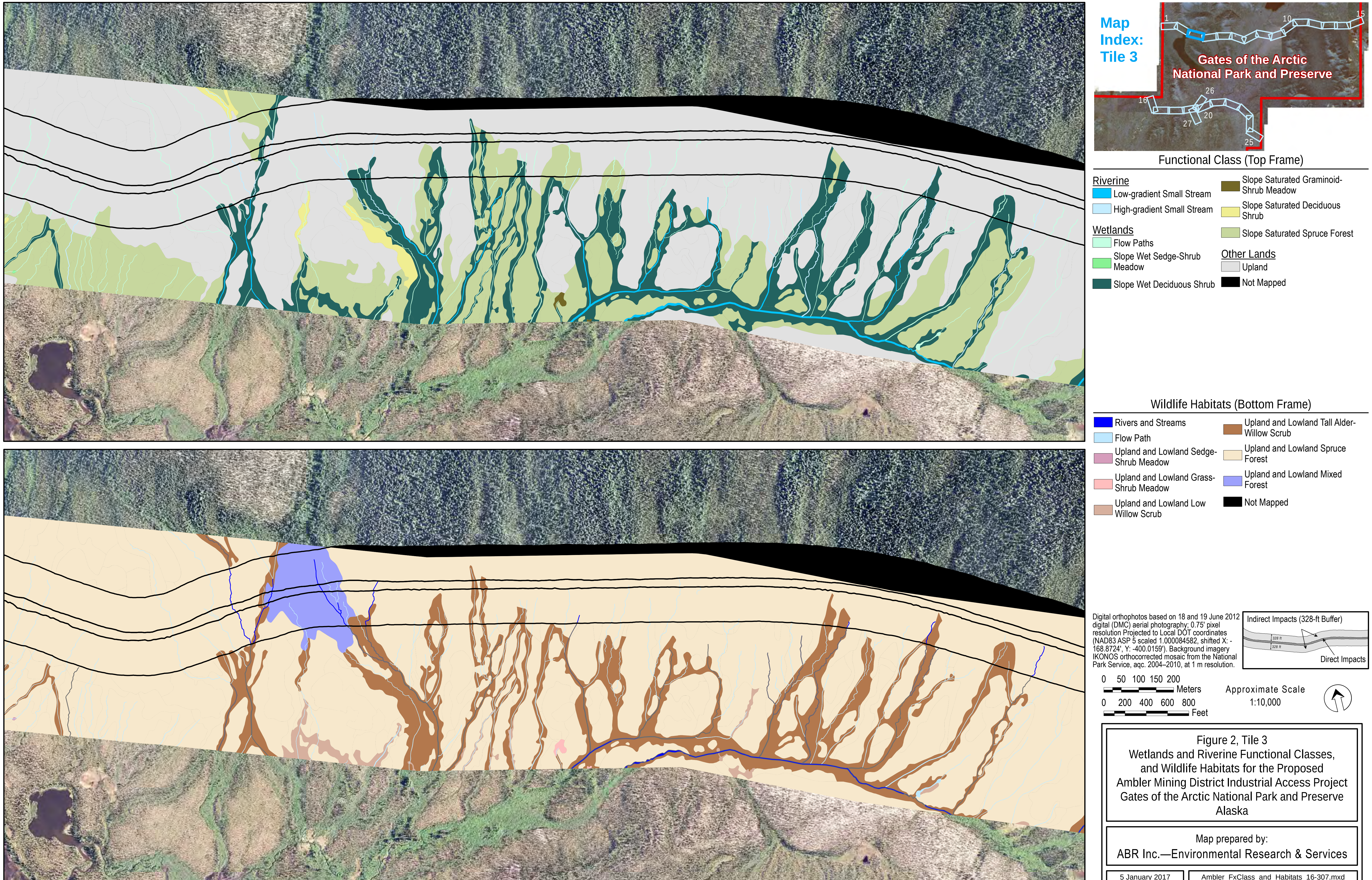
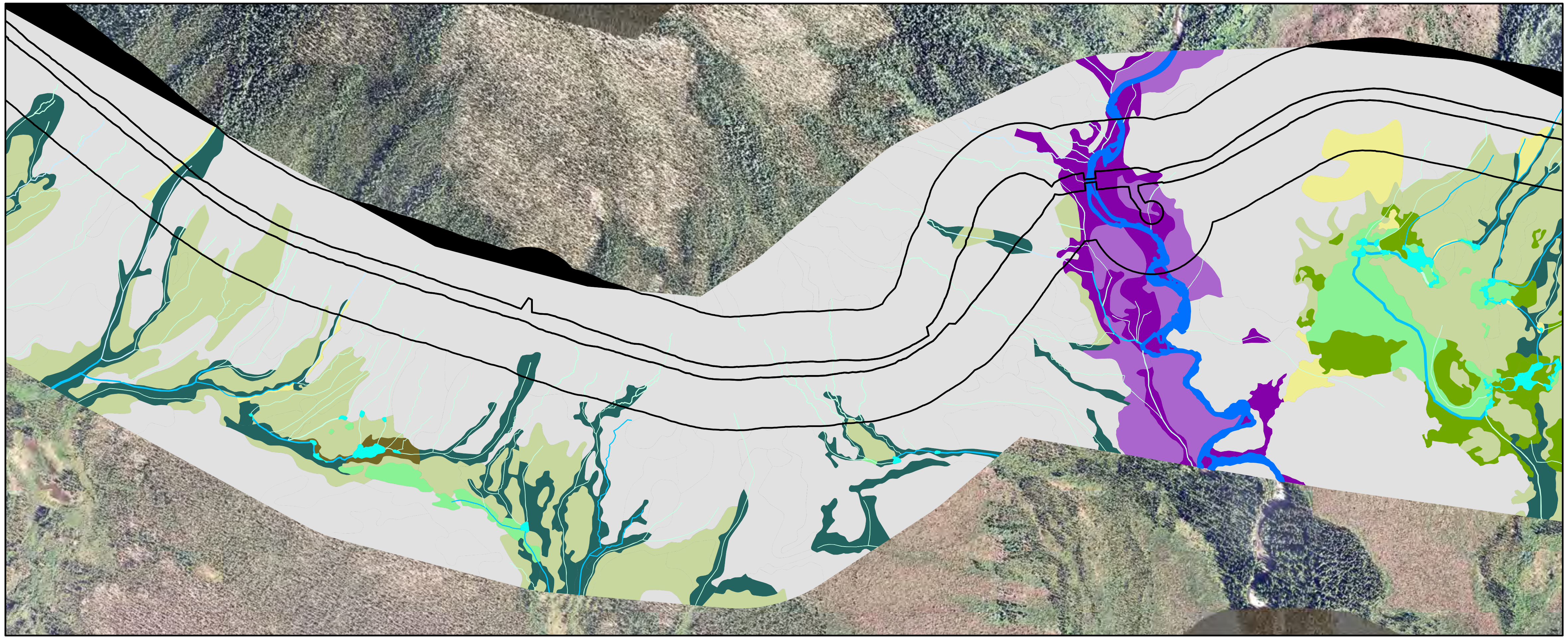
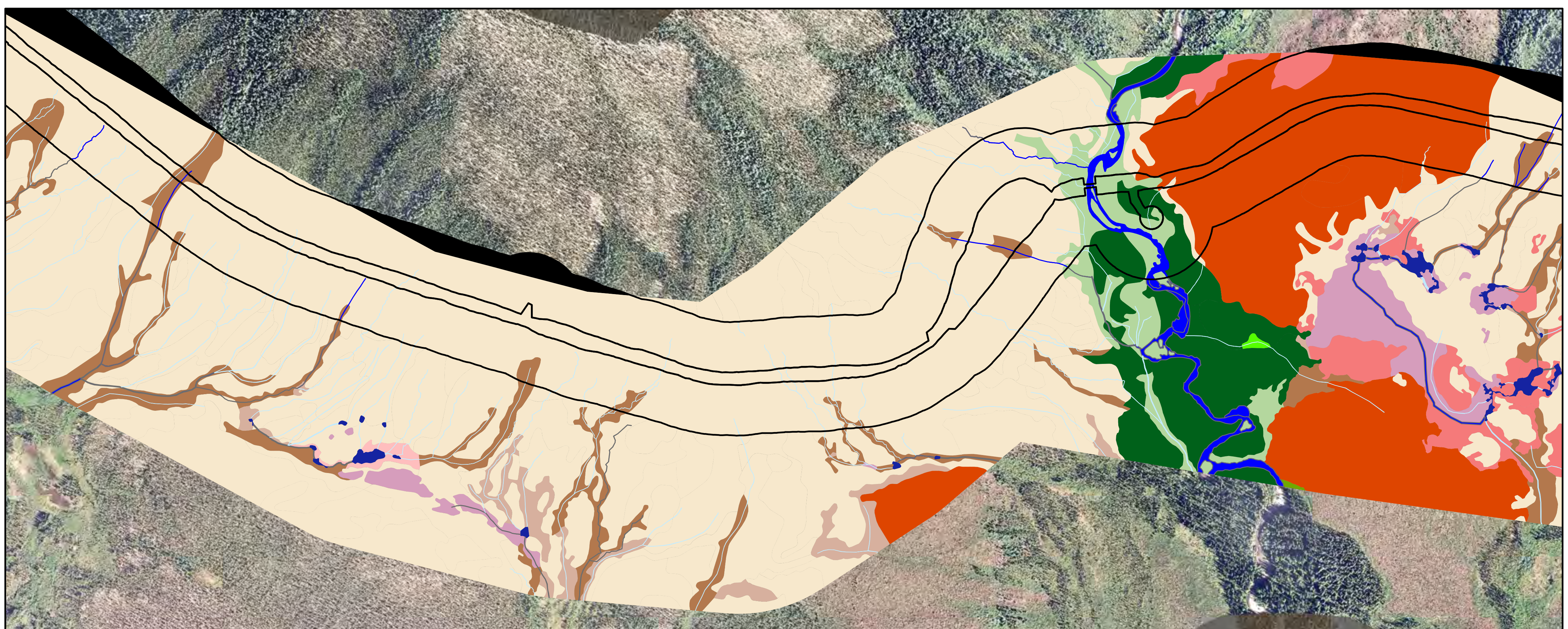


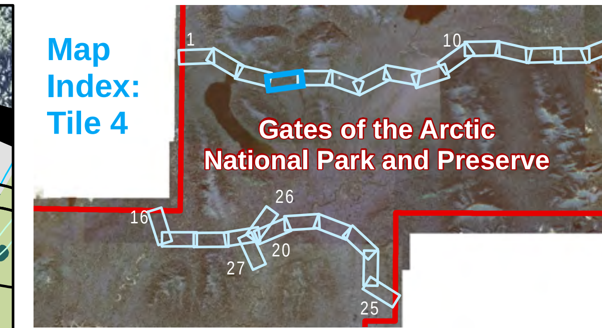
Figure 2, Tile 3
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd







Functional Class (Top Frame)

Riverine
- Large Stream
- Low-gradient Small Stream
- High-gradient Small Stream

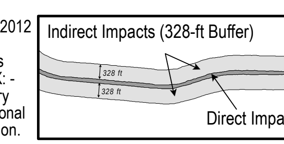
Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Low Birch-Ericaceous Scrub
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



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Approximate Scale 1:10,000

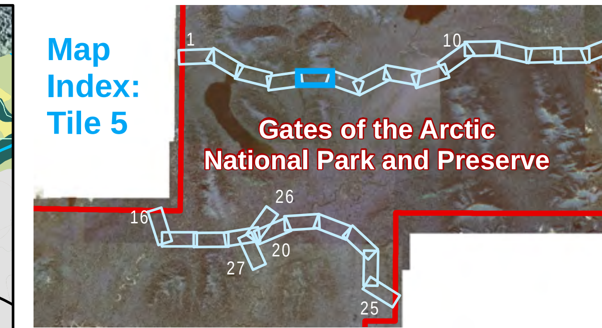
Figure 2, Tile 4
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

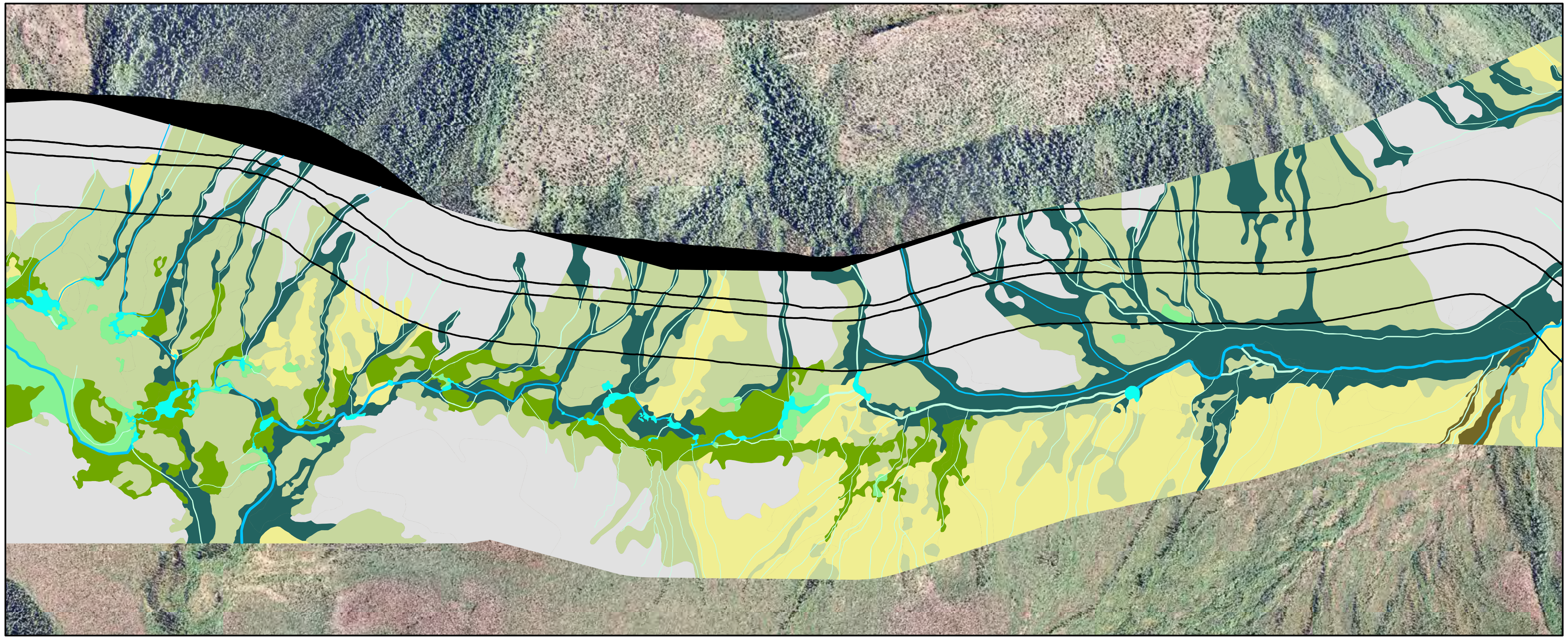
Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017

Ambler_FxClass_and_Habitats_16-307.mxd

Map Index: Tile 5



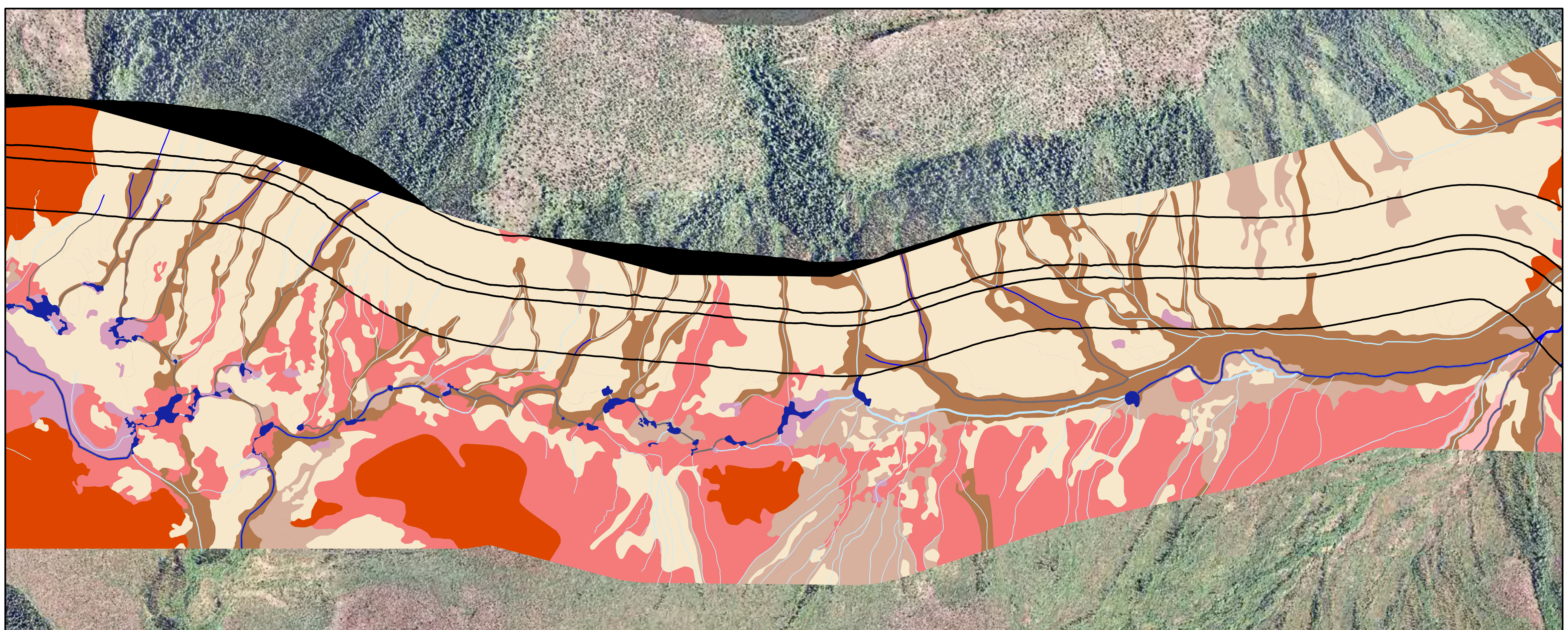


Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream
- High-gradient Small Stream

Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest

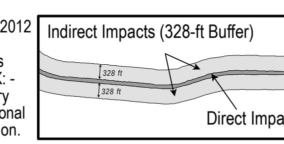
Other Lands
- Upland
- Not Mapped



Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724'; Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

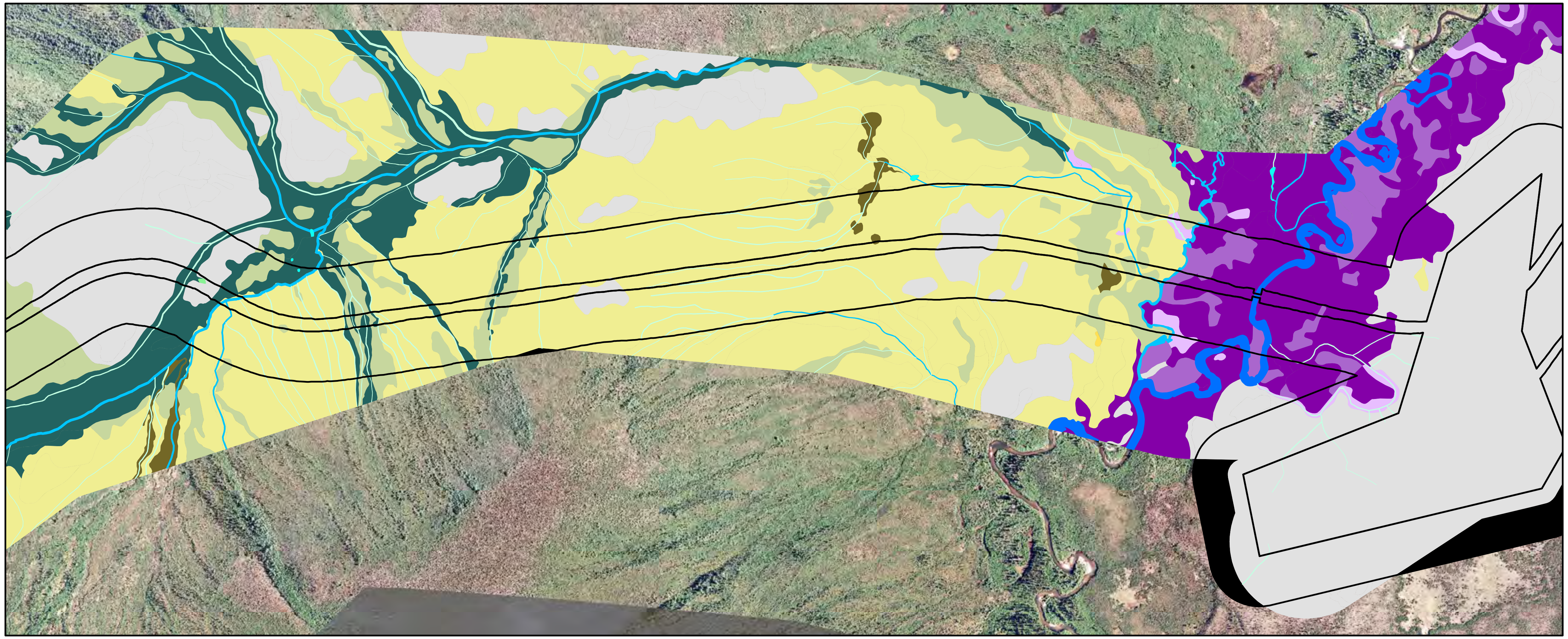
0 200 400 600 800 Feet

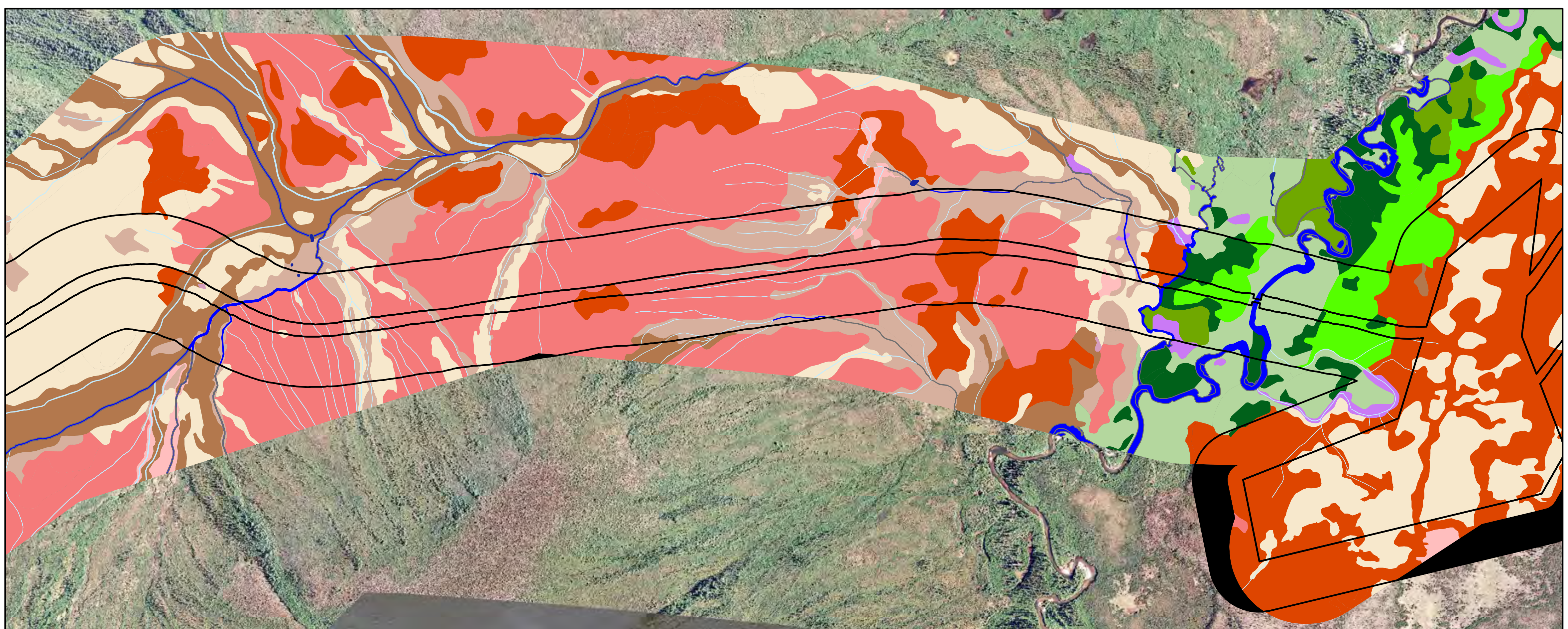
Approximate Scale 1:10,000

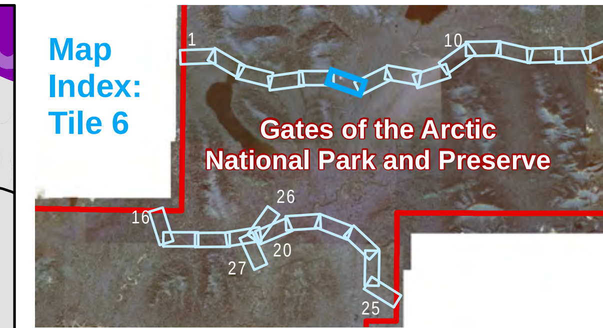
Figure 2, Tile 5
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd







Functional Class (Top Frame)

Riverine
- Large Stream
- Low-gradient Small Stream

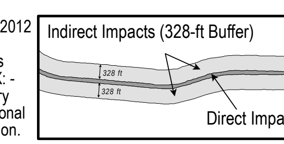
Wetlands
- Flow Paths
- Lakes and Ponds
- Depressional Wet Sedge-Shrub Meadow
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Seasonally Flooded Graminoid-Shrub Meadow
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Grass-Shrub Meadow
- Riverine Low Birch-Ericaceous Scrub
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

0 200 400 600 800 Feet

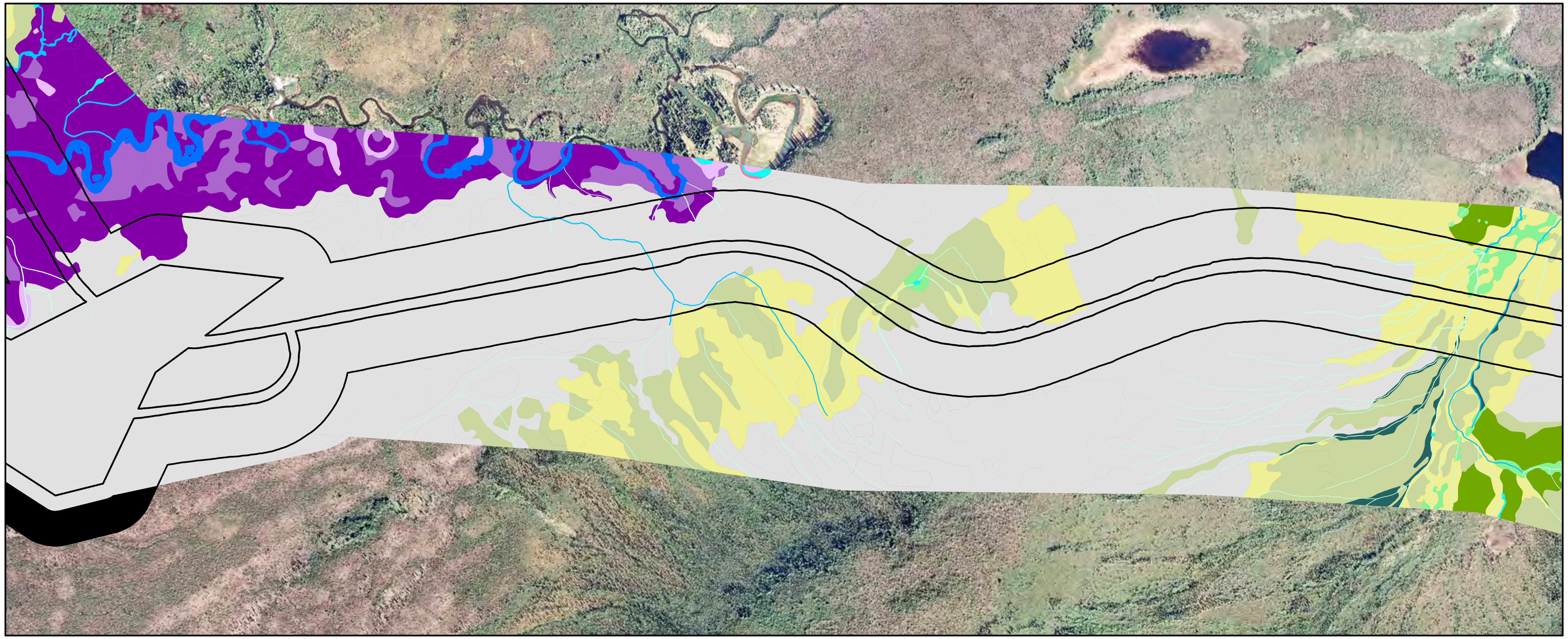
Approximate Scale 1:10,000

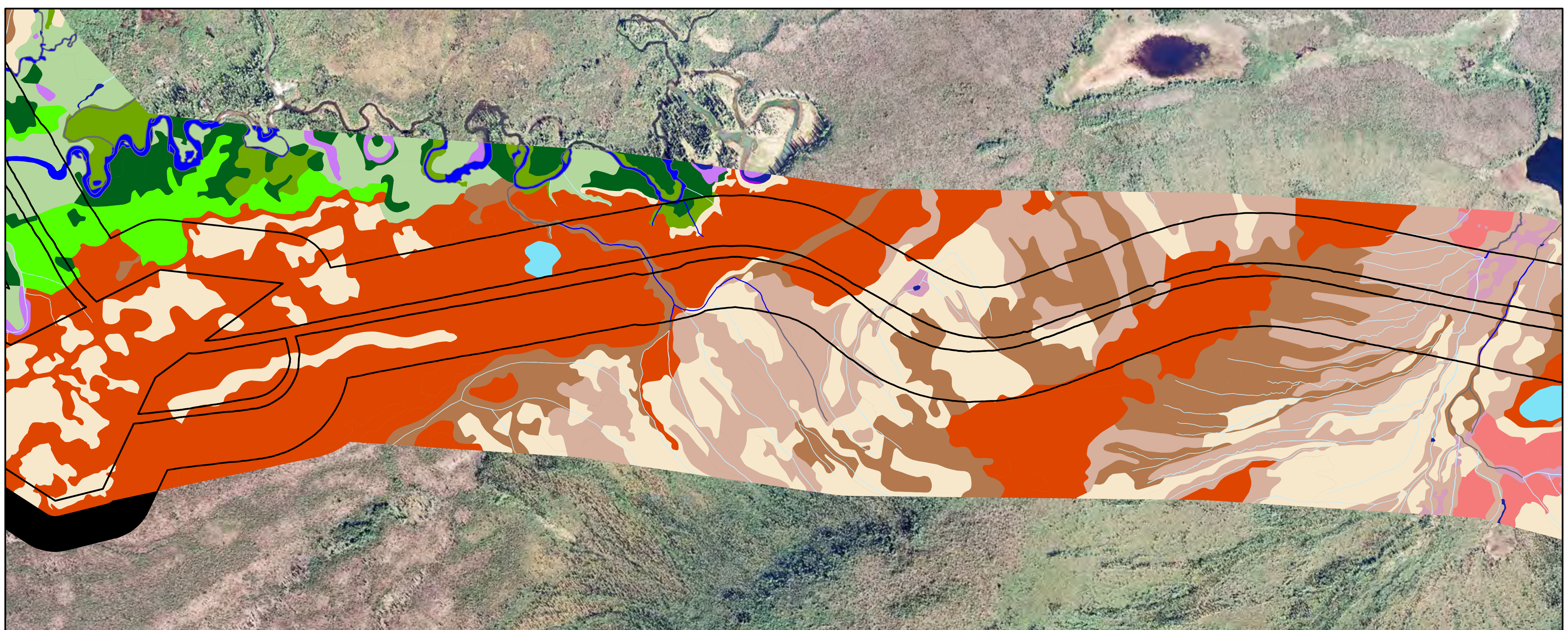
Figure 2, Tile 6
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

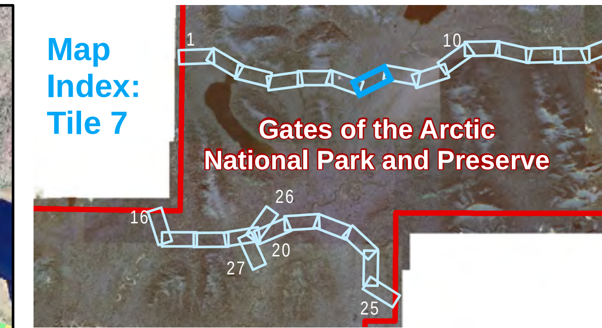
Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017

Ambler_FxClass_and_Habitats_16-307.mxd







Functional Class (Top Frame)

Riverine
- Large Stream
- Low-gradient Small Stream
- High-gradient Small Stream

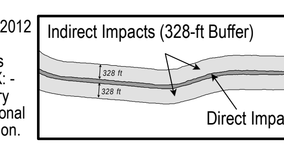
Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Wet Sedge-Shrub Meadow
- Riverine Seasonally Flooded Graminoid-Shrub Meadow
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Sedge-Shrub Meadow
- Riverine Grass-Shrub Meadow
- Riverine Low Birch-Ericaceous Scrub
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Upland Broadleaf Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

0 200 400 600 800 Feet

Approximate Scale 1:10,000

Figure 2, Tile 7
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

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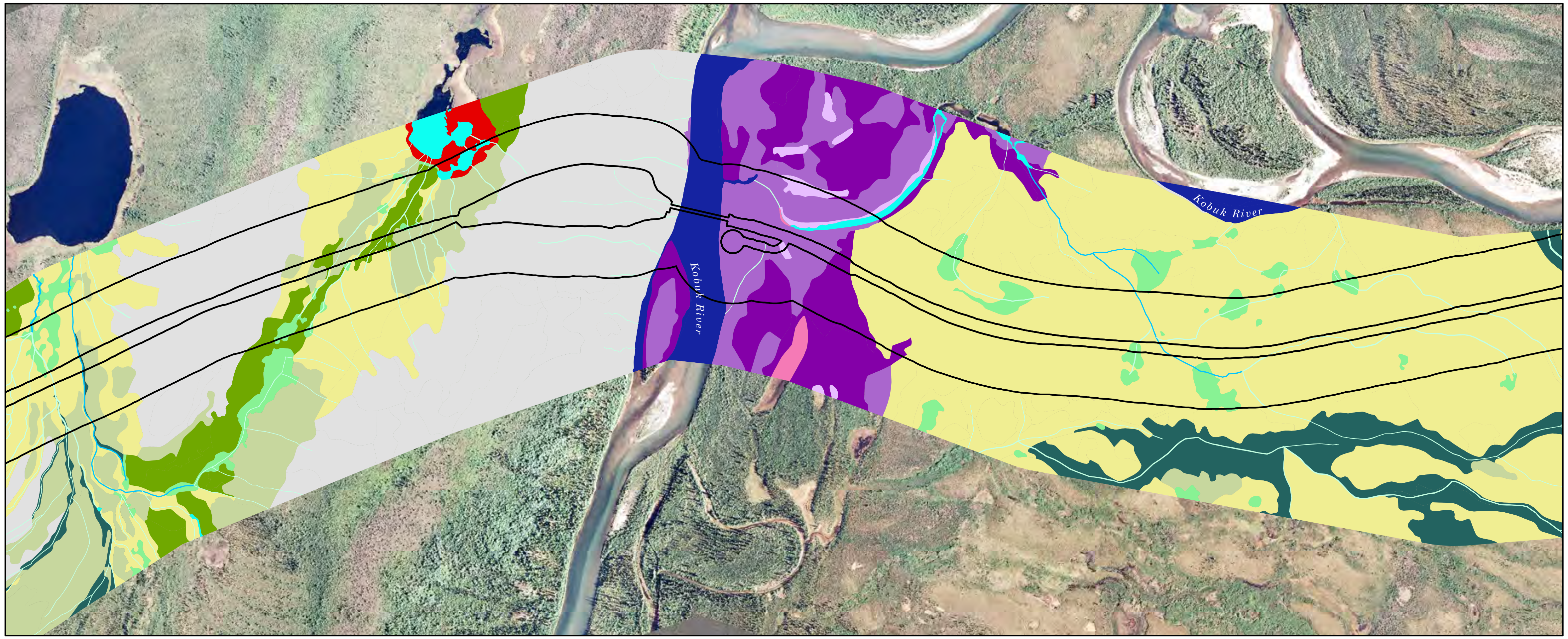
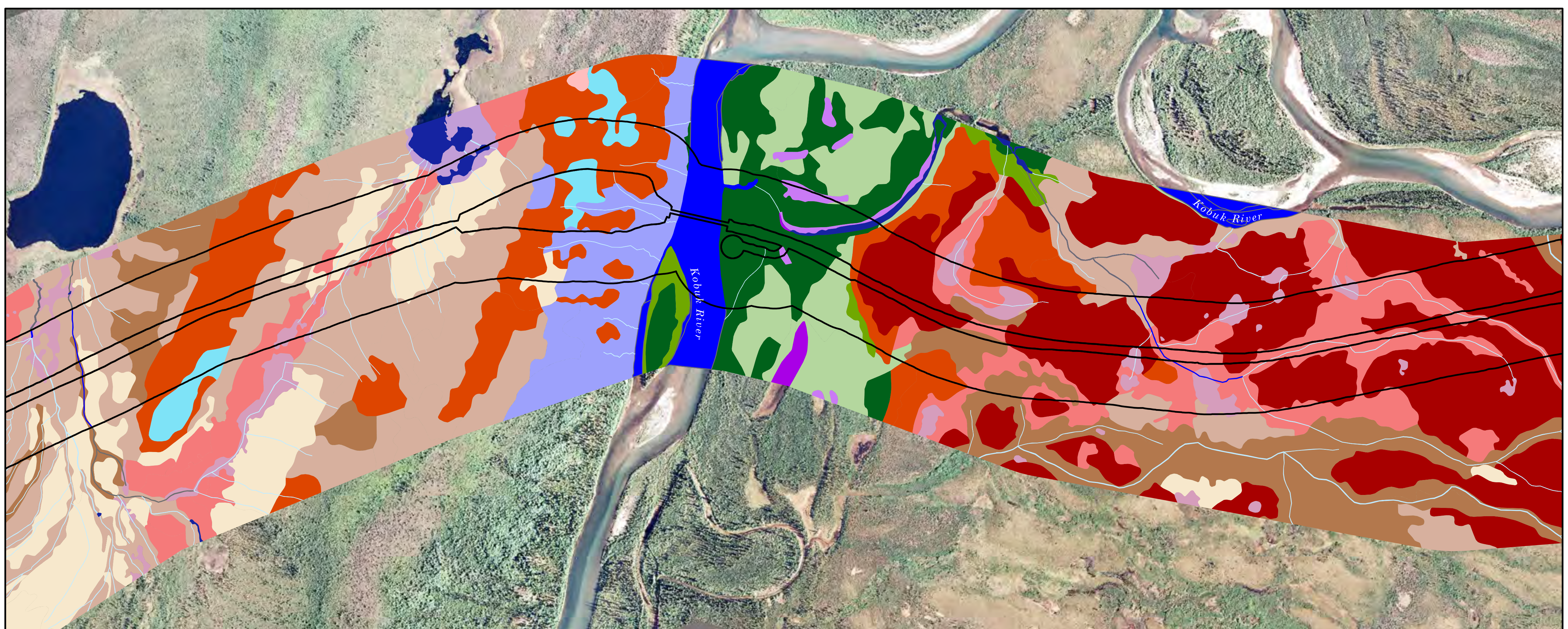
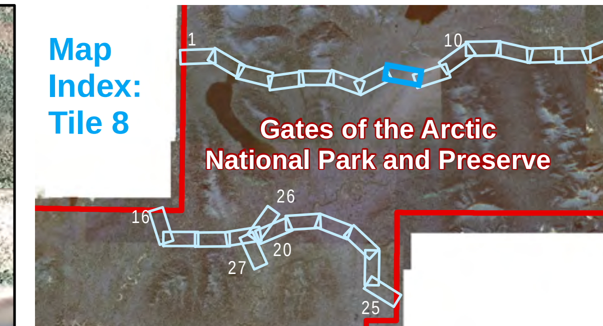






Functional Class (Top Frame)

Riverine
- Major River
- Low-gradient Small Stream

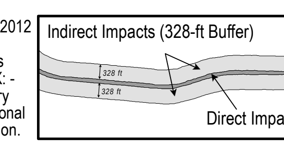
Wetlands
- Flow Paths
- Lakes and Ponds
- Lacustrine Fringe Wet Sedge Meadow
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Wet Sedge-Shrub Meadow
- Riverine Seasonally Flooded Graminoid-Shrub Meadow
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

Other Lands
- Upland

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Lacustrine Sedge Meadow
- Rivers and Streams
- Riverine Sedge-Shrub Meadow
- Riverine Grass-Shrub Meadow
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Tussock Tundra
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Upland Broadleaf Forest

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

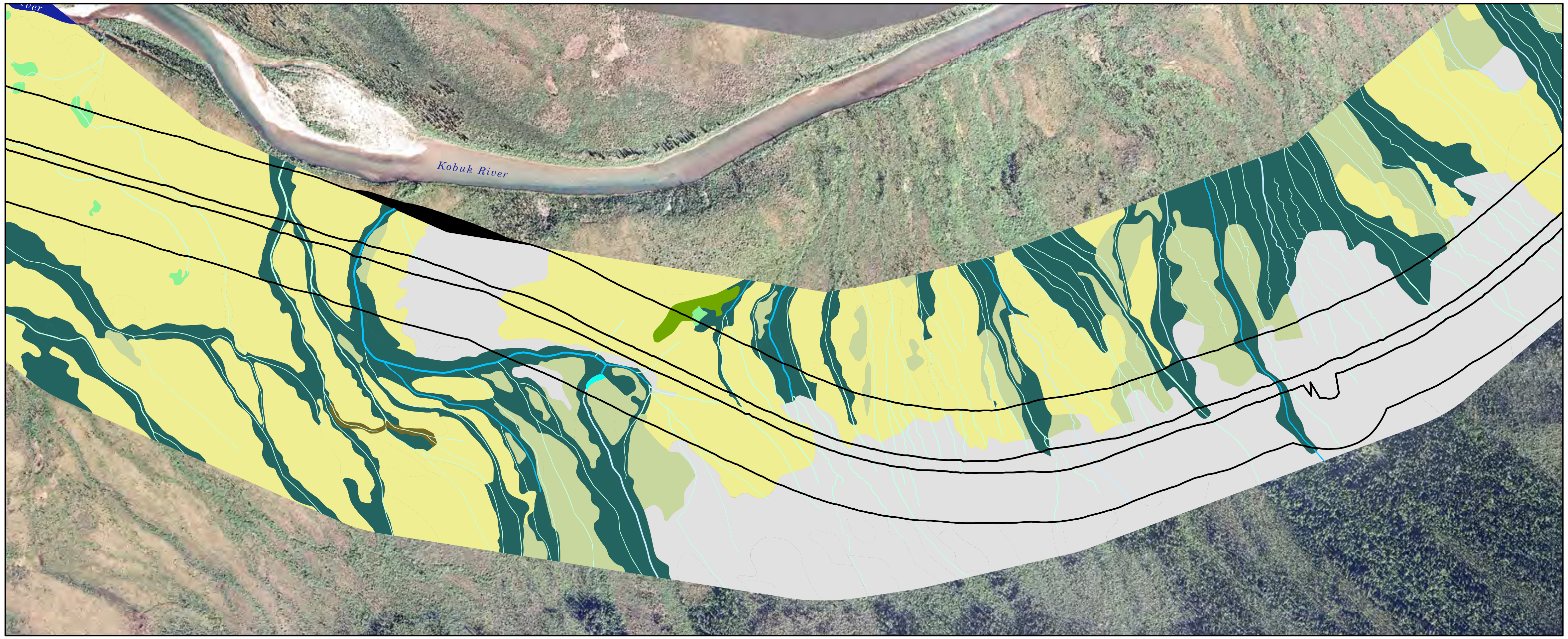
0 200 400 600 800 Feet

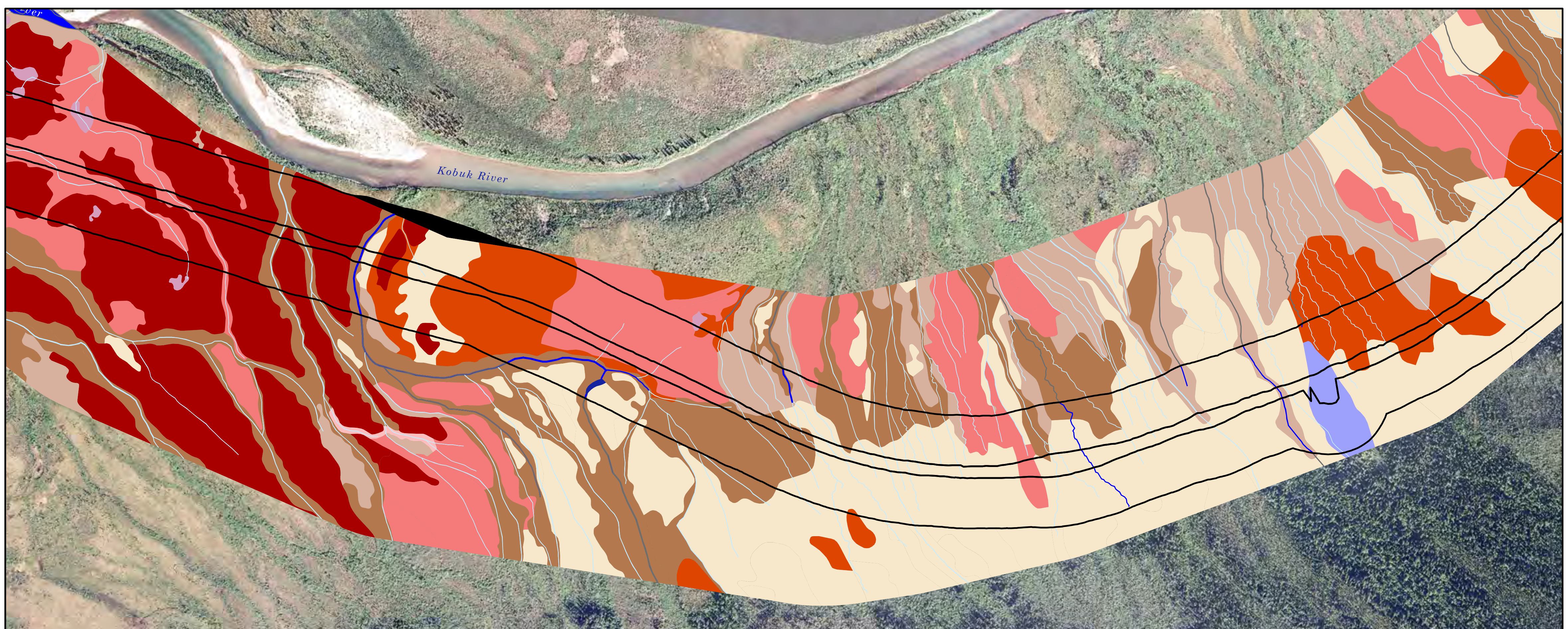
Approximate Scale 1:10,000

Figure 2, Tile 8
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

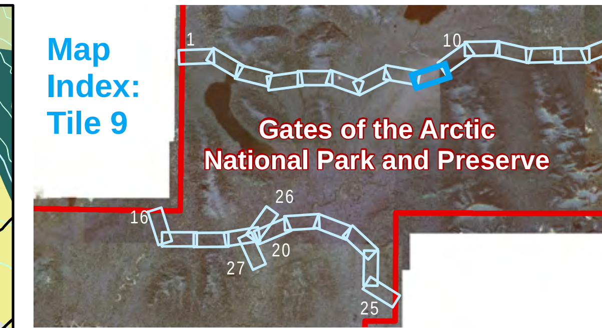
Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd





Map Index: Tile 9



Functional Class (Top Frame)

Riverine
- Major River
- Low-gradient Small Stream
- High-gradient Small Stream

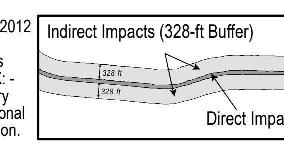
Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Tussock Tundra
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

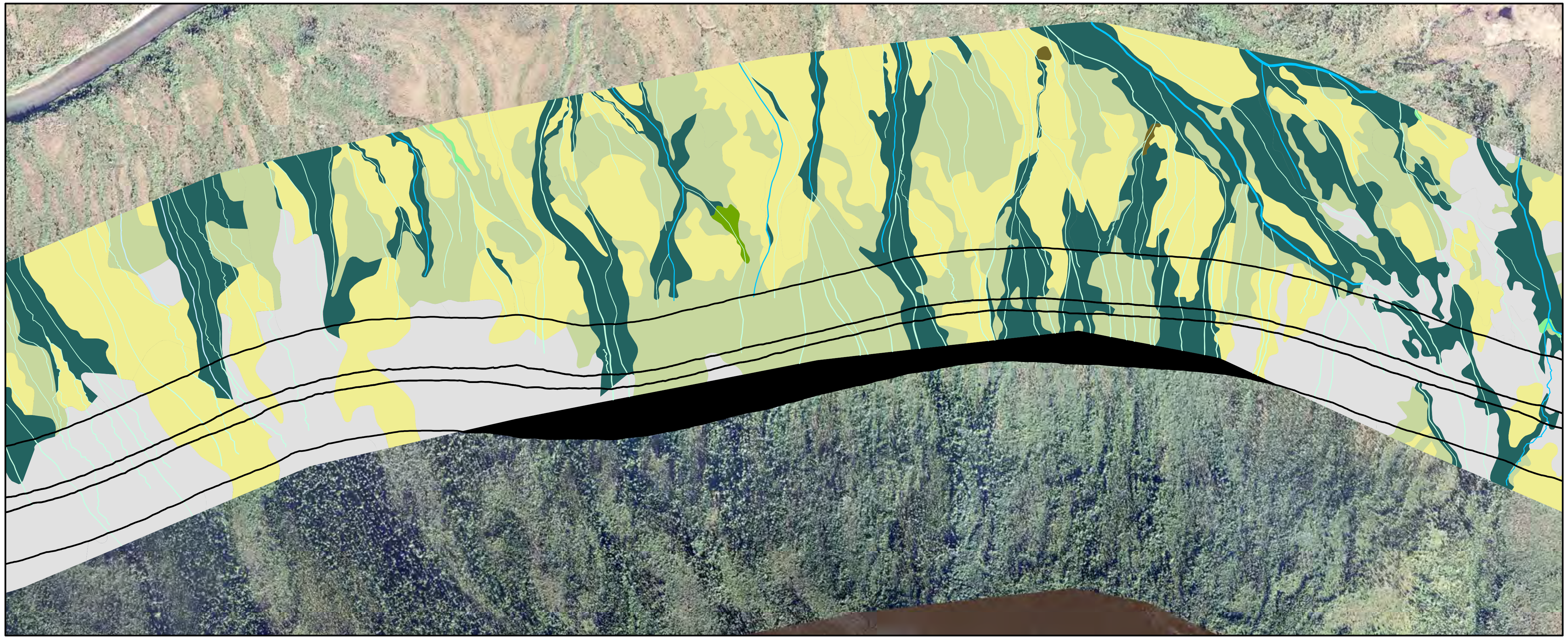
0 200 400 600 800 Feet

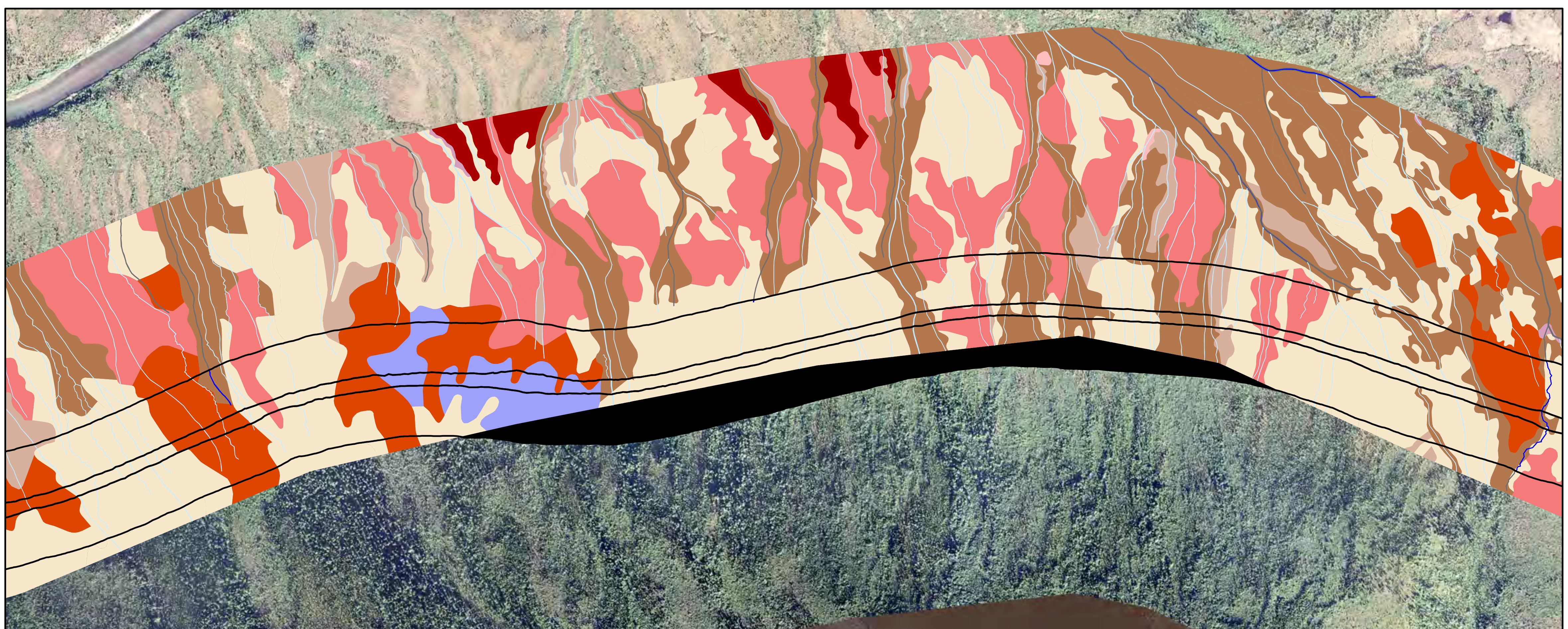
Approximate Scale 1:10,000

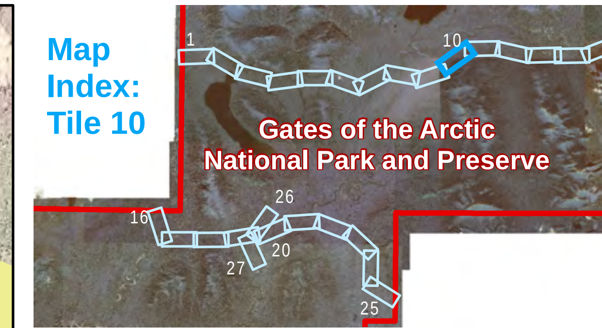
Figure 2, Tile 9
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd







Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream
- High-gradient Small Stream

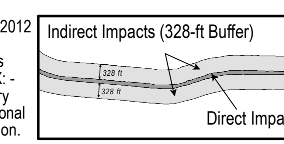
Wetlands
- Flow Paths
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Rivers and Streams
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Tussock Tundra
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

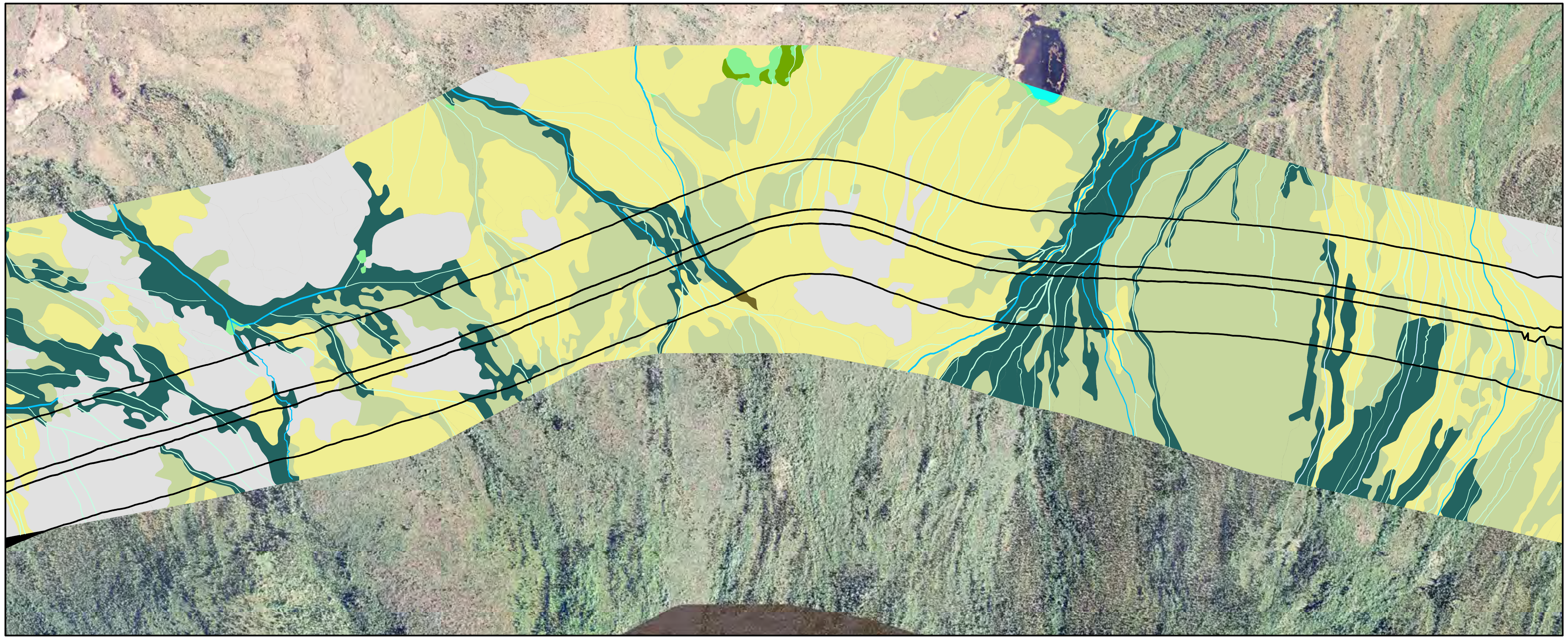
0 200 400 600 800 Feet

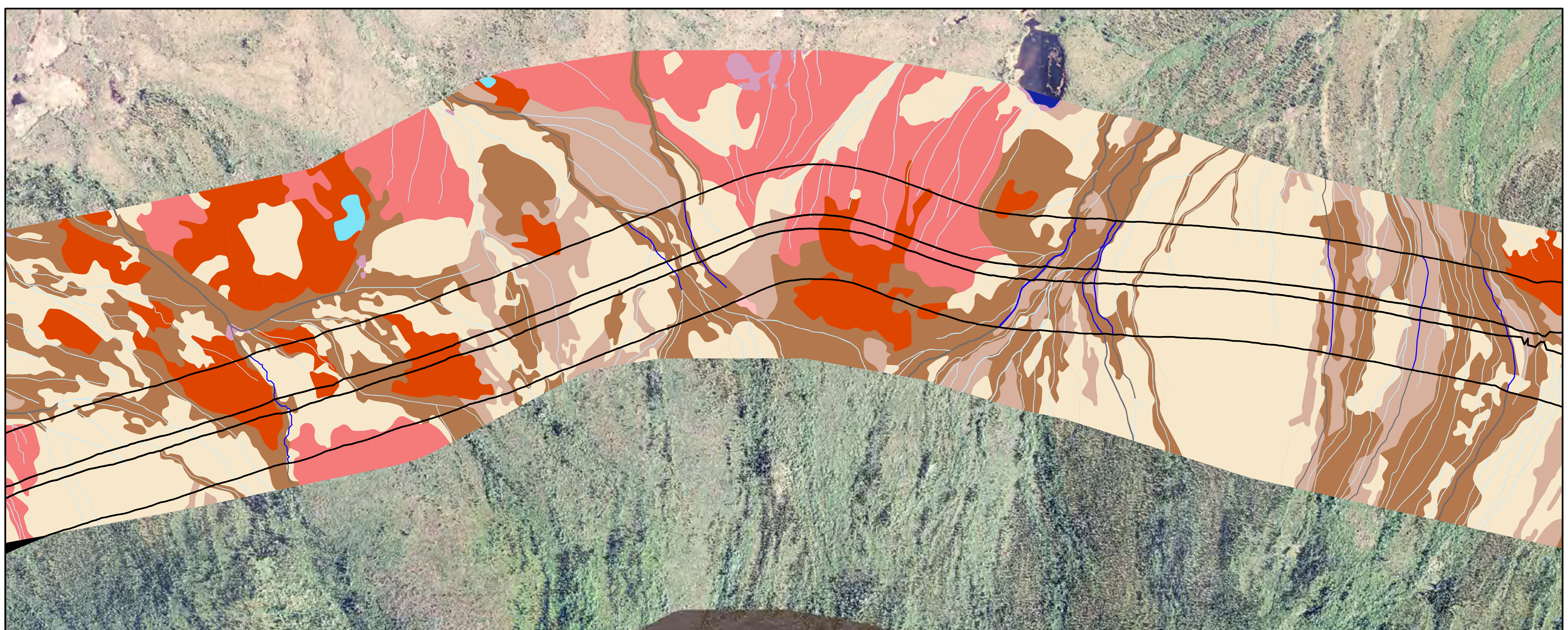
Approximate Scale 1:10,000

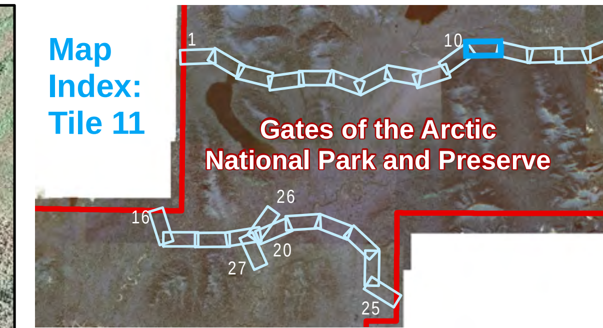
Figure 2, Tile 10
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd







Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream
- High-gradient Small Stream

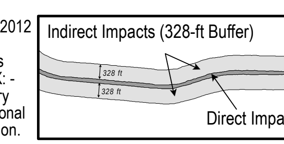
Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Upland Broadleaf Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

0 200 400 600 800 Feet

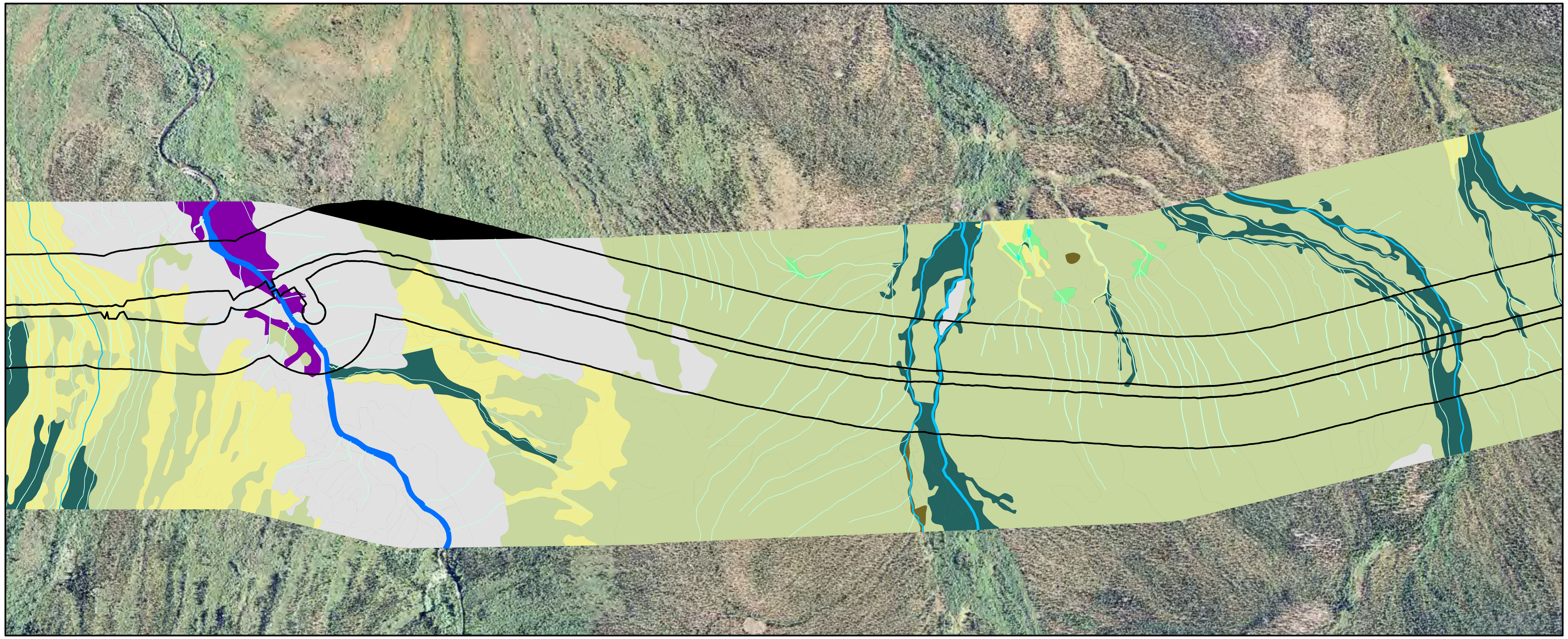
Approximate Scale
1:10,000

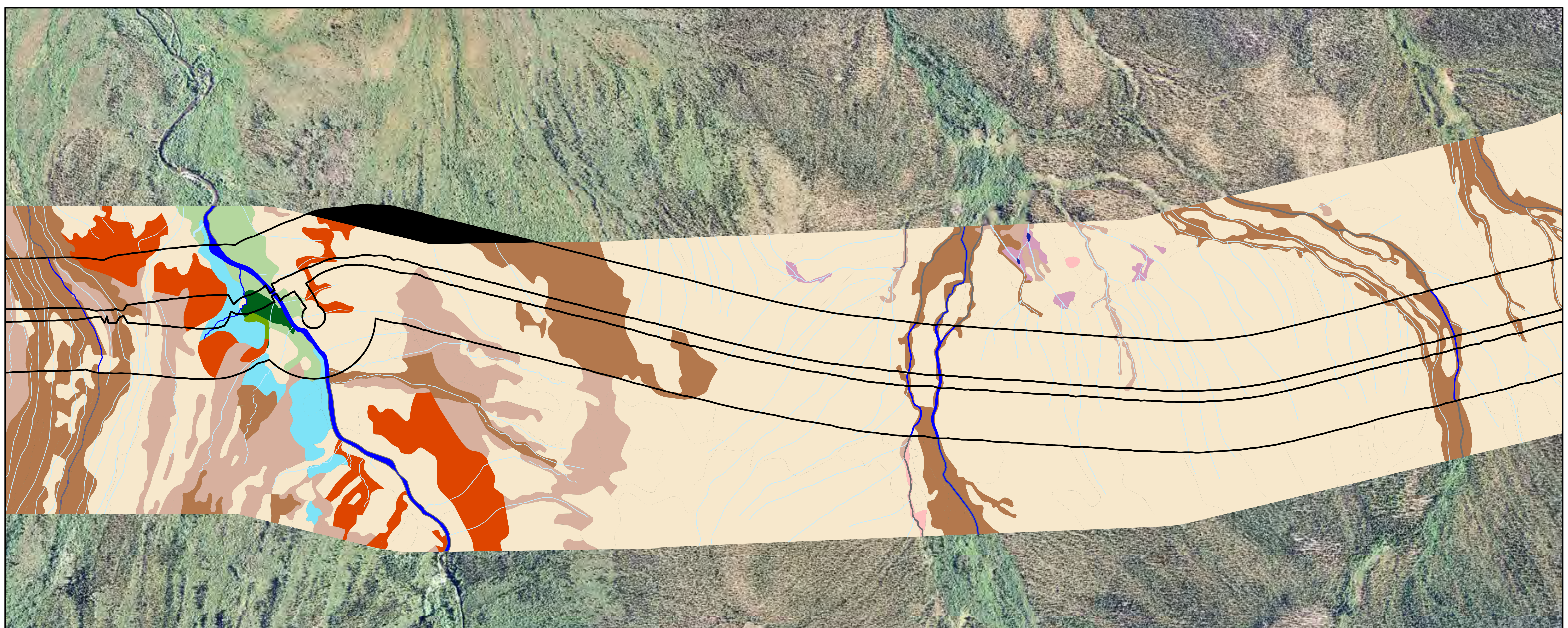
Figure 2, Tile 11
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

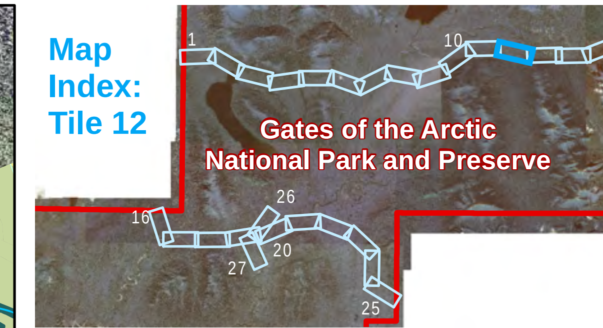
Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017

Ambler_FxClass_and_Habitats_16-307.mxd







Functional Class (Top Frame)

Riverine
- Large Stream
- Low-gradient Small Stream
- High-gradient Small Stream

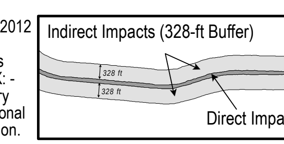
Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Upland Broadleaf Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

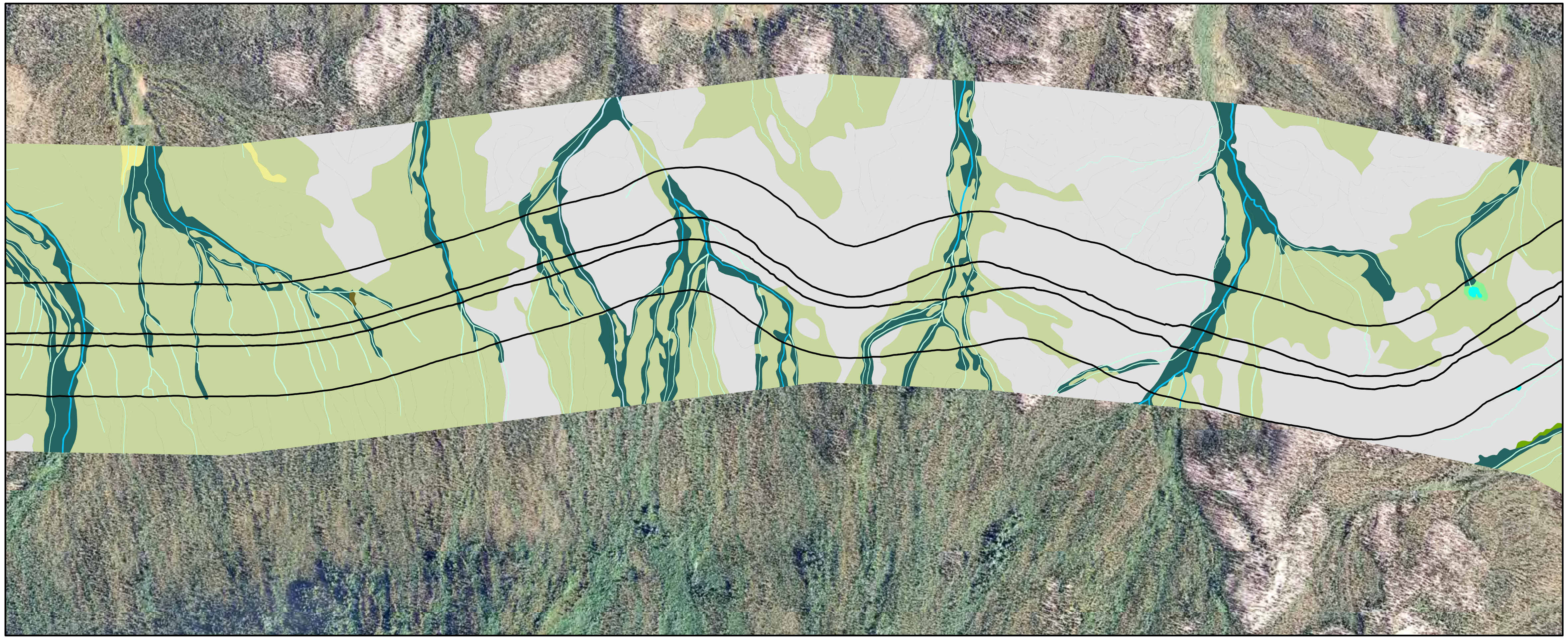
0 200 400 600 800 Feet

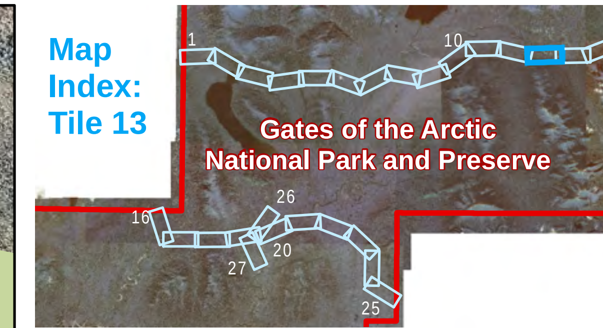
Approximate Scale 1:10,000

Figure 2, Tile 12
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd





Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream
- High-gradient Small Stream

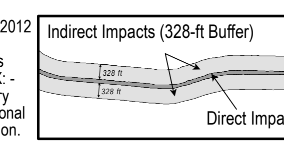
Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest

Other Lands
- Upland

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724'; Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

0 200 400 600 800 Feet

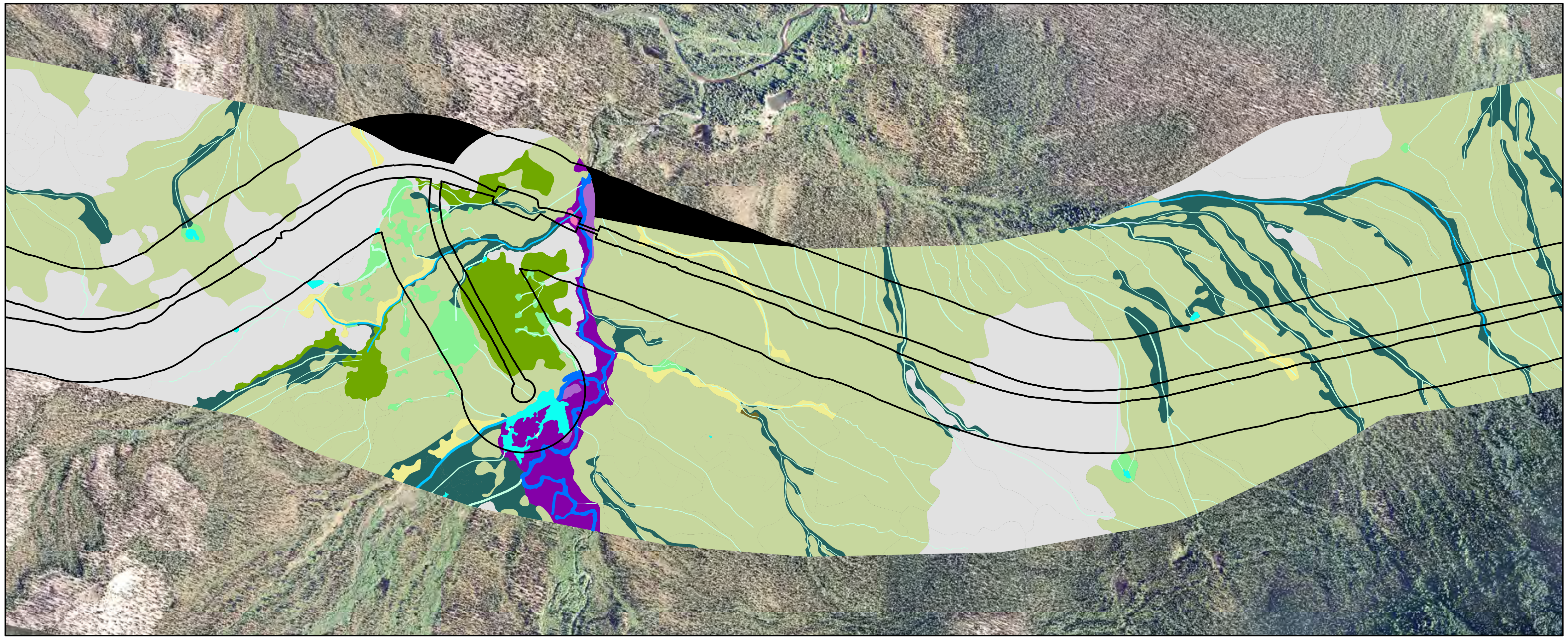
Approximate Scale
1:10,000

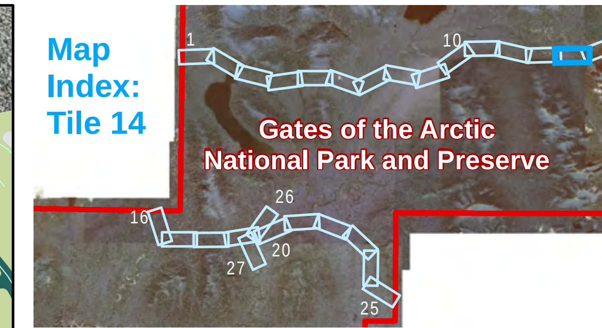
Figure 2, Tile 13
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017

Ambler_FxClass_and_Habitats_16-307.mxd



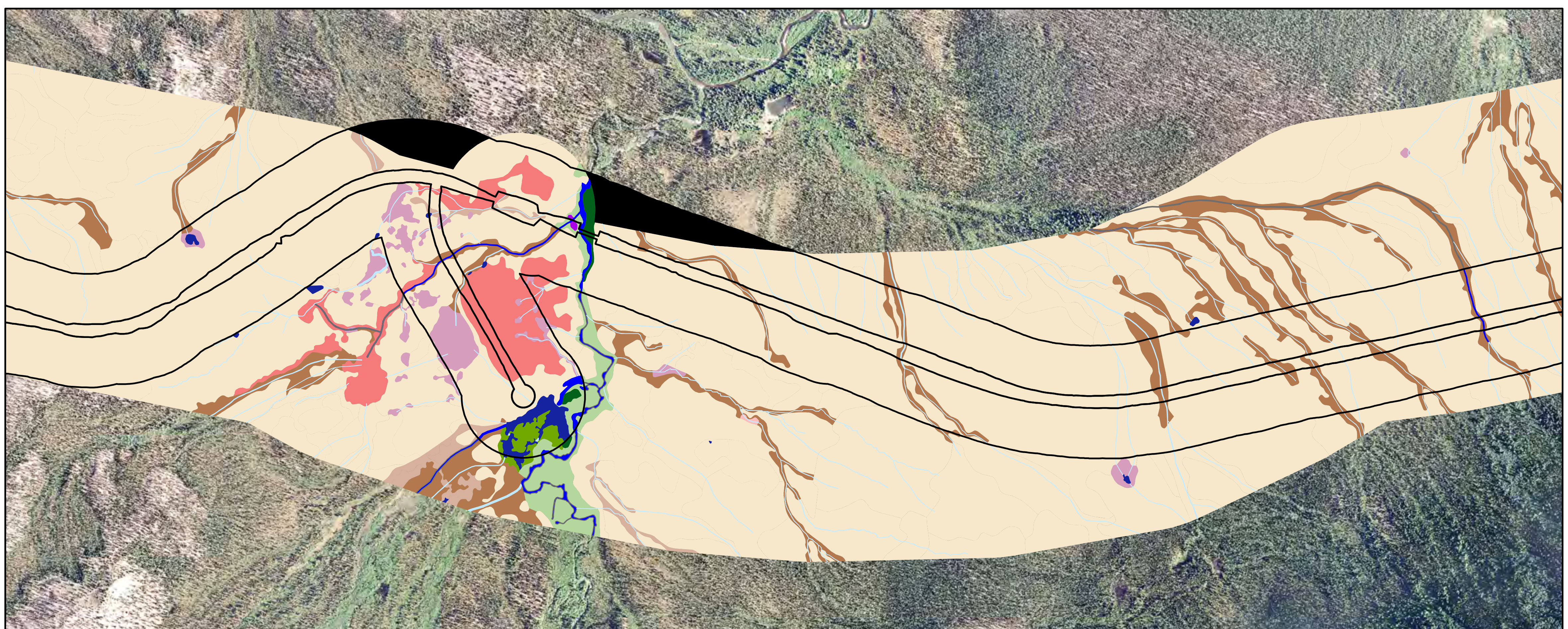


Functional Class (Top Frame)

Riverine
- Large Stream
- Low-gradient Small Stream
- High-gradient Small Stream

Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Wet Sedge-Shrub Meadow
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

Other Lands
- Upland
- Not Mapped



Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Sedge-Shrub Meadow
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.

Indirect Impacts (328-ft Buffer)
328 ft
328 ft
Direct Impacts

0 50 100 150 200 Meters
0 200 400 600 800 Feet

Approximate Scale
1:10,000

Figure 2, Tile 14
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

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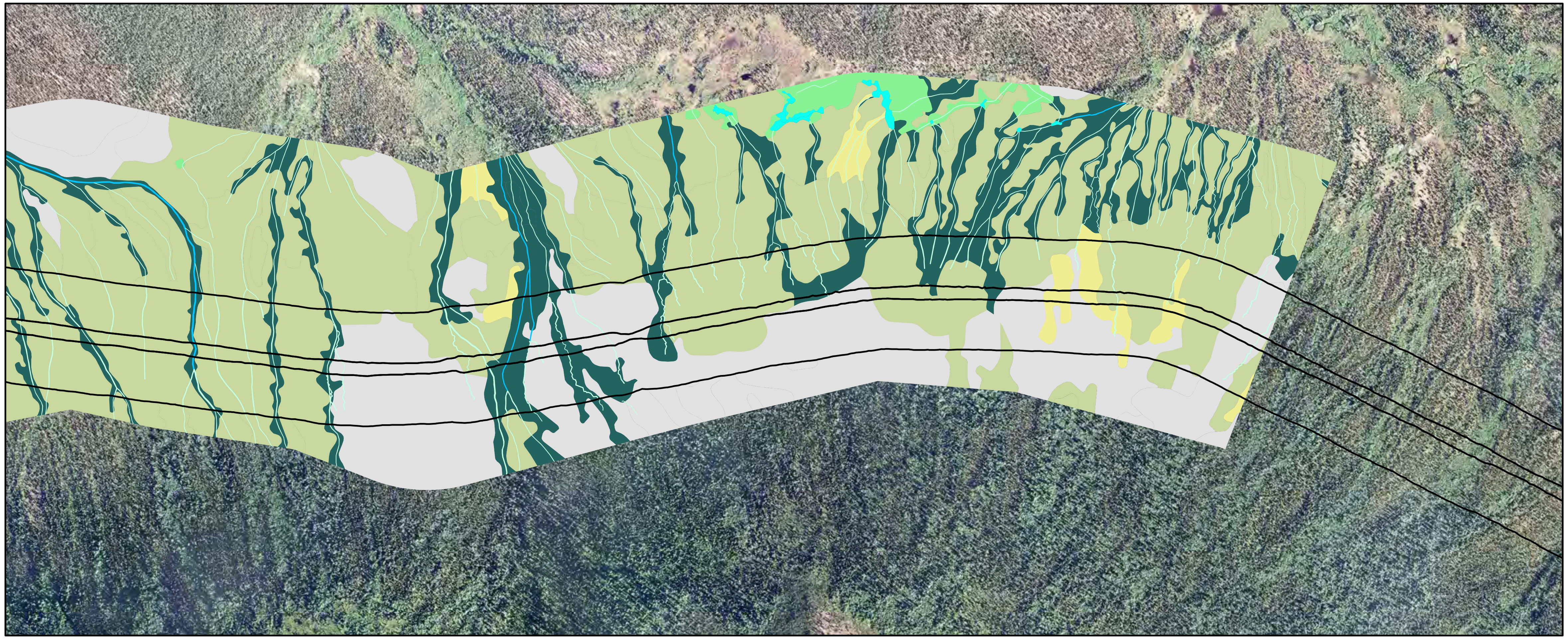
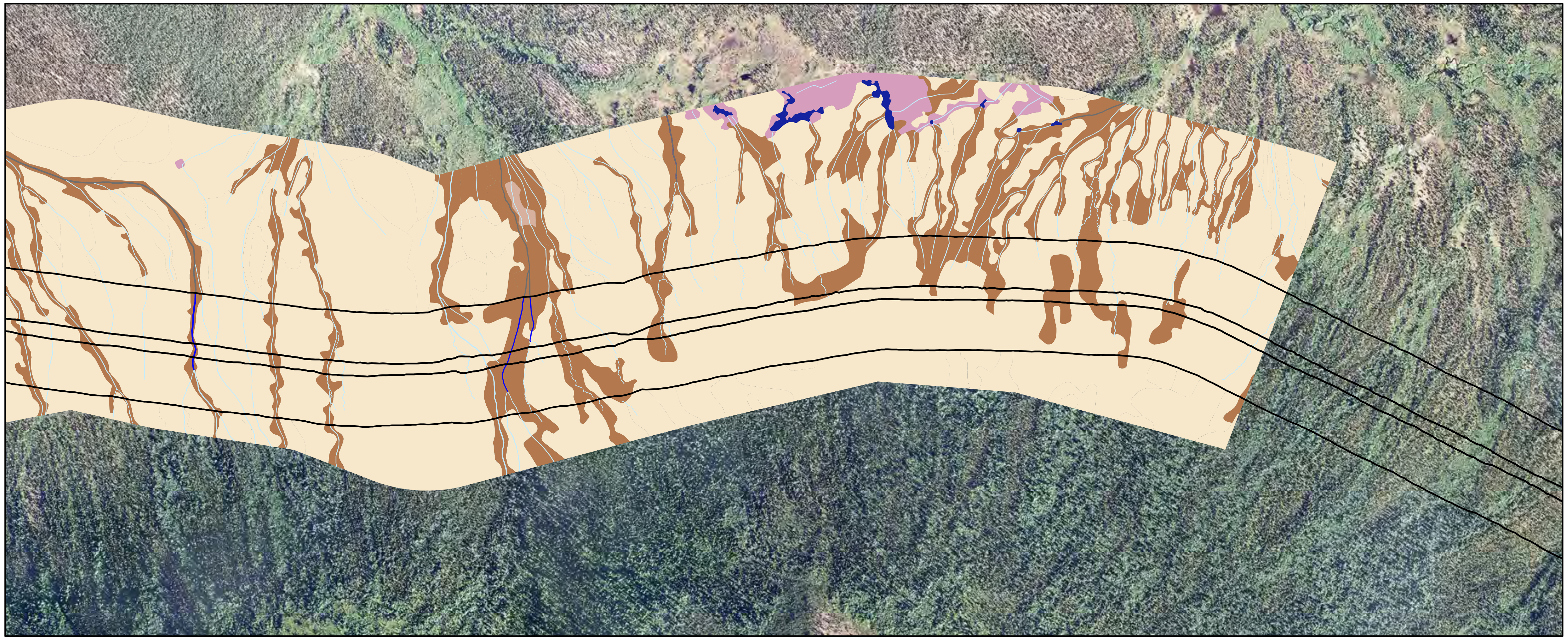




Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream

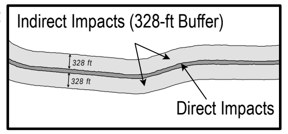
Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest

Other Lands
- Upland

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

0 200 400 600 800 Feet

Approximate Scale 1:10,000

Figure 2, Tile 15
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project Gates of the Arctic National Park and Preserve Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

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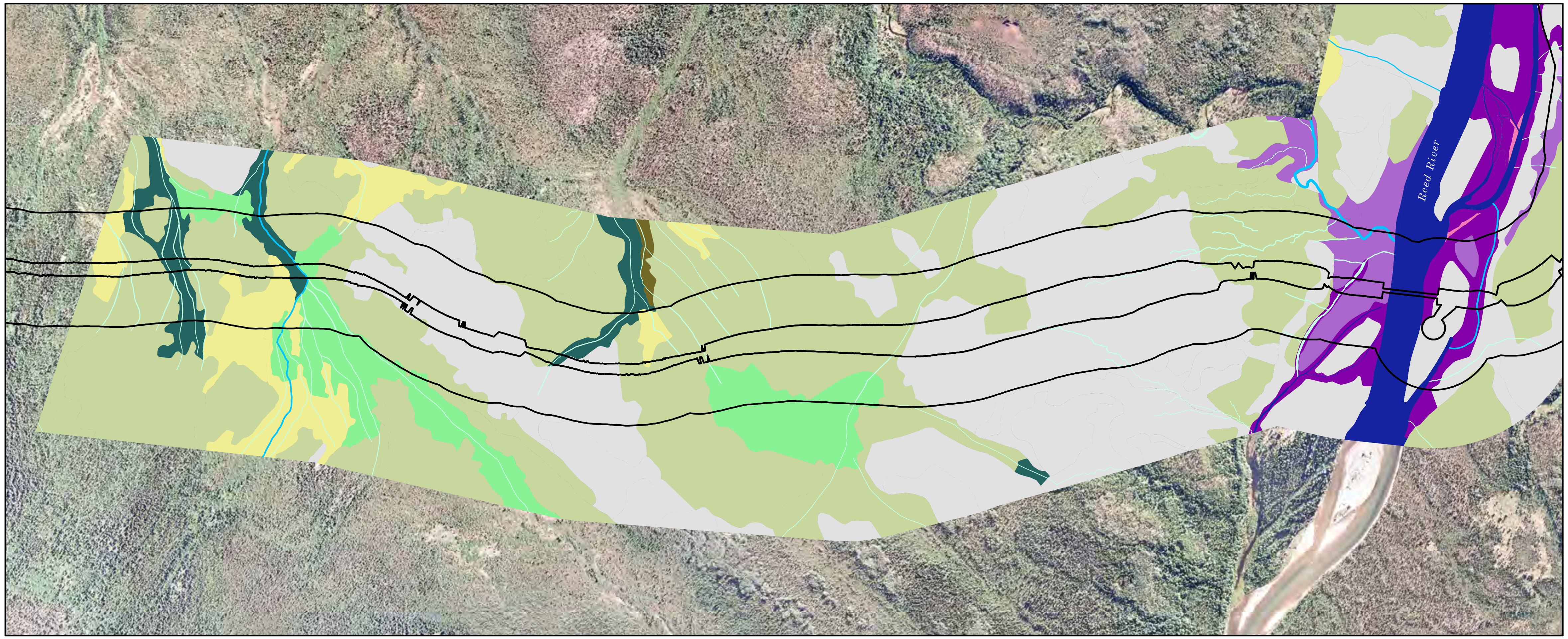
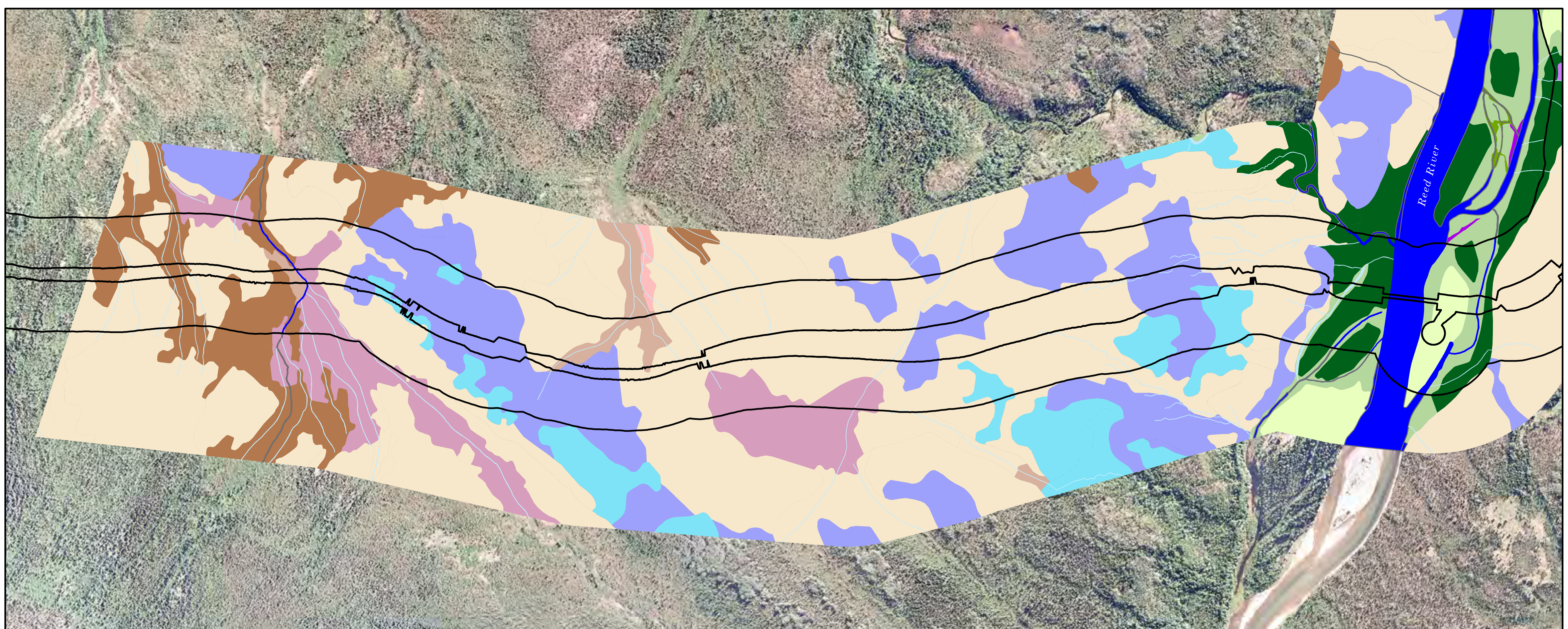
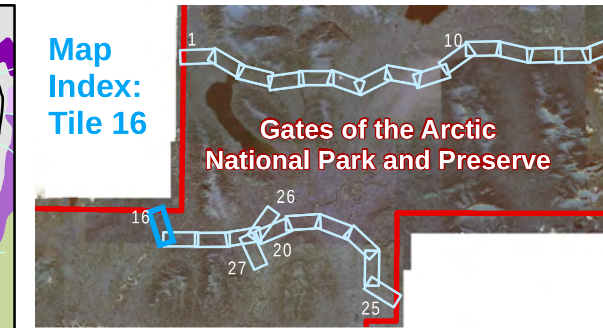






Functional Class (Top Frame)

Riverine
- Major River
- Low-gradient Small Stream

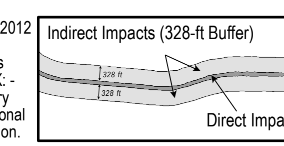
Wetlands
- Flow Paths
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Wet Sedge-Shrub Meadow
- Riverine Seasonally Flooded Graminoid-Shrub Meadow
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

Other Lands
- Upland

Wildlife Habitats (Bottom Frame)

- Rivers and Streams
- Riverine Sedge-Shrub Meadow
- Riverine Grass-Shrub Meadow
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Mixed Forest
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Upland Broadleaf Forest

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

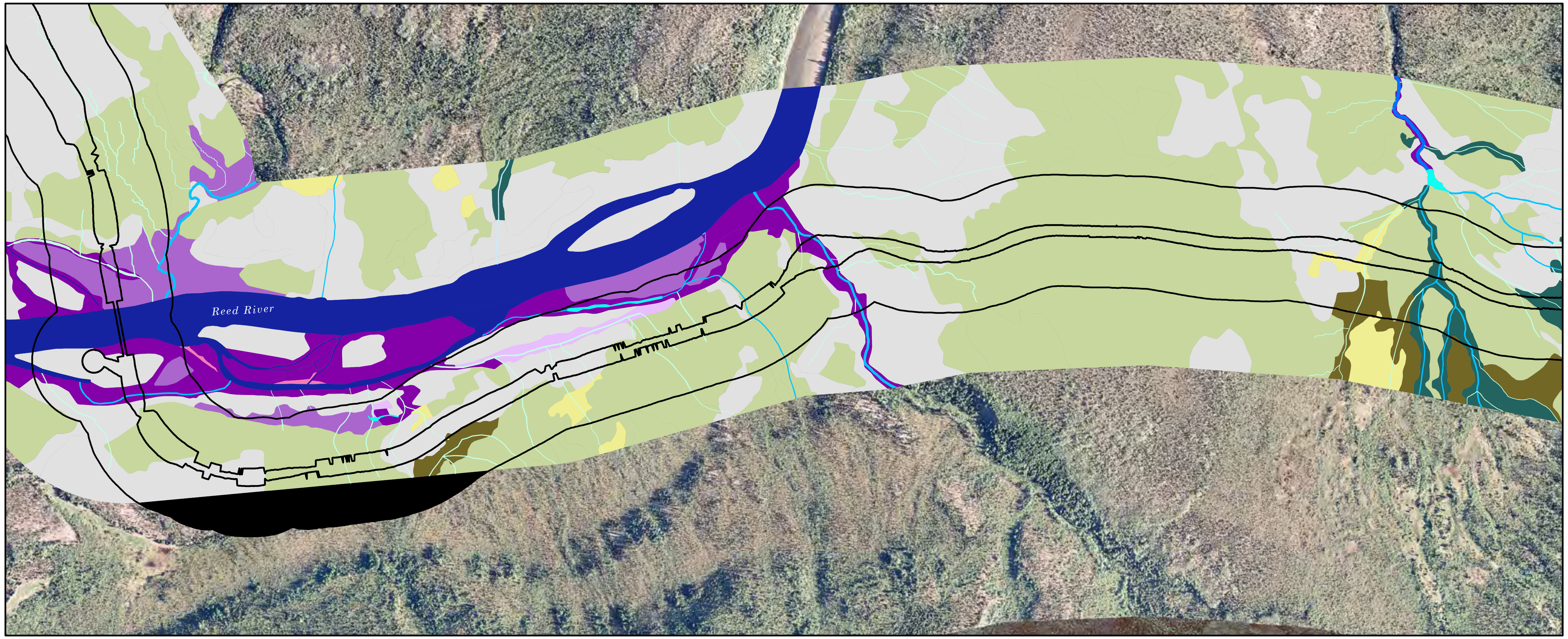
0 200 400 600 800 Feet

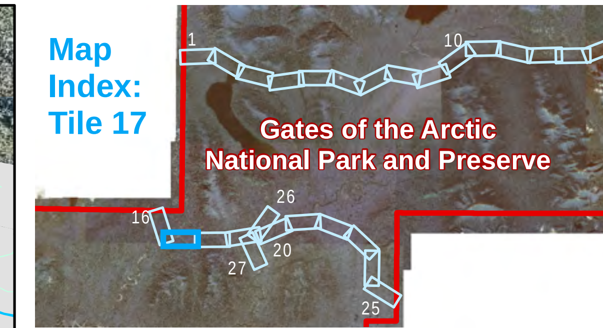
Approximate Scale 1:10,000

Figure 2, Tile 16
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd



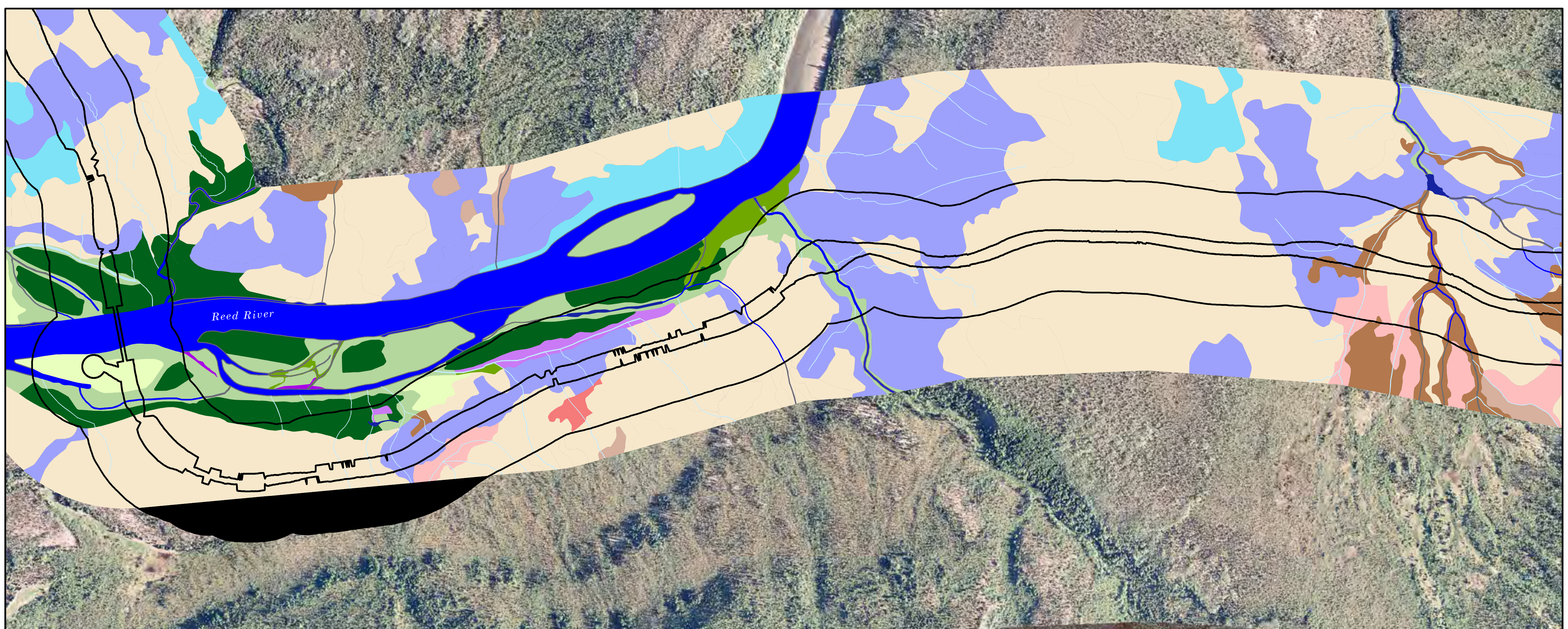


Functional Class (Top Frame)

Riverine
- Major River
- Large Stream
- Low-gradient Small Stream
- High-gradient Small Stream

Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Wet Sedge-Shrub Meadow
- Riverine Seasonally Flooded Graminoid-Shrub Meadow
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

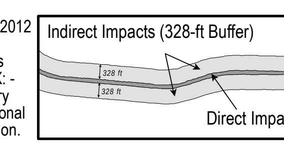
Other Lands
- Upland
- Not Mapped

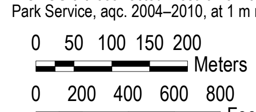


Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Sedge-Shrub Meadow
- Riverine Grass-Shrub Meadow
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Mixed Forest
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Upland Broadleaf Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



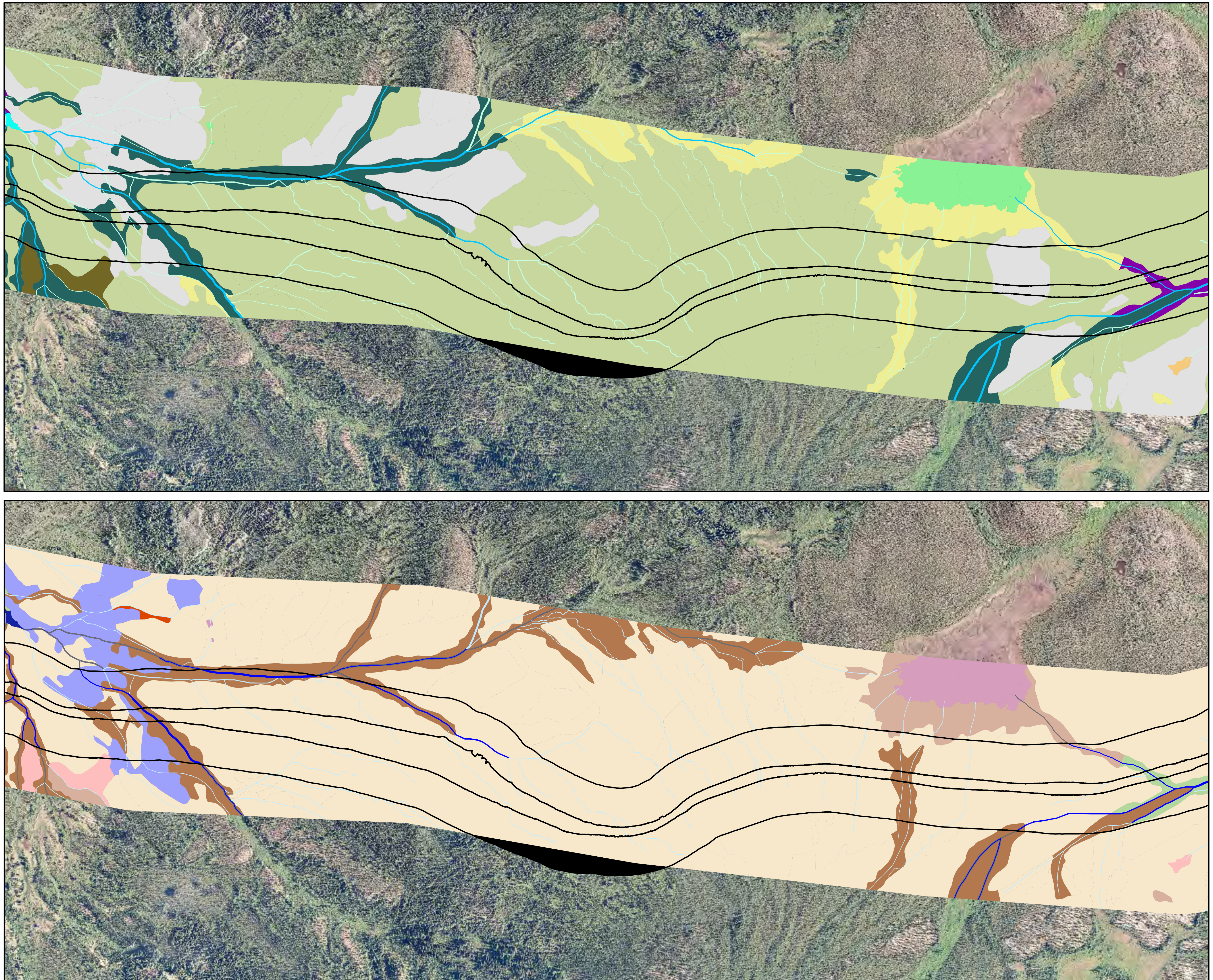


Approximate Scale
1:10,000

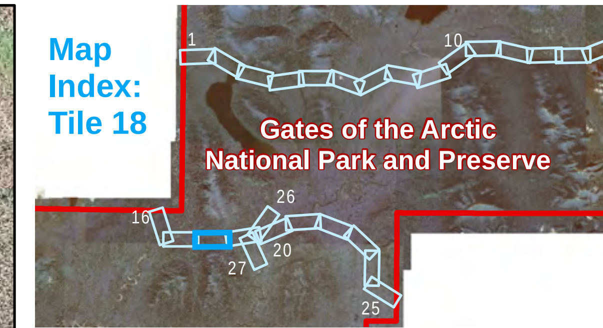
Figure 2, Tile 17
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd



Map Index: Tile 18



Functional Class (Top Frame)

Riverine
- Large Stream
- Low-gradient Small Stream

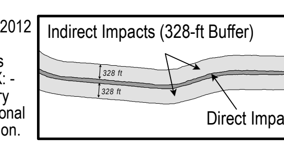
Wetlands
- Flow Paths
- Lakes and Ponds
- Depressional Saturated Graminoid-Shrub Meadow
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Seasonally Flooded Deciduous Shrub

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Tall Alder-Willow Scrub
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Seral Spruce Woodland-Tall Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

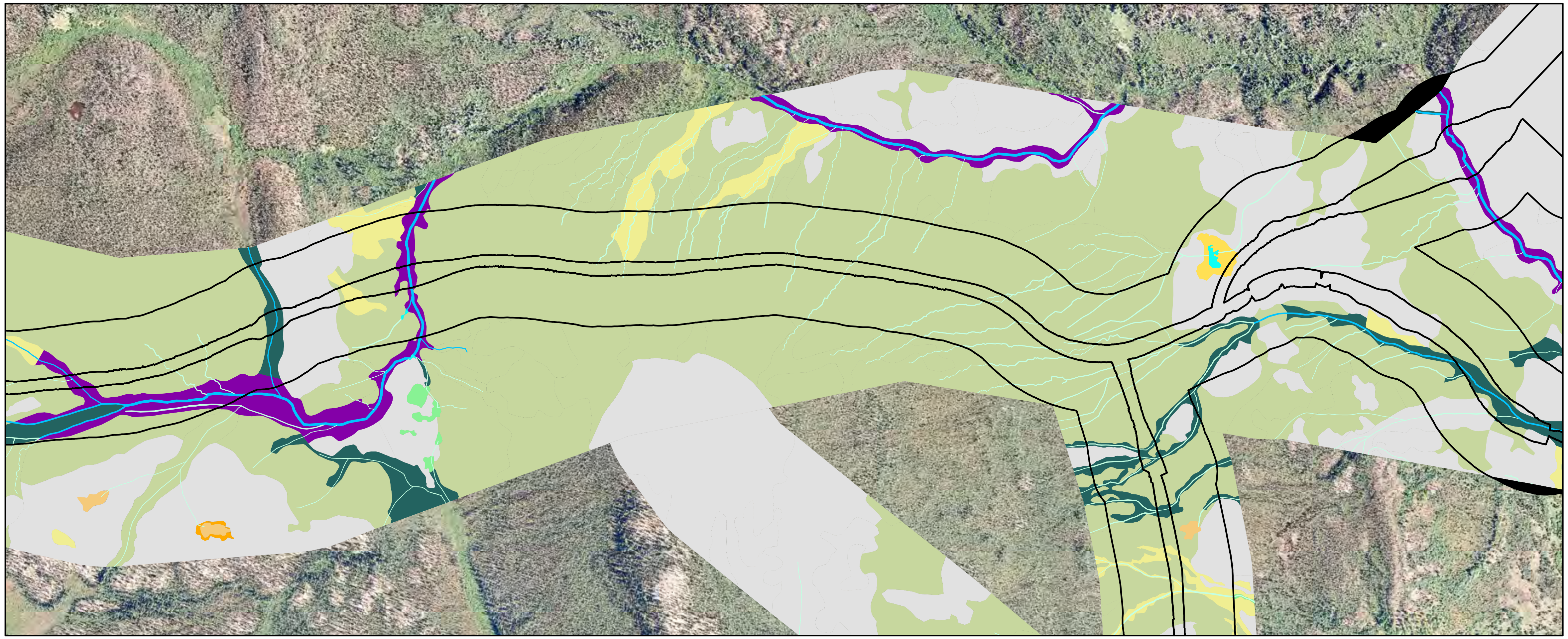
0 200 400 600 800 Feet

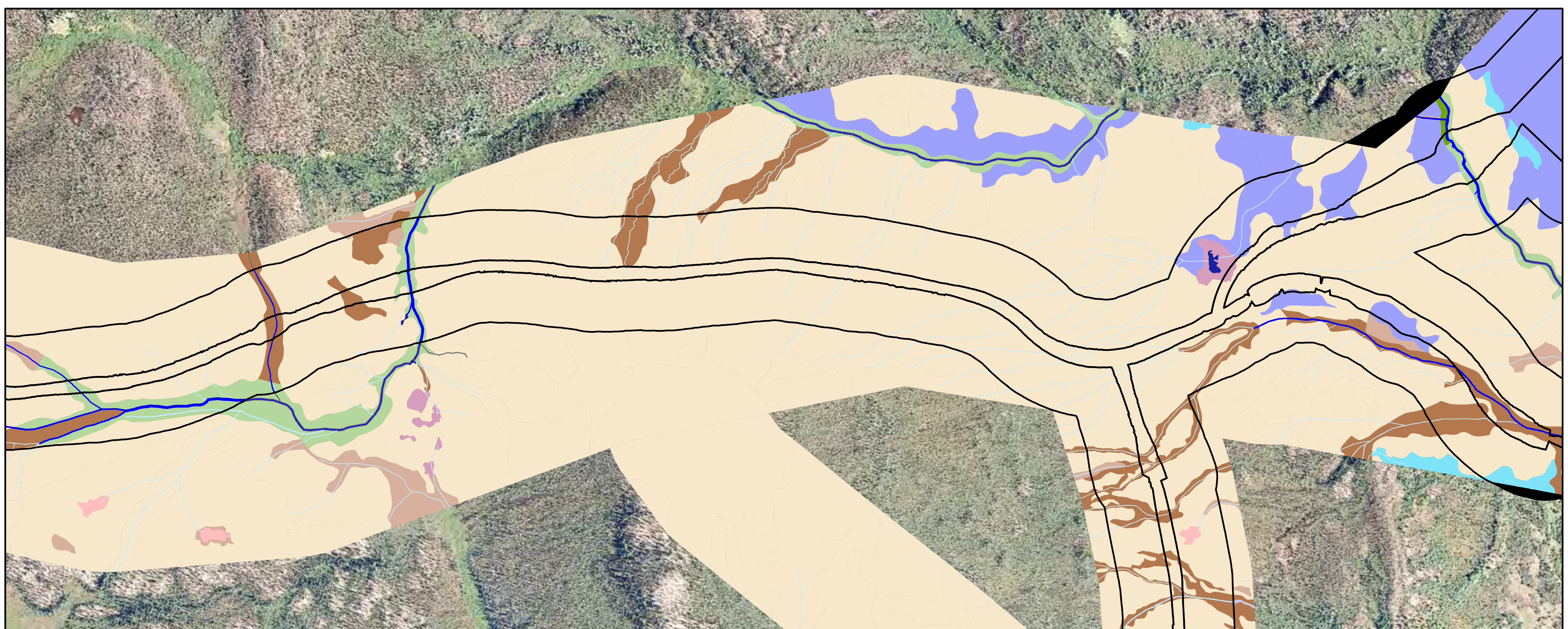
Approximate Scale 1:10,000

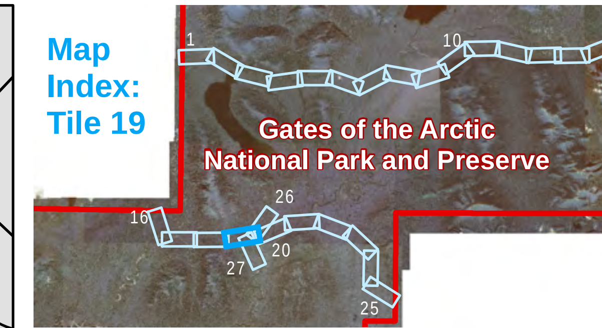
Figure 2, Tile 18
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd







Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream

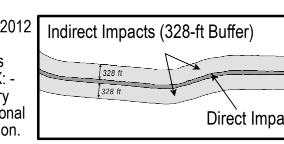
Wetlands
- Flow Paths
- Lakes and Ponds
- Depressional Wet Sedge-Shrub Meadow
- Depressional Saturated Graminoid-Shrub Meadow
- Depressional Saturated Deciduous Shrub
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Seasonally Flooded Deciduous Shrub

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Upland Broadleaf Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

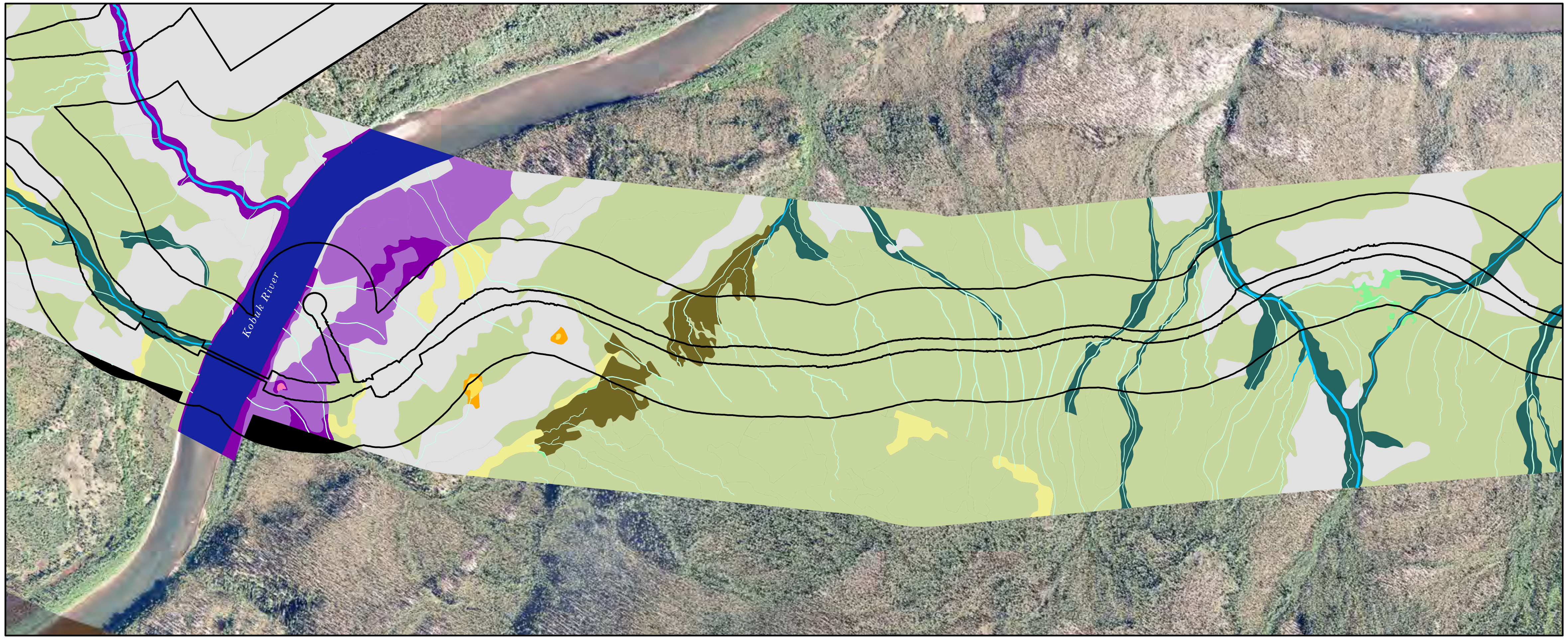
0 200 400 600 800 Feet

Approximate Scale 1:10,000

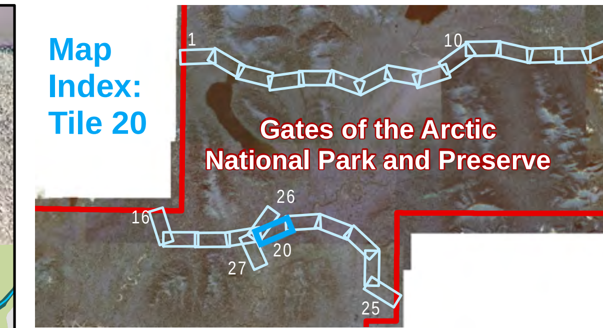
Figure 2, Tile 19
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project Gates of the Arctic National Park and Preserve Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd



Map Index: Tile 20

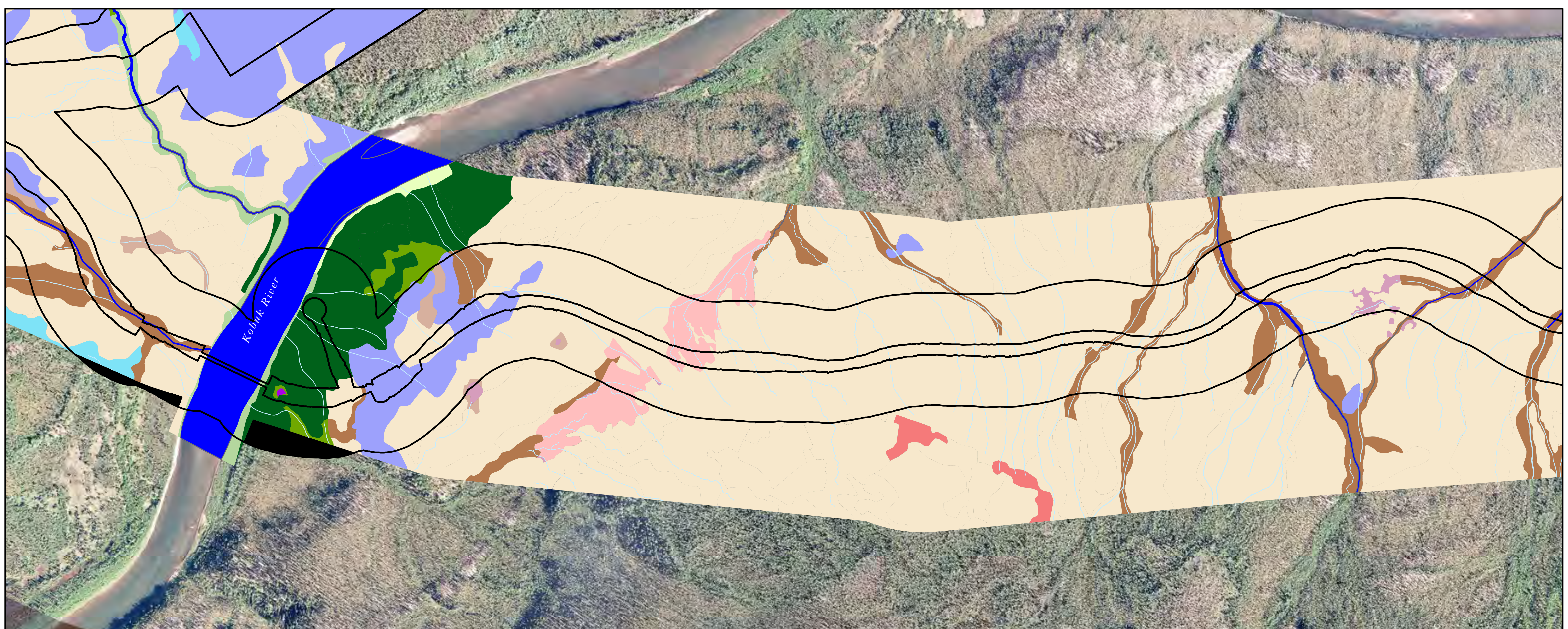


Functional Class (Top Frame)

Riverine
- Major River
- Low-gradient Small Stream

Wetlands
- Flow Paths
- Depressional Wet Sedge-Shrub Meadow
- Depressional Saturated Deciduous Shrub
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Graminoid-Shrub Meadow
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Wet Sedge-Shrub Meadow
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

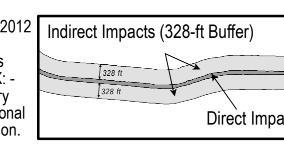
Other Lands
- Upland
- Not Mapped



Wildlife Habitats (Bottom Frame)

- Rivers and Streams
- Riverine Sedge-Shrub Meadow
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Mixed Forest
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Upland Broadleaf Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, acq. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

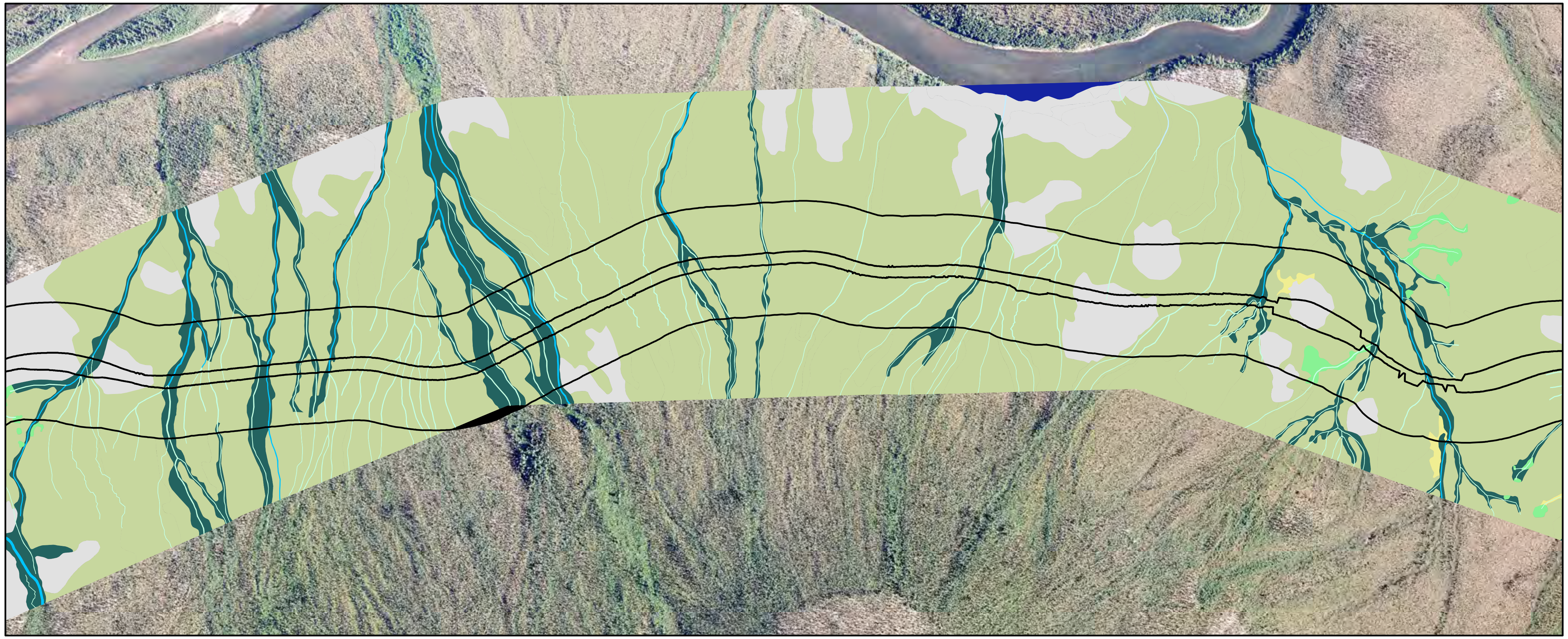
0 200 400 600 800 Feet

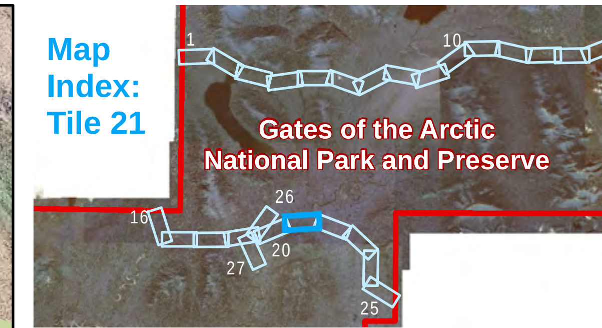
Approximate Scale 1:10,000

Figure 2, Tile 20
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd



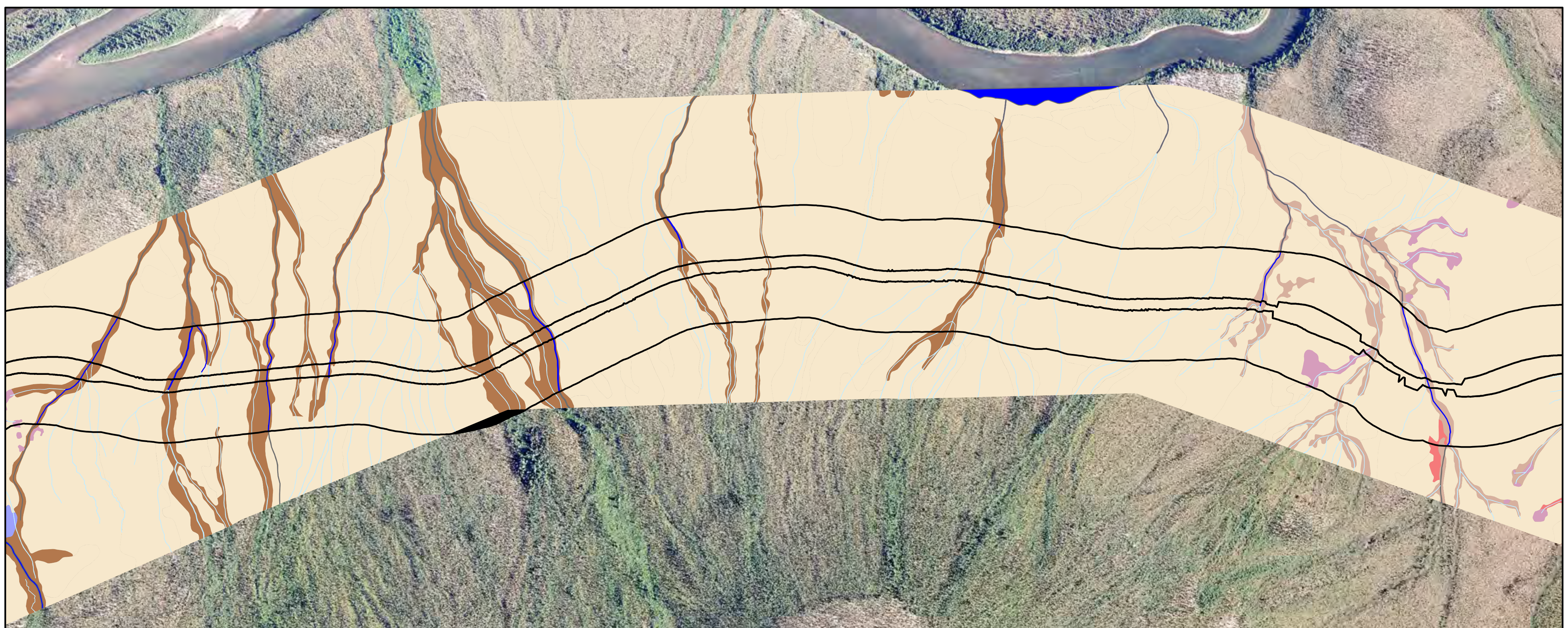


Functional Class (Top Frame)

Riverine
- Major River
- Low-gradient Small Stream
- High-gradient Small Stream

Wetlands
- Flow Paths
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest

Other Lands
- Upland
- Not Mapped



Wildlife Habitats (Bottom Frame)

- Rivers and Streams
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.

Indirect Impacts (328-ft Buffer)
328 ft
328 ft
Direct Impacts

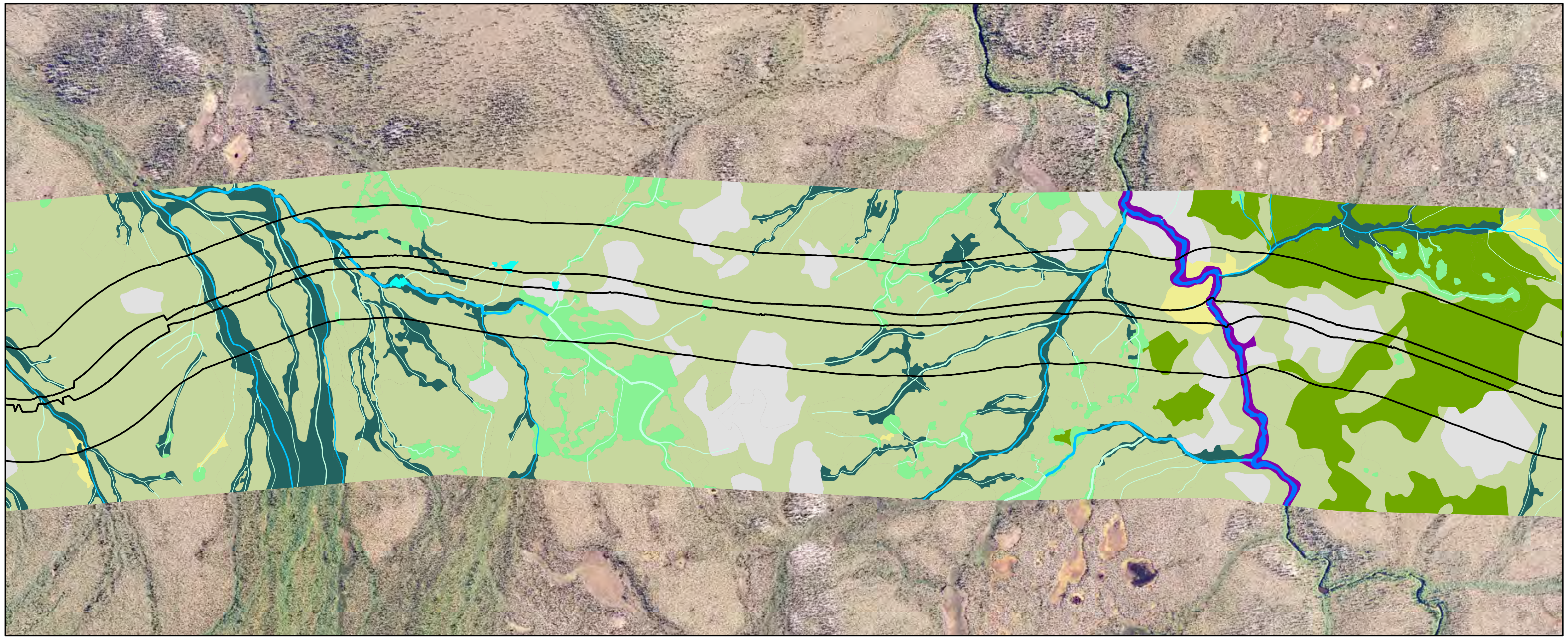
0 50 100 150 200 Meters
0 200 400 600 800 Feet

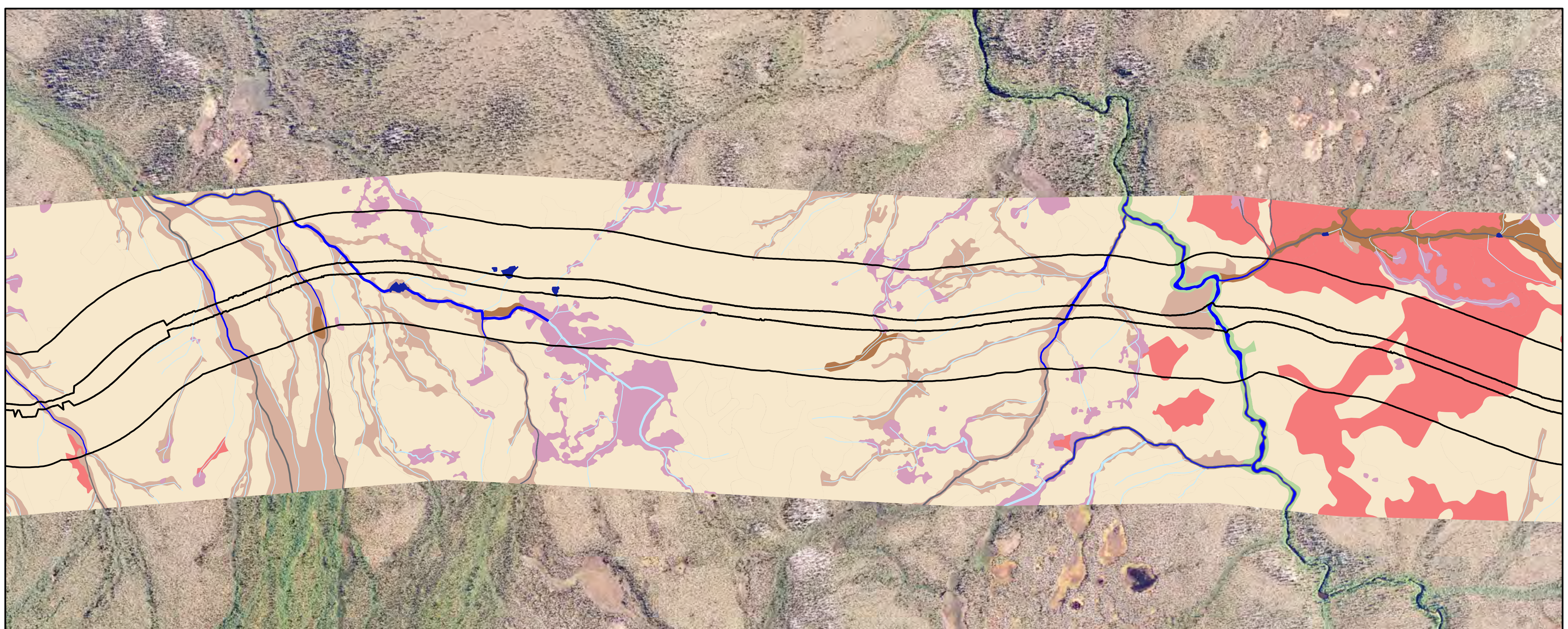
Approximate Scale 1:10,000

Figure 2, Tile 21
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

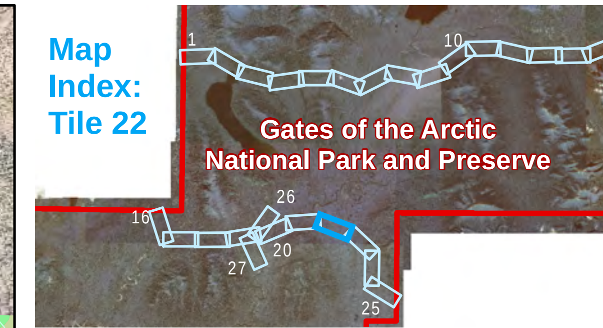
Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd





Map Index: Tile 22



Functional Class (Top Frame)

Riverine
- Large Stream
- Low-gradient Small Stream

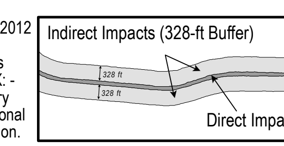
Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Seasonally Flooded Deciduous Shrub

Other Lands
- Upland

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Tall Alder-Willow Scrub
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



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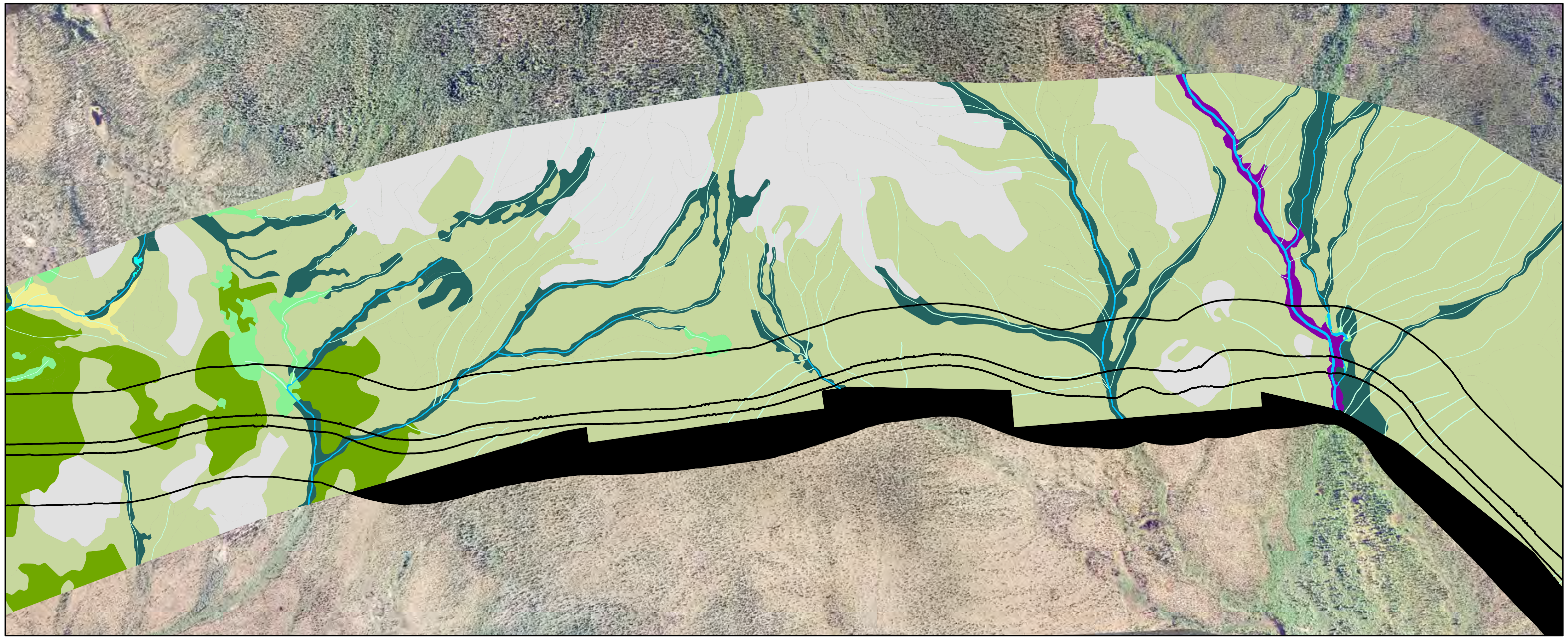
0 200 400 600 800 Feet

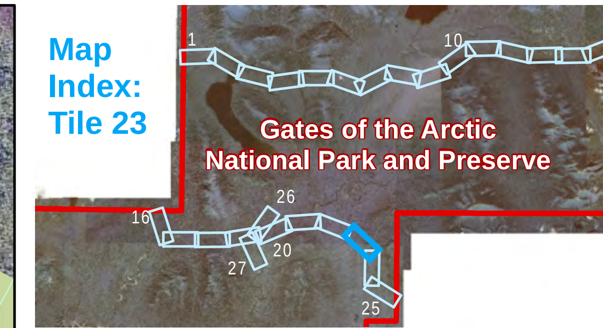
Approximate Scale 1:10,000

Figure 2, Tile 22
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd





Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream

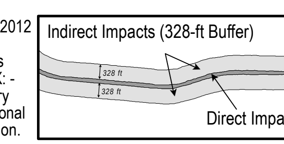
Wetlands
- Flow Paths
- Lakes and Ponds
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Seasonally Flooded Deciduous Shrub

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Tall Alder-Willow Scrub
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



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0 200 400 600 800 Feet

Approximate Scale 1:10,000

Figure 2, Tile 23
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

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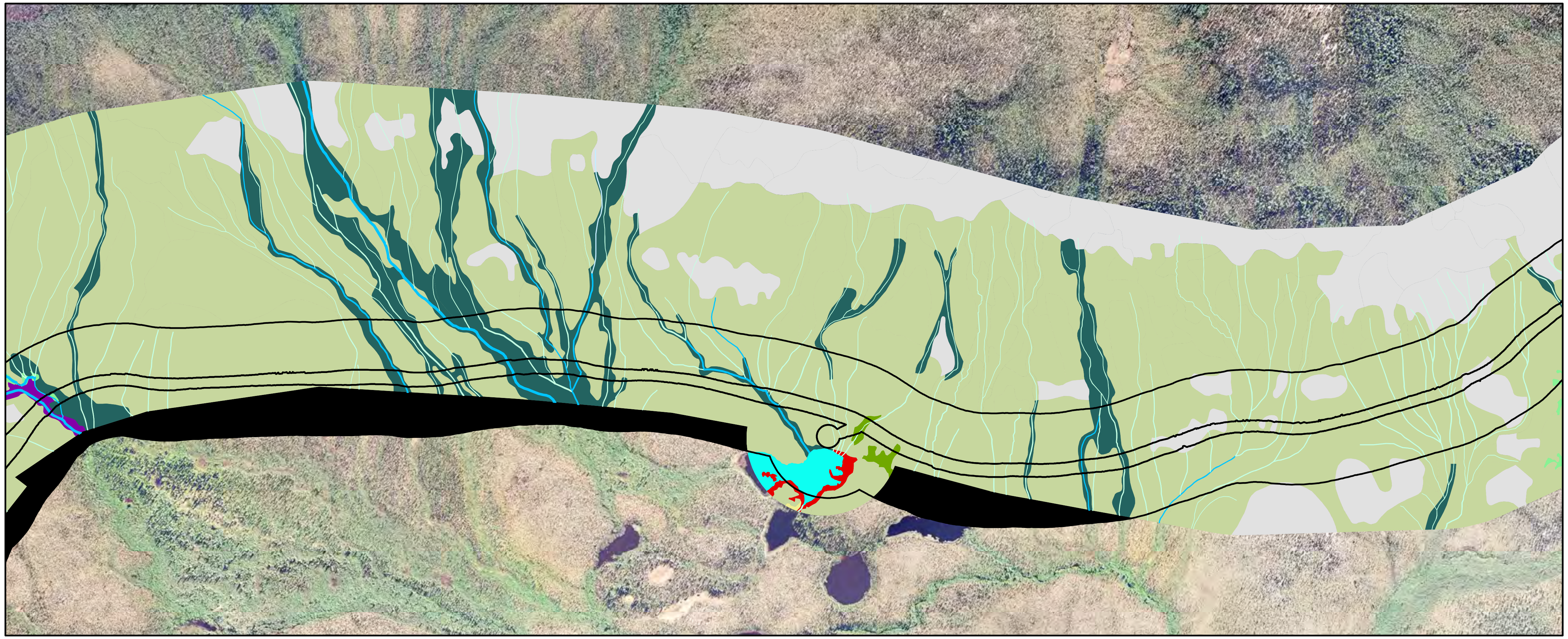
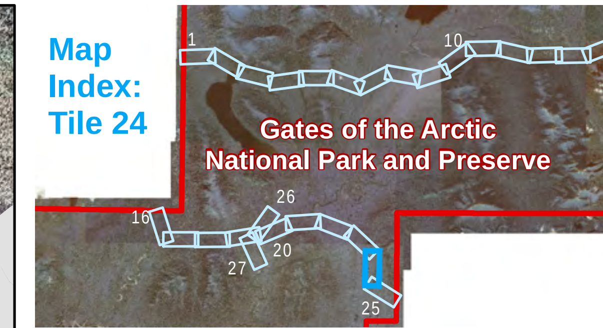


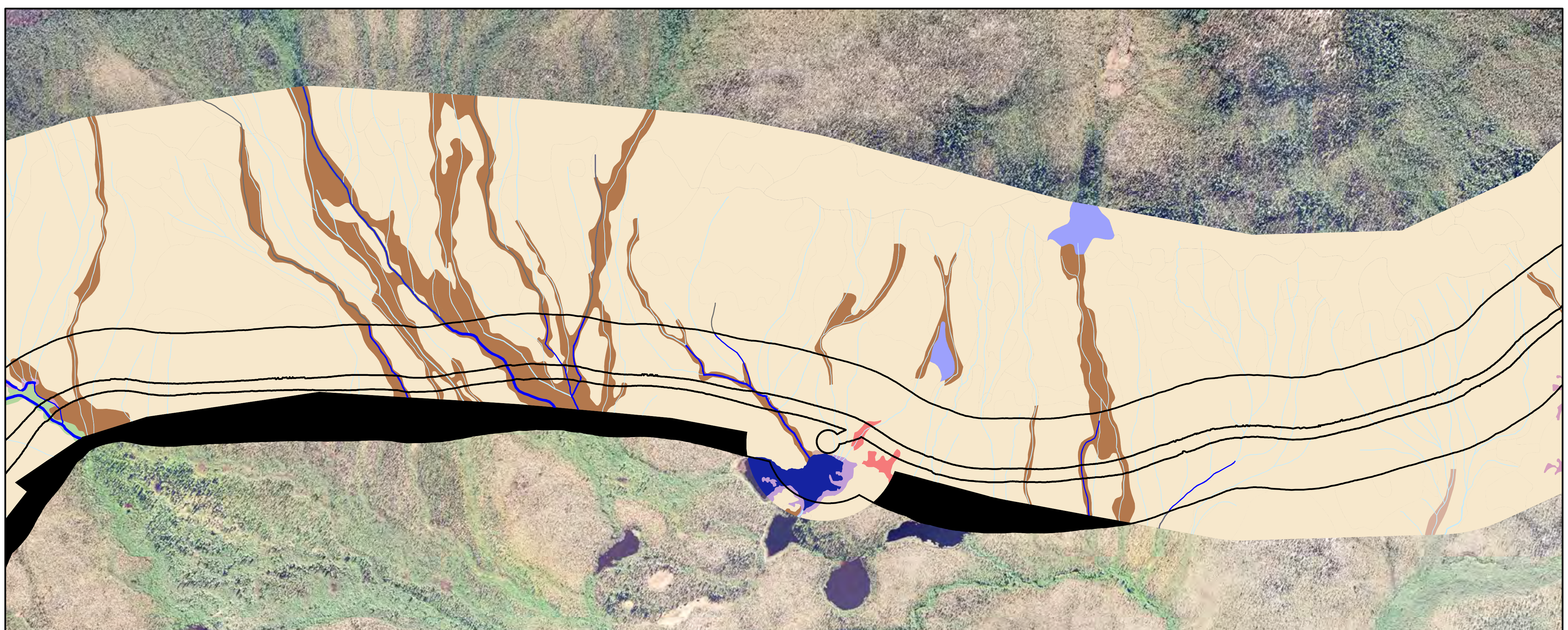


Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream
- High-gradient Small Stream

Wetlands
- Flow Paths
- Lakes and Ponds
- Lacustrine Fringe Wet Sedge Meadow
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Shrub Peatland
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Seasonally Flooded Deciduous Shrub

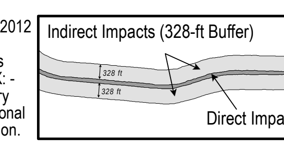
Other Lands
- Upland
- Not Mapped



Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Lacustrine Sedge Meadow
- Rivers and Streams
- Riverine Tall Alder-Willow Scrub
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, acq. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

0 200 400 600 800 Feet

Approximate Scale 1:10,000

Figure 2, Tile 24
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
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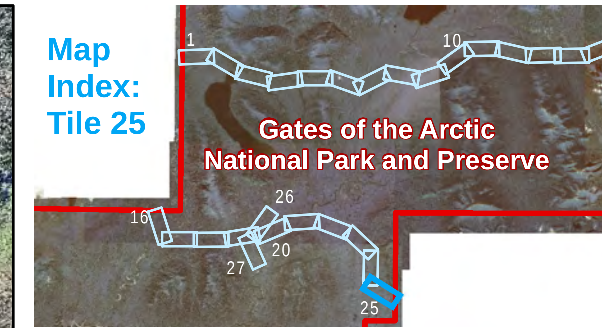
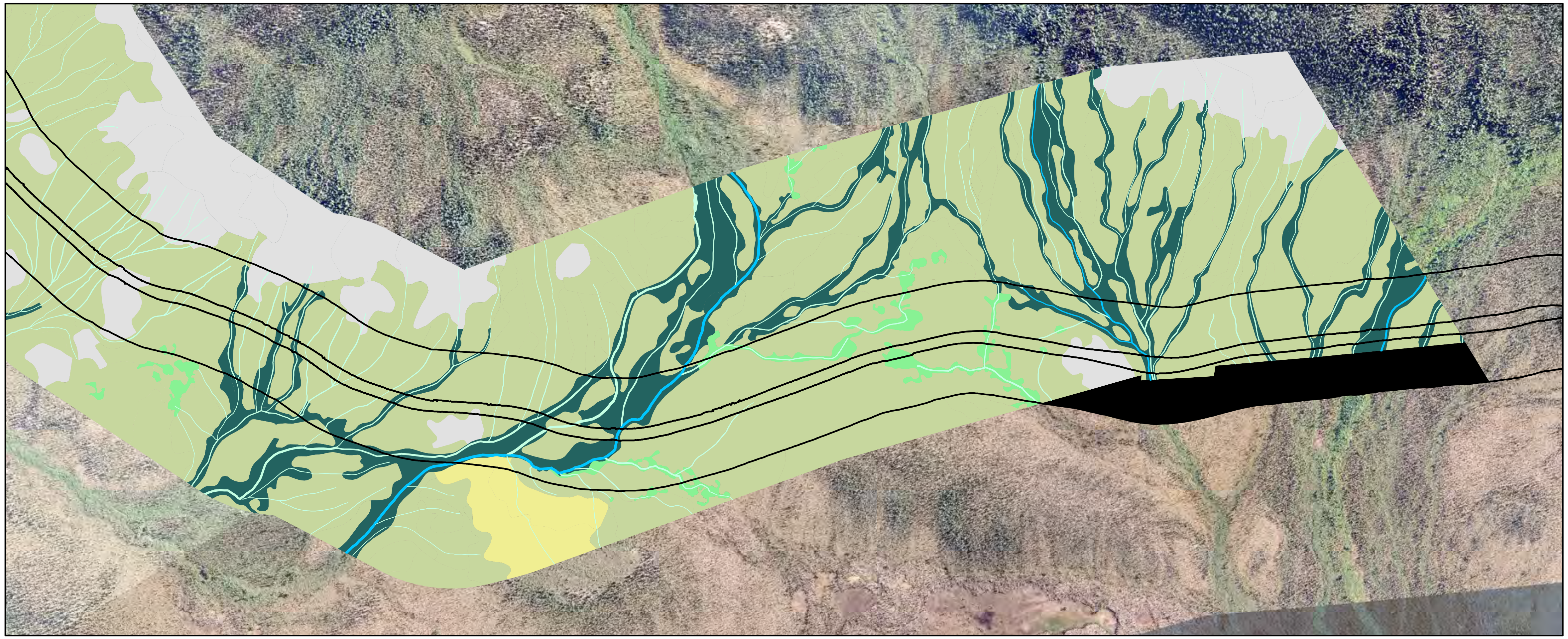


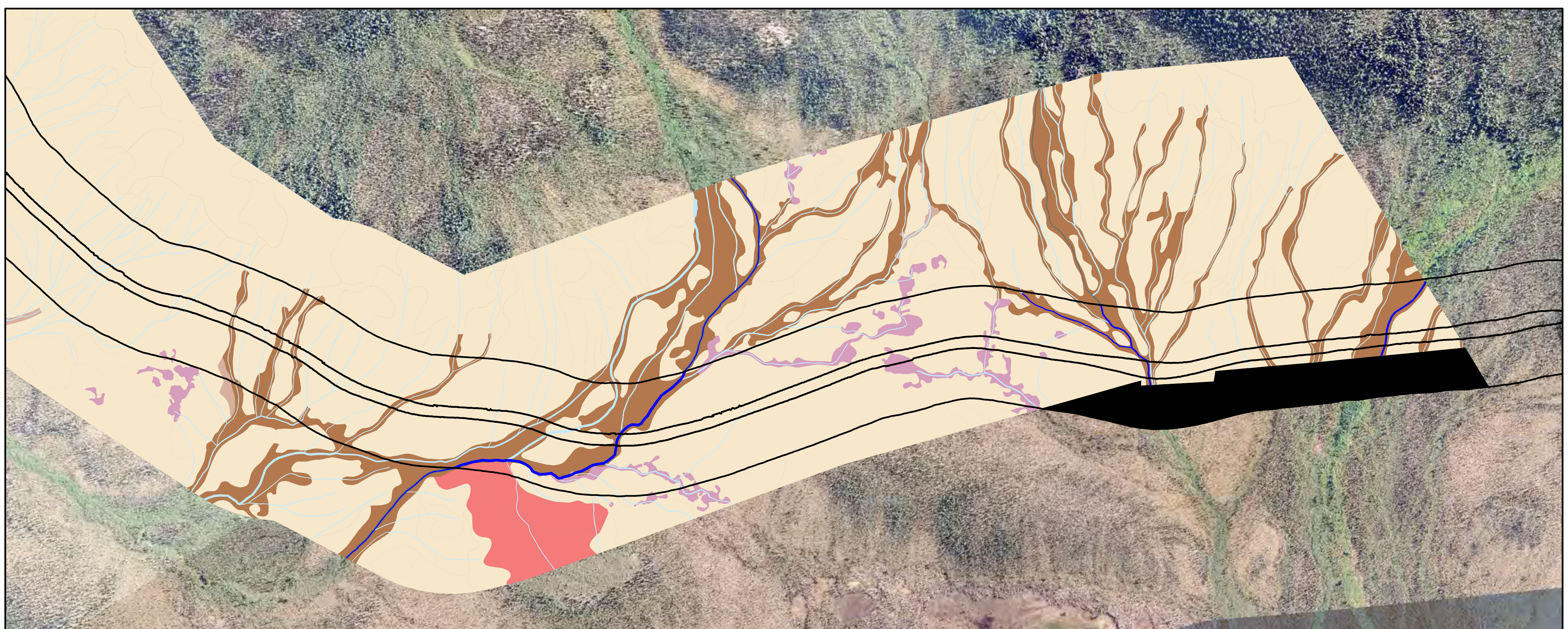


Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream

Wetlands
- Flow Paths
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest

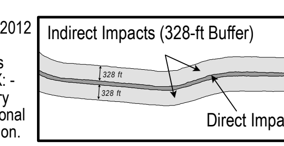
Other Lands
- Upland
- Not Mapped



Wildlife Habitats (Bottom Frame)

- Rivers and Streams
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Low Birch-Ericaceous Scrub
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, acq. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

0 200 400 600 800 Feet

Approximate Scale 1:10,000

Figure 2, Tile 25
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

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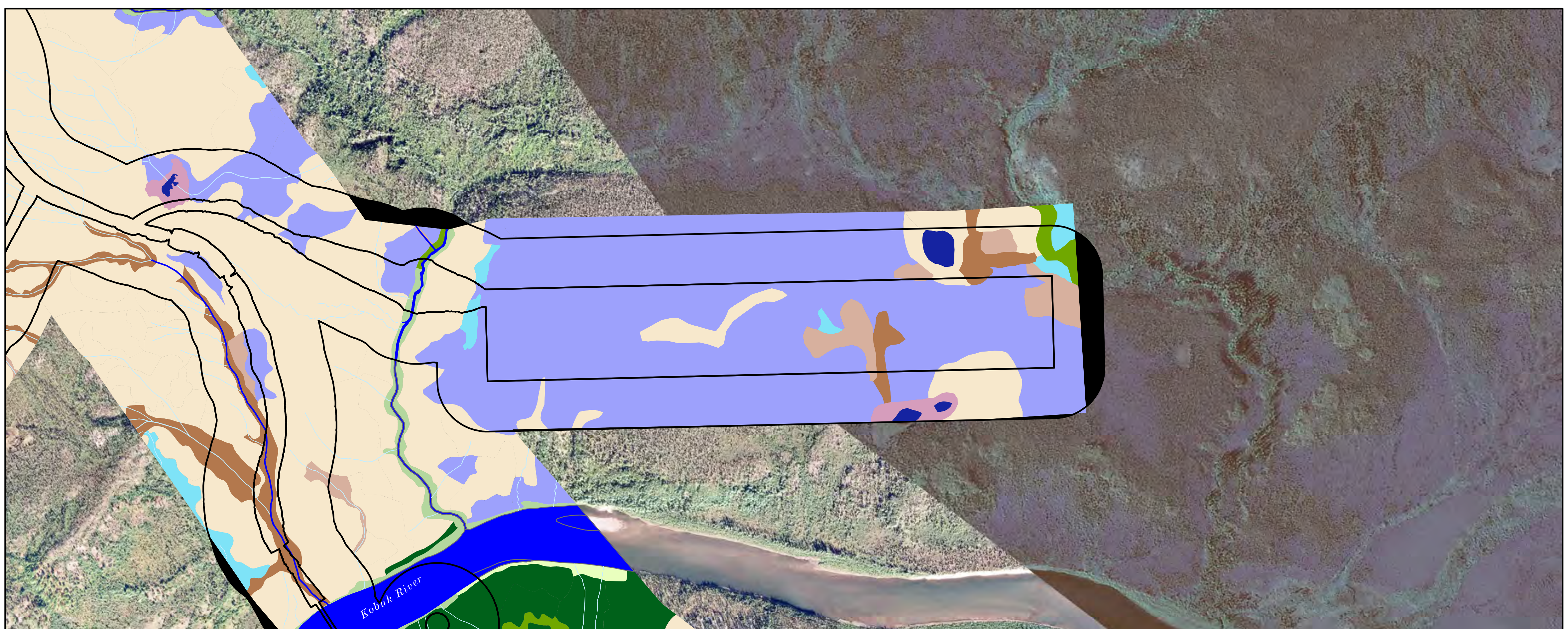
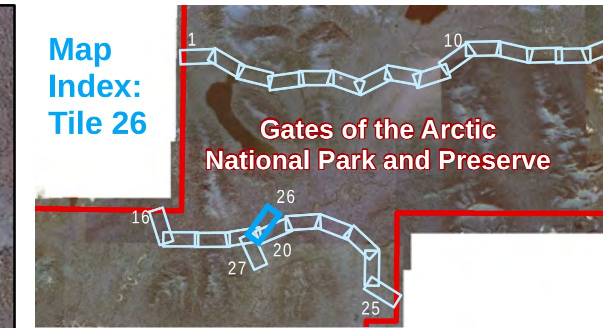




Functional Class (Top Frame)

Riverine
- Major River
- Low-gradient Small Stream

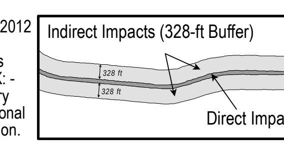
Wetlands
- Flow Paths
- Lakes and Ponds
- Depressional Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest
- Riverine Seasonally Flooded Deciduous Shrub
- Riverine Seasonally Flooded Spruce Forest

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Riverine Low Willow Scrub
- Riverine Tall Alder-Willow Scrub
- Riverine Mixed Forest
- Riverine Spruce Forest
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Upland Broadleaf Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, aqc. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

0 200 400 600 800 Feet

Approximate Scale 1:10,000

Figure 2, Tile 26
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

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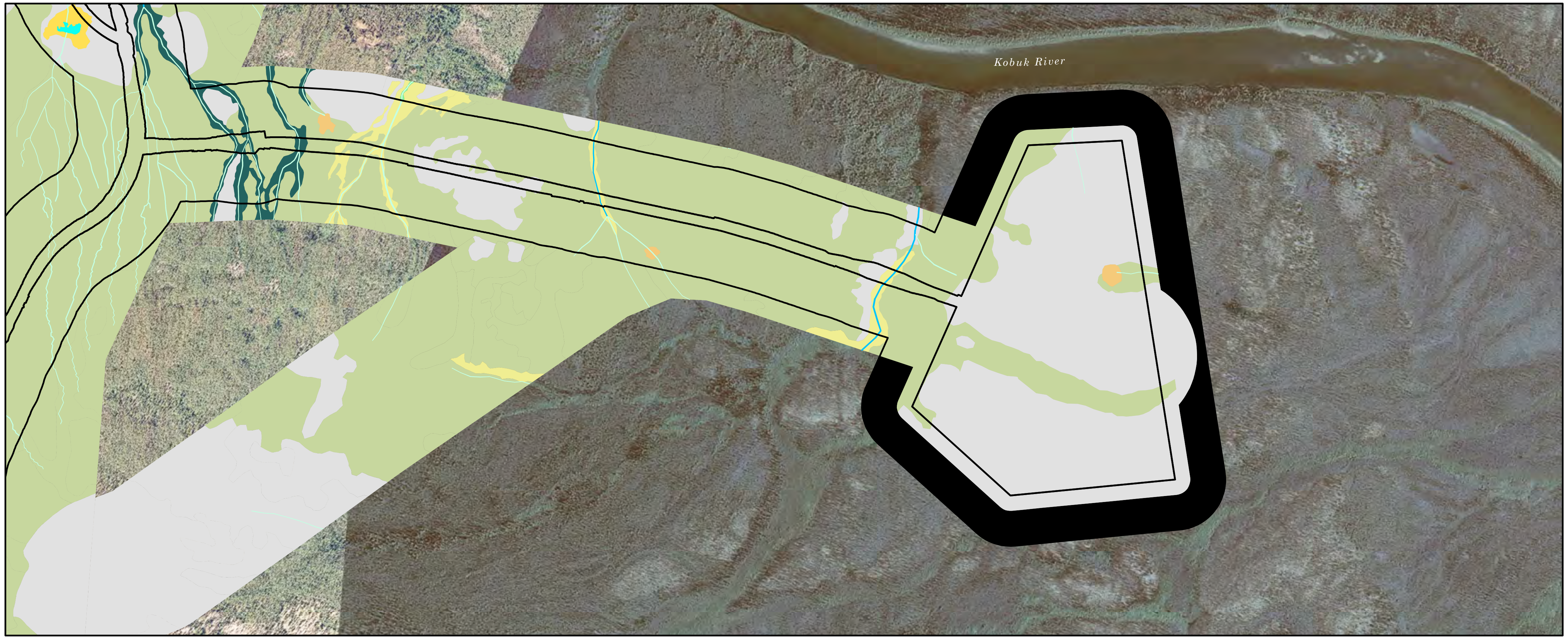
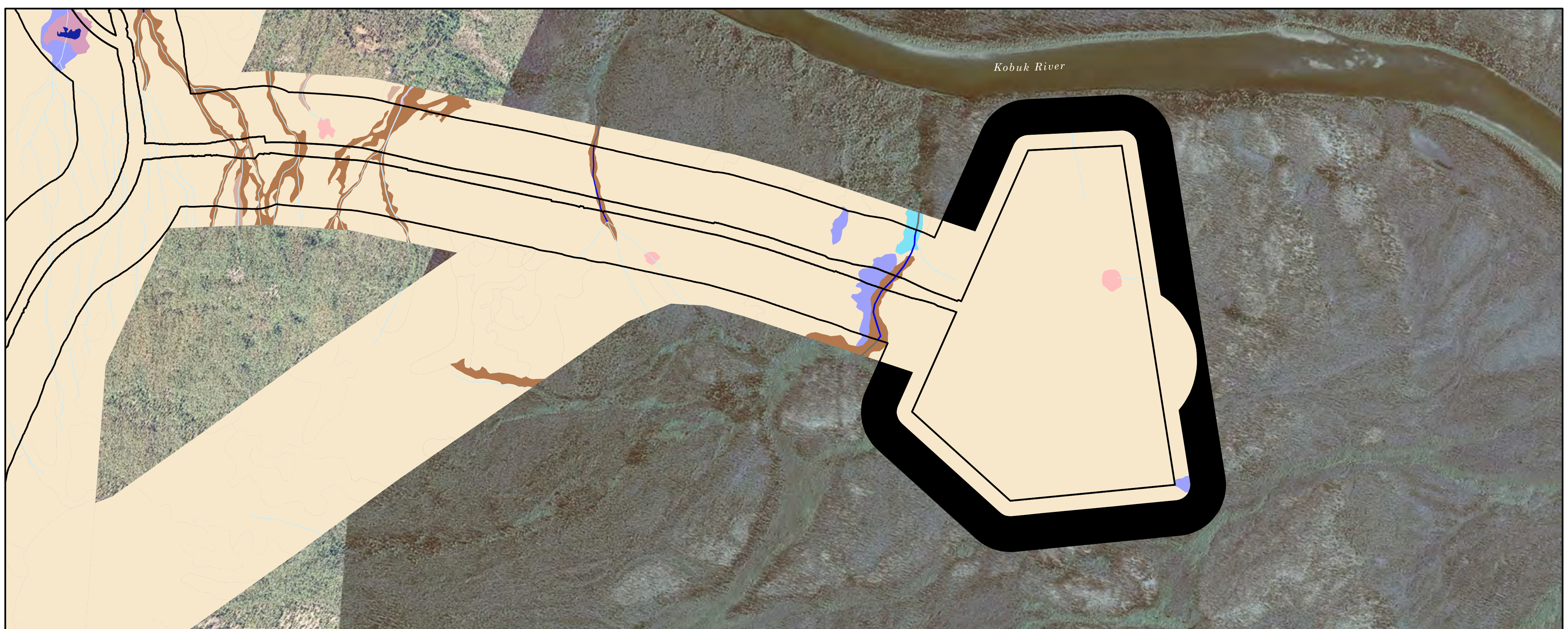
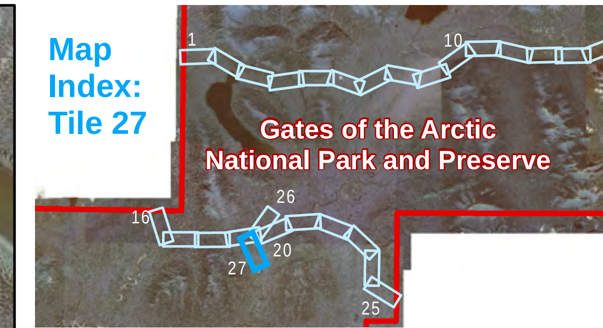






Functional Class (Top Frame)

Riverine
- Low-gradient Small Stream

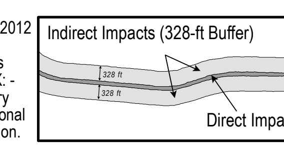
Wetlands
- Flow Paths
- Lakes and Ponds
- Depressional Wet Sedge-Shrub Meadow
- Depressional Saturated Graminoid-Shrub Meadow
- Slope Wet Sedge-Shrub Meadow
- Slope Wet Deciduous Shrub
- Slope Saturated Deciduous Shrub
- Slope Saturated Spruce Forest

Other Lands
- Upland
- Not Mapped

Wildlife Habitats (Bottom Frame)

- Lakes and Ponds
- Rivers and Streams
- Flow Path
- Upland and Lowland Sedge-Shrub Meadow
- Upland and Lowland Grass-Shrub Meadow
- Upland and Lowland Low Willow Scrub
- Upland and Lowland Tall Alder-Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Mixed Forest
- Upland Broadleaf Forest
- Not Mapped

Digital orthophotos based on 18 and 19 June 2012 digital (DMC) aerial photography; 0.75' pixel resolution Projected to Local DOT coordinates (NAD83 ASP 5 scaled 1.000084582, shifted X: -168.8724', Y: -400.0159'). Background imagery IKONOS orthocorrected mosaic from the National Park Service, acq. 2004–2010, at 1 m resolution.



0 50 100 150 200 Meters

0 200 400 600 800 Feet

Approximate Scale 1:10,000

Figure 2, Tile 27
Wetlands and Riverine Functional Classes, and Wildlife Habitats for the Proposed Ambler Mining District Industrial Access Project
Gates of the Arctic National Park and Preserve
Alaska

Map prepared by:
ABR Inc.—Environmental Research & Services

5 January 2017 | Ambler_FxClass_and_Habitats_16-307.mxd

Appendix A. Wildlife habitat type derivation

Concatenation: Physiography_Vegetation	Wildlife Habitat Type
_bpv	Flow Path
p_hgwsl	Lacustrine Sedge Meadow
p_hgwsmb	Lacustrine Sedge Meadow
l_wf	Lakes and Ponds
p_wf	Lakes and Ponds
r_hgmb	Riverine Grass-Shrub Meadow
r_hgmbh	Riverine Grass-Shrub Meadow
r_hgmbs	Riverine Grass-Shrub Meadow
r_slobe	Riverine Low Birch-Ericaceous Scrub
r_slod	Riverine Low Birch-Ericaceous Scrub
r_slcw	Riverine Low Willow Scrub
r_slow	Riverine Low Willow Scrub
r_slowg	Riverine Low Willow Scrub
r_fmosb	Riverine Mixed Forest
r_fmwsb	Riverine Mixed Forest
r_hgwsl	Riverine Sedge-Shrub Meadow
r_fnobs	Riverine Spruce Forest
r_fnows	Riverine Spruce Forest
r_fnwbs	Riverine Spruce Forest
r_fnwts	Riverine Spruce Forest
r_fnwws	Riverine Spruce Forest
r_stca	Riverine Tall Alder-Willow Scrub
r_stcw	Riverine Tall Alder-Willow Scrub
r_stow	Riverine Tall Alder-Willow Scrub
r_bbg	Rivers and Streams
r_wf	Rivers and Streams
l_slott	Tussock Tundra
u_slott	Tussock Tundra
l_hgmb	Upland and Lowland Grass-Shrub Meadow
l_hgmbs	Upland and Lowland Grass-Shrub Meadow
u_hgdgs	Upland and Lowland Grass-Shrub Meadow
u_hgmb	Upland and Lowland Grass-Shrub Meadow
u_hgmbs	Upland and Lowland Grass-Shrub Meadow
l_slobe	Upland and Lowland Low Birch-Ericaceous Scrub
l_slod	Upland and Lowland Low Birch-Ericaceous Scrub
l_sloe	Upland and Lowland Low Birch-Ericaceous Scrub
l_sloeb	Upland and Lowland Low Birch-Ericaceous Scrub
u_slcbe	Upland and Lowland Low Birch-Ericaceous Scrub
u_slcd	Upland and Lowland Low Birch-Ericaceous Scrub
u_slobe	Upland and Lowland Low Birch-Ericaceous Scrub
u_slod	Upland and Lowland Low Birch-Ericaceous Scrub

Appendix A. Continued.

Concatenation: Physiography_Vegetation	Wildlife Habitat Type
u_sloe	Upland and Lowland Low Birch-Ericaceous Scrub
u_sloeb	Upland and Lowland Low Birch-Ericaceous Scrub
l_slcw	Upland and Lowland Low Willow Scrub
l_slobw	Upland and Lowland Low Willow Scrub
l_slow	Upland and Lowland Low Willow Scrub
u_slcw	Upland and Lowland Low Willow Scrub
u_slobw	Upland and Lowland Low Willow Scrub
u_slow	Upland and Lowland Low Willow Scrub
u_fmosb	Upland and Lowland Mixed Forest
u_fmwsa	Upland and Lowland Mixed Forest
u_fmwsb	Upland and Lowland Mixed Forest
l_hgwsb	Upland and Lowland Sedge-Shrub Meadow
l_hgwsl	Upland and Lowland Sedge-Shrub Meadow
l_hgwsmb	Upland and Lowland Sedge-Shrub Meadow
u_hgwsl	Upland and Lowland Sedge-Shrub Meadow
l_stod	Upland and Lowland Seral Spruce Woodland-Tall Scrub
u_stod	Upland and Lowland Seral Spruce Woodland-Tall Scrub
l_fnobs	Upland and Lowland Spruce Forest
l_fnows	Upland and Lowland Spruce Forest
l_fnwbs	Upland and Lowland Spruce Forest
l_sfobs	Upland and Lowland Spruce Forest
l_sfwbs	Upland and Lowland Spruce Forest
u_fnobs	Upland and Lowland Spruce Forest
u_fnows	Upland and Lowland Spruce Forest
u_fnwbs	Upland and Lowland Spruce Forest
u_fnwts	Upland and Lowland Spruce Forest
u_fnwws	Upland and Lowland Spruce Forest
u_sfwbs	Upland and Lowland Spruce Forest
l_stcss	Upland and Lowland Tall Alder-Willow Scrub
l_stcw	Upland and Lowland Tall Alder-Willow Scrub
l_stow	Upland and Lowland Tall Alder-Willow Scrub
u_stca	Upland and Lowland Tall Alder-Willow Scrub
u_stcaw	Upland and Lowland Tall Alder-Willow Scrub
u_stcw	Upland and Lowland Tall Alder-Willow Scrub
u_stoa	Upland and Lowland Tall Alder-Willow Scrub
u_stow	Upland and Lowland Tall Alder-Willow Scrub
u_fbcb	Upland Broadleaf Forest
u_fboa	Upland Broadleaf Forest
u_fbob	Upland Broadleaf Forest
u_fbwb	Upland Broadleaf Forest

Appendix B. Wetland functional class ecotype and habitat type crosswalk.

Wetland Functional Class	Analogous ELS Ecotype	Wildlife Habitat Type
Depressional Saturated Deciduous Shrub	Lacustrine Willow Shrub	Upland and Lowland Low Willow Scrub
Depressional Saturated Deciduous Shrub	Lacustrine Willow Shrub	Upland and Lowland Tall Alder-Willow Scrub
Depressional Saturated Graminoid-Shrub Meadow	Lacustrine Bluejoint Meadow	Upland and Lowland Grass-Shrub Meadow
Depressional Wet Sedge-Shrub Meadow	Lacustrine Wet Sedge Meadow	Upland and Lowland Sedge-Shrub Meadow
Lacustrine Fringe Wet Sedge Meadow	Lacustrine Wet Sedge Meadow	Lacustrine Sedge Meadow
Lakes and Ponds	Riverine Lake	Lakes and Ponds
Lakes and Ponds	Lowland Lake	Lakes and Ponds
Riverine Seasonally Flooded Deciduous Shrub	Riverine Birch-Willow Low Shrub	Riverine Low Birch-Ericaceous Scrub
Riverine Seasonally Flooded Deciduous Shrub	Riverine Willow Low Shrub	Riverine Low Willow Scrub
Riverine Seasonally Flooded Deciduous Shrub	Riverine Moist Willow Tall Shrub	Riverine Tall Alder-Willow Scrub
Riverine Seasonally Flooded Deciduous Shrub	Riverine Wet Willow Tall Shrub	Riverine Tall Alder-Willow Scrub
Riverine Seasonally Flooded Graminoid-Shrub Meadow	Riverine Bluejoint Meadow	Riverine Grass-Shrub Meadow
Riverine Seasonally Flooded Spruce Forest	Riverine White Spruce-Willow Forest	Riverine Spruce Forest
Riverine Wet Sedge-Shrub Meadow	Riverine Wet Sedge Meadow	Riverine Sedge-Shrub Meadow
Rivers and Streams (see Riverine Functional Classes)	River	Rivers and Streams
Rivers and Streams (see Riverine Functional Classes)	Riverine Barrens	Rivers and Streams
Slope Saturated Deciduous Shrub	Upland Dwarf Birch-Tussock Shrub	Tussock Tundra
Slope Saturated Deciduous Shrub	Upland Birch-Ericaceous Low Shrub	Upland and Lowland Low Birch-Ericaceous Scrub
Slope Saturated Deciduous Shrub	Lowland Birch-Ericaceous Low Shrub	Upland and Lowland Low Birch-Ericaceous Scrub
Slope Saturated Deciduous Shrub	Upland Birch-Willow Low Shrub	Upland and Lowland Low Willow Scrub
Slope Saturated Deciduous Shrub	Upland Willow Low Shrub	Upland and Lowland Low Willow Scrub
Slope Saturated Deciduous Shrub	Lowland Birch-Willow Low Shrub	Upland and Lowland Low Willow Scrub
Slope Saturated Deciduous Shrub	*no analogous ecotype	Upland and Lowland Seral Spruce Woodland-Tall Scrub
Slope Saturated Deciduous Shrub	*no analogous ecotype	Upland and Lowland Seral Spruce Woodland-Tall Scrub
Slope Saturated Deciduous Shrub	Upland Alder-Willow Tall Shrub	Upland and Lowland Tall Alder-Willow Scrub
Slope Saturated Graminoid-Shrub Meadow	Upland Bluejoint Meadow	Upland and Lowland Grass-Shrub Meadow
Slope Saturated Shrub Peatland	Lowland Ericaceous Shrub Bog	Upland and Lowland Low Birch-Ericaceous Scrub
Slope Saturated Spruce Forest	Lowland Black Spruce Forest	Upland and Lowland Spruce Forest

Appendix B. Continued.

Wetland Functional Class	Analogous ELS Ecotype	Wildlife Habitat Type
Slope Wet Deciduous Shrub	Lowland Willow Low Shrub	Upland and Lowland Low Willow Scrub
Slope Wet Sedge-Shrub Meadow	Lowland Sedge Fen	Upland and Lowland Sedge-Shrub Meadow
Slope Wet Sedge-Shrub Meadow	Lowland Sedge-Willow Fen	Upland and Lowland Sedge-Shrub Meadow
Upland	Riverine White Spruce-Poplar Forest	Riverine Mixed Forest
Upland	Riverine White Spruce-Willow Forest	Riverine Spruce Forest
Upland	Riverine Moist Willow Tall Shrub	Riverine Tall Alder-Willow Scrub
Upland	Upland Bluejoint Meadow	Upland and Lowland Grass-Shrub Meadow
Upland	Upland Birch-Ericaceous Low Shrub	Upland and Lowland Low Birch-Ericaceous Scrub
Upland	Upland Willow Low Shrub	Upland and Lowland Low Willow Scrub
Upland	Upland Spruce-Birch Forest	Upland and Lowland Mixed Forest
Upland	*no analogous ecotype	Upland and Lowland Seral Spruce Woodland-Tall Scrub
Upland	Lowland Black Spruce Forest	Upland and Lowland Spruce Forest
Upland	Upland White Spruce-Ericaceous Forest	Upland and Lowland Spruce Forest
Upland	Upland White Spruce-Willow Forest	Upland and Lowland Spruce Forest
Upland	Upland Alder-Willow Tall Shrub	Upland and Lowland Tall Alder-Willow Scrub
Upland	Upland Birch Forest	Upland Broadleaf Forest

Appendix C. Wetland and riverine functional class derivation.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
l_DEPRESSIONAL_PEM1B_slow_b	Depressional Saturated Deciduous Shrub
l_DEPRESSIONAL_PSS1/EM1B_slow_b	Depressional Saturated Deciduous Shrub
l_DEPRESSIONAL_PSS1/EM1B_stow_b	Depressional Saturated Deciduous Shrub
l_DEPRESSIONAL_PSS1/EM1C_slow_b	Depressional Saturated Deciduous Shrub
l_DEPRESSIONAL_PSS1B_slcw_b	Depressional Saturated Deciduous Shrub
l_DEPRESSIONAL_PSS1B_slow_b	Depressional Saturated Deciduous Shrub
l_DEPRESSIONAL_PSS1C_slow_b	Depressional Saturated Deciduous Shrub
l_DEPRESSIONAL_PEM1/SS1B_hgmb_b	Depressional Saturated Graminoid-Shrub Meadow
l_DEPRESSIONAL_PEM1B_hgmb_b	Depressional Saturated Graminoid-Shrub Meadow
l_DEPRESSIONAL_PEM1C_hgmb_b	Depressional Saturated Graminoid-Shrub Meadow
l_DEPRESSIONAL_PEM1C_hgmbs_b	Depressional Saturated Graminoid-Shrub Meadow
l_DEPRESSIONAL_PSS1/EM1B_hgmbs_b	Depressional Saturated Graminoid-Shrub Meadow
l_DEPRESSIONAL_PSS1/EM1C_hgmbs_b	Depressional Saturated Graminoid-Shrub Meadow
l_DEPRESSIONAL_PSS4/1B_hgmbs_b	Depressional Saturated Graminoid-Shrub Meadow
l_DEPRESSIONAL_PEM1C_hgwsl_b	Depressional Wet Sedge-Shrub Meadow
l_DEPRESSIONAL_PEM1H_hgwsl_b	Depressional Wet Sedge-Shrub Meadow
_RIVERINE_CHANNEL_R3UBH_bpv_d	Flow Path[1]
p_LACUSTRINE FRINGE_PEM1C_hgwsl_lm	Lacustrine Fringe Wet Sedge Meadow
p_LACUSTRINE FRINGE_PEM1C_hgwsmb_lm	Lacustrine Fringe Wet Sedge Meadow
p_LACUSTRINE FRINGE_PEM1H_hgwsmb_lm	Lacustrine Fringe Wet Sedge Meadow
p_LACUSTRINE FRINGE_PSS1/EM1C_hgwsmb_lm	Lacustrine Fringe Wet Sedge Meadow
l_SLOPE_PUBH_wf_d	Lakes and Ponds
l_SLOPE_PUBH_wf_st	Lakes and Ponds
l_SLOPE_PUBH_wf_w	Lakes and Ponds
p_DEPRESSIONAL_L1UBH_wf_w	Lakes and Ponds
p_DEPRESSIONAL_PUBH_wf_w	Lakes and Ponds
p_DEPRESSIONAL_PUBH_wf_wi	Lakes and Ponds
p_RIVERINE_PUBH_wf_w	Lakes and Ponds
p_RIVERINE_R3UBH_wf_w	Lakes and Ponds
p_SLOPE_PUBH_wf_st	Lakes and Ponds
p_SLOPE_PUBH_wf_w	Lakes and Ponds
r_RIVERINE_R3USC_bbg_fb	Major River, Large Stream
r_RIVERINE_CHANNEL_R3UBH_wf_r	Major River, Large Stream, Low-gradient Small Stream, High-gradient Small Stream
r_RIVERINE_PEM1C_slow_fi	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1/EM1B_slobe_f	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1/EM1C_slcw_f	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1/EM1C_slod_ft	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1/EM1C_slow_f	Riverine Seasonally Flooded Deciduous Shrub

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
r_RIVERINE_PSS1/EM1C_slowg_f	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1/EM1C_stow_f	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1B_slow_f	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1C_slcw_f	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1C_slod_ft	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1C_slod_s	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1C_slow_f	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1C_stcw_f	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1C_stow_f	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1H_slow_fi	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PSS1H_stcw_fi	Riverine Seasonally Flooded Deciduous Shrub
r_RIVERINE_PEM1/SS1C_hgmbs_f	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PEM1/SS1C_hgmbs_fi	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PEM1C_hgmb_f	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PEM1C_hgmb_fi	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PEM1C_hgmbs_f	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PEM1C_hgmbs_fi	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PFO4/SS1C_hgmb_f	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PSS1/EM1B_hgmbs_f	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PSS1/EM1C_hgmbh_f	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PSS1/EM1C_hgmbs_f	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PSS1C_hgmb_f	Riverine Seasonally Flooded Graminoid-Shrub Meadow
r_RIVERINE_PFO4/SS1B_fnobs_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PFO4/SS1B_fnobs_s	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PFO4/SS1C_fnobs_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PFO4/SS1C_fnobs_ft	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PFO4/SS1C_fnobs_s	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PFO4/SS1C_fnows_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PFO4/SS1C_fnwts_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PSS1/EM1C_fnwts_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PSS1/FO4C_fnwbs_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PSS1/FO4C_fnwbs_s	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PSS1/FO4C_fnwts_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PSS1/FO4C_fnwws_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PSS1C_fnwts_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PSS4/1C_fnwbs_f	Riverine Seasonally Flooded Spruce Forest
r_RIVERINE_PEM1C_hgwsl_f	Riverine Wet Sedge-Shrub Meadow
r_RIVERINE_PEM1H_hgwsl_f	Riverine Wet Sedge-Shrub Meadow
l_SLOPE_PEM1/SS1B_slott_sf	Slope Saturated Deciduous Shrub

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
l_SLOPE_PEM1/SS1B_slott_sl	Slope Saturated Deciduous Shrub
l_SLOPE_PEM1/SS1B_slott_st	Slope Saturated Deciduous Shrub
l_SLOPE_PEM1B_slow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PEM1H_slow_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slobe_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slod_sl	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slod_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_sloe_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_sloe_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slott_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slott_sl	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slott_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slow_s	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slow_sl	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_slow_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_stod_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_stow_s	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_stow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1B_stow_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_slobe_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_slod_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_sloe_s	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_sloe_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_slott_sl	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_slow_s	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_slow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_slow_sl	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_slow_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_stow_s	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1/EM1C_stow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_slcw_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_slcw_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_slobw_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_slod_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_sloe_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_slott_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_slow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_stod_s	Slope Saturated Deciduous Shrub

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
l_SLOPE_PSS1B_stod_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_stow_s	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_stow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1B_stow_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_slcw_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_slcw_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_slobw_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_slod_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_sloe_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_slow_s	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_slow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_slow_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_stcw_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_stcw_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_stod_s	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_stow_s	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_stow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1C_stow_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1H_slcw_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS1H_slow_sf	Slope Saturated Deciduous Shrub
l_SLOPE_PSS4/1B_slobe_st	Slope Saturated Deciduous Shrub
l_SLOPE_PSS4/1B_slott_sf	Slope Saturated Deciduous Shrub
u_SLOPE_PEM1/SS1B_slobe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PEM1/SS1B_sloe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PEM1B_slott_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PEM1C_slcw_sb	Slope Saturated Deciduous Shrub
u_SLOPE_PFO4/SS1B_slobe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PFO4/SS1C_slow_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/4B_slcw_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_slcw_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_slobe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_slobe_sf	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_slod_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_slod_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_sloe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_sloe_sf	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_slott_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_slott_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_slow_s	Slope Saturated Deciduous Shrub

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
u_SLOPE_PSS1/EM1B_slow_sf	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_slow_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_stoa_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_stod_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_stod_sf	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_stod_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_stow_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1B_stow_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_slobe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_slod_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_sloe_ft	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_sloe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_slow_ft	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_slow_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_slow_sf	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_stod_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_stow_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/EM1C_stow_st	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1/FO4B_slobe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_slcw_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_slcw_sf	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_slcw_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_slobe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_slod_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_sloe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_slow_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_slow_sf	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_stca_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_stcaw_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_stcaw_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_stcaw_su	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_stcw_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_stcw_st	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_stod_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_stow_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1B_stow_st	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_slcw_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_slcw_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_slobe_s	Slope Saturated Deciduous Shrub

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
u_SLOPE_PSS1C_slobw_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_slod_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_sloe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_slow_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_stcw_ft	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_stcw_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_stcw_sl	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_stow_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS1C_stow_su	Slope Saturated Deciduous Shrub
u_SLOPE_PSS3H_slobe_s	Slope Saturated Deciduous Shrub
u_SLOPE_PSS4/1B_sloe_s	Slope Saturated Deciduous Shrub
l_SLOPE_PEM1B_hgmb_st	Slope Saturated Graminoid-Shrub Meadow
l_SLOPE_PEM1C_hgmb_d	Slope Saturated Graminoid-Shrub Meadow
l_SLOPE_PEM1C_hgmb_sf	Slope Saturated Graminoid-Shrub Meadow
l_SLOPE_PEM1C_hgmbs_st	Slope Saturated Graminoid-Shrub Meadow
l_SLOPE_PSS1/EM1C_hgmb_sf	Slope Saturated Graminoid-Shrub Meadow
l_SLOPE_PSS1/EM1C_hgmb_st	Slope Saturated Graminoid-Shrub Meadow
l_SLOPE_PSS1/EM1C_hgmbs_st	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PEM1B_hgmb_st	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PEM1B_hgmbs_s	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PEM1B_hgmbs_sl	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PEM1C_hgmb_d	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PEM1C_hgmbs_d	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PSS1/EM1B_hgmbs_d	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PSS1/EM1B_hgmbs_s	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PSS1/EM1B_hgmbs_sl	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PSS1/EM1C_hgmbs_d	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PSS1/EM1C_hgmbs_ft	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PSS1/EM1C_hgmbs_s	Slope Saturated Graminoid-Shrub Meadow
u_SLOPE_PSS1C_hgmbs_d	Slope Saturated Graminoid-Shrub Meadow
l_SLOPE_PEM1/SS1B_sloeb_s	Slope Saturated Shrub Peatland
l_SLOPE_PEM1C_sloeb_sf	Slope Saturated Shrub Peatland
l_SLOPE_PEM1C_sloeb_st	Slope Saturated Shrub Peatland
l_SLOPE_PFO4/SS1B_sloeb_st	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/4B_sloeb_s	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/4B_sloeb_sf	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/4B_sloeb_st	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/EM1B_sloeb_fpa	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/EM1B_sloeb_s	Slope Saturated Shrub Peatland

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
l_SLOPE_PSS1/EM1B_sloeb_sf	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/EM1B_sloeb_st	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/EM1C_sloeb_d	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/EM1C_sloeb_fpa	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/EM1C_sloeb_sf	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/EM1C_sloeb_st	Slope Saturated Shrub Peatland
l_SLOPE_PSS1/FO4B_sloeb_sf	Slope Saturated Shrub Peatland
l_SLOPE_PSS1B_sloeb_st	Slope Saturated Shrub Peatland
l_SLOPE_PSS1C_sloeb_st	Slope Saturated Shrub Peatland
l_SLOPE_PSS4/1B_sloeb_fpa	Slope Saturated Shrub Peatland
l_SLOPE_PSS4/1B_sloeb_st	Slope Saturated Shrub Peatland
u_SLOPE_PSS1/EM1B_sloeb_st	Slope Saturated Shrub Peatland
u_SLOPE_PSS1/EM1C_sloeb_st	Slope Saturated Shrub Peatland
l_SLOPE_PFO4/SS1B_fnobs_d	Slope Saturated Spruce Forest
l_SLOPE_PFO4/SS1B_fnobs_s	Slope Saturated Spruce Forest
l_SLOPE_PFO4/SS1B_fnobs_sf	Slope Saturated Spruce Forest
l_SLOPE_PFO4/SS1B_fnobs_sl	Slope Saturated Spruce Forest
l_SLOPE_PFO4/SS1B_fnobs_st	Slope Saturated Spruce Forest
l_SLOPE_PFO4/SS1B_fnwbs_sf	Slope Saturated Spruce Forest
l_SLOPE_PFO4/SS1B_fnwbs_sl	Slope Saturated Spruce Forest
l_SLOPE_PFO4/SS1B_fnwbs_st	Slope Saturated Spruce Forest
l_SLOPE_PFO4/SS1C_fnobs_sf	Slope Saturated Spruce Forest
l_SLOPE_PSS1/4B_sfwbs_s	Slope Saturated Spruce Forest
l_SLOPE_PSS1/4B_sfwbs_sf	Slope Saturated Spruce Forest
l_SLOPE_PSS1/EM1B_fnobs_st	Slope Saturated Spruce Forest
l_SLOPE_PSS1/EM1B_fnwbs_sf	Slope Saturated Spruce Forest
l_SLOPE_PSS1/EM1B_fnwbs_st	Slope Saturated Spruce Forest
l_SLOPE_PSS1/EM1B_sfwbs_st	Slope Saturated Spruce Forest
l_SLOPE_PSS1/EM1C_fnwbs_sf	Slope Saturated Spruce Forest
l_SLOPE_PSS1/FO4B_fnwbs_s	Slope Saturated Spruce Forest
l_SLOPE_PSS1/FO4B_fnwbs_sf	Slope Saturated Spruce Forest
l_SLOPE_PSS1/FO4B_fnwbs_sl	Slope Saturated Spruce Forest
l_SLOPE_PSS1/FO4B_fnwbs_st	Slope Saturated Spruce Forest
l_SLOPE_PSS1B_fnobs_st	Slope Saturated Spruce Forest
l_SLOPE_PSS1B_fnwbs_sf	Slope Saturated Spruce Forest
l_SLOPE_PSS1B_fnwbs_st	Slope Saturated Spruce Forest
l_SLOPE_PSS1C_fnobs_st	Slope Saturated Spruce Forest
l_SLOPE_PSS3B_fnwbs_st	Slope Saturated Spruce Forest
l_SLOPE_PSS4/1B_fnwbs_d	Slope Saturated Spruce Forest

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
l_SLOPE_PSS4/1B_fnwbs_s	Slope Saturated Spruce Forest
l_SLOPE_PSS4/1B_fnwbs_sf	Slope Saturated Spruce Forest
l_SLOPE_PSS4/1B_fnwbs_sl	Slope Saturated Spruce Forest
l_SLOPE_PSS4/1B_fnwbs_st	Slope Saturated Spruce Forest
l_SLOPE_PSS4/1B_sfobs_s	Slope Saturated Spruce Forest
l_SLOPE_PSS4/1C_fnwbs_s	Slope Saturated Spruce Forest
l_SLOPE_PSS4/EM1B_fnwbs_sf	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnobs_d	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnobs_ft	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnobs_s	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnobs_sf	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnobs_sl	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnobs_st	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnobs_su	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnwbs_d	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnwbs_sf	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnwbs_sl	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1B_fnwts_s	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1C_fnobs_ft	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1C_fnobs_s	Slope Saturated Spruce Forest
u_SLOPE_PFO4/SS1C_fnwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PFO4B_fnobs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS1/4B_fnwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS1/4B_sfwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS1/4B_sfwbs_sl	Slope Saturated Spruce Forest
u_SLOPE_PSS1/4C_fnwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS1/4C_sfwbs_f	Slope Saturated Spruce Forest
u_SLOPE_PSS1/4C_sfwbs_ft	Slope Saturated Spruce Forest
u_SLOPE_PSS1/EM1B_fnobs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS1/EM1B_fnwbs_d	Slope Saturated Spruce Forest
u_SLOPE_PSS1/EM1B_fnwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS1/EM1B_fnwbs_sl	Slope Saturated Spruce Forest
u_SLOPE_PSS1/FO4B_fnwbs_	Slope Saturated Spruce Forest
u_SLOPE_PSS1/FO4B_fnwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS1/FO4B_fnwbs_sl	Slope Saturated Spruce Forest
u_SLOPE_PSS1/FO4C_fnwbs_ft	Slope Saturated Spruce Forest
u_SLOPE_PSS1/FO4C_fnwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS1B_fnwbs_s	Slope Saturated Spruce Forest

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
u_SLOPE_PSS1B_fnwbs_sl	Slope Saturated Spruce Forest
u_SLOPE_PSS1B_fnwts_s	Slope Saturated Spruce Forest
u_SLOPE_PSS1B_fnwts_su	Slope Saturated Spruce Forest
u_SLOPE_PSS1C_fnwts_s	Slope Saturated Spruce Forest
u_SLOPE_PSS4/1B_fnwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS4/1B_fnwbs_sl	Slope Saturated Spruce Forest
u_SLOPE_PSS4/1C_fnwbs_ft	Slope Saturated Spruce Forest
u_SLOPE_PSS4/1C_fnwbs_s	Slope Saturated Spruce Forest
u_SLOPE_PSS4/1C_fnwbs_sl	Slope Saturated Spruce Forest
u_SLOPE_PSS4B_fnwbs_s	Slope Saturated Spruce Forest
l_SLOPE_PFO4/SS1B_stow_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1/EM1B_slow_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1/EM1C_slow_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1/EM1C_stcss_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1/EM1C_stow_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1B_slcw_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1B_stcw_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1B_stow_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1C_slcw_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1C_slow_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1C_stcss_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1C_stcw_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1C_stow_d	Slope Wet Deciduous Shrub
l_SLOPE_PSS1H_slow_d	Slope Wet Deciduous Shrub
u_SLOPE_PEM1C_slcw_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1/4B_slow_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1/EM1B_slow_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1/EM1B_stcw_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1/EM1B_stow_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1/EM1C_slow_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1/EM1C_stcw_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1/EM1C_stow_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1B_slcw_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1B_slow_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1B_stcw_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1B_stod_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1B_stow_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1C_slcw_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1C_slobw_d	Slope Wet Deciduous Shrub

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
u_SLOPE_PSS1C_slow_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1C_stcaw_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1C_stcw_d	Slope Wet Deciduous Shrub
u_SLOPE_PSS1C_stow_d	Slope Wet Deciduous Shrub
l_SLOPE_PEM1/SS1B_hgwsl_s	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1/SS1C_hgwsl_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1B_hgwsl_s	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1B_hgwsl_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1C_hgwsb_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1C_hgwsl_d	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1C_hgwsl_sf	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1C_hgwsl_sl	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1C_hgwsl_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1C_hgwsmb_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1H_hgwsl_s	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1H_hgwsl_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PEM1H_hgwsmb_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PSS1/EM1B_hgwsl_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PSS1/EM1C_hgwsb_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PSS1/EM1C_hgwsl_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PSS1/EM1C_hgwsmb_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PSS1/EM1H_hgwsl_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PSS1B_hgwsb_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PSS1B_hgwsl_st	Slope Wet Sedge-Shrub Meadow
l_SLOPE_PSS1C_hgwsl_st	Slope Wet Sedge-Shrub Meadow
u_SLOPE_PEM1B_hgwsl_st	Slope Wet Sedge-Shrub Meadow
u_SLOPE_PEM1C_hgwsl_s	Slope Wet Sedge-Shrub Meadow
u_SLOPE_PEM1C_hgwsl_st	Slope Wet Sedge-Shrub Meadow
u_SLOPE_PSS1/EM1C_hgwsl_st	Slope Wet Sedge-Shrub Meadow
l_N/A_UPLAND_fnobs_sf	Upland
l_N/A_UPLAND_fnows_s	Upland
l_N/A_UPLAND_fnows_sf	Upland
l_N/A_UPLAND_fnwbs_sf	Upland
l_N/A_UPLAND_sfwbs_st	Upland
r_N/A_UPLAND_fmosb_f	Upland
r_N/A_UPLAND_fmwsb_f	Upland
r_N/A_UPLAND_fnows_f	Upland
r_N/A_UPLAND_fnows_s	Upland
r_N/A_UPLAND_fnwbs_f	Upland

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
r_N/A_UPLAND_stca_f	Upland
r_N/A_UPLAND_stca_sb	Upland
r_N/A_UPLAND_stow_f	Upland
r_N/A_UPLAND_stow_fb	Upland
u_N/A_UPLAND_fbcb_sb	Upland
u_N/A_UPLAND_fbcb_su	Upland
u_N/A_UPLAND_fboa_s	Upland
u_N/A_UPLAND_fbob_f	Upland
u_N/A_UPLAND_fbob_s	Upland
u_N/A_UPLAND_fbob_sb	Upland
u_N/A_UPLAND_fbwb_s	Upland
u_N/A_UPLAND_fmosb_ft	Upland
u_N/A_UPLAND_fmosb_s	Upland
u_N/A_UPLAND_fmosb_su	Upland
u_N/A_UPLAND_fmwsa_s	Upland
u_N/A_UPLAND_fmwsb_s	Upland
u_N/A_UPLAND_fmwsb_sb	Upland
u_N/A_UPLAND_fnobs_s	Upland
u_N/A_UPLAND_fnobs_sl	Upland
u_N/A_UPLAND_fnobs_su	Upland
u_N/A_UPLAND_fnows_ft	Upland
u_N/A_UPLAND_fnows_s	Upland
u_N/A_UPLAND_fnows_sb	Upland
u_N/A_UPLAND_fnows_sl	Upland
u_N/A_UPLAND_fnows_su	Upland
u_N/A_UPLAND_fnwbs_s	Upland
u_N/A_UPLAND_fnwbs_sl	Upland
u_N/A_UPLAND_fnwts_s	Upland
u_N/A_UPLAND_fnwws_s	Upland
u_N/A_UPLAND_fnwws_sh	Upland
u_N/A_UPLAND_fnwws_su	Upland
u_N/A_UPLAND_hgdgs_s	Upland
u_N/A_UPLAND_hgmb_s	Upland
u_N/A_UPLAND_slcbe_s	Upland
u_N/A_UPLAND_slcd_s	Upland
u_N/A_UPLAND_slcw_d	Upland
u_N/A_UPLAND_slcw_s	Upland
u_N/A_UPLAND_slcw_sl	Upland
u_N/A_UPLAND_slobe_s	Upland

Appendix C. Continued.

Concatenation: Physiography_HGM_NWI_ Vegetation_Macrotopography	Wetland or Riverine Functional Class
u_N/A_UPLAND_slod_s	Upland
u_N/A_UPLAND_sloe_s	Upland
u_N/A_UPLAND_slott_sl	Upland
u_N/A_UPLAND_slow_s	Upland
u_N/A_UPLAND_stca_sb	Upland
u_N/A_UPLAND_stca_su	Upland
u_N/A_UPLAND_stcw_s	Upland
u_N/A_UPLAND_stoa_s	Upland
u_N/A_UPLAND_stod_s	Upland
u_N/A_UPLAND_stow_d	Upland
u_N/A_UPLAND_stow_s	Upland

[1] No single physiographic type was designated for Flow Paths because they occur in several different physiographic areas.

Appendix D. Wetland functional assessment scoring sheets

Wetland Functional Class: Flow Paths
Analogous Ecotypes (Jorgenson et al. 2009): N/A
DOWL (2014) Field Plot ID: N/A
HGM Type: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Flow Paths within the footprint of the AMDIAR would be routed through a culvert, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	As Flow Paths frequently flow through shrubby communities, they are assumed to have woody vegetation.	0	0.5	Some localized changes in plant community composition are possible at road-vegetation interface. Plant community composition will likely shift to one dominated by graminoids over time due to impoundments, although overall cover and biomass may decrease (Auerbach et al. 1997, Myers-Smith et al. 2006).	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM Class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	The landscape position of Flow Paths precludes substantial surface water storage.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	0	While not in riverine channels, Flow Paths are ephemeral features where water flow is concentrated in shallow drainages.	0	0		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	1		0	0.5		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.13		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Flow Paths within the footprint of the AMDIAR would be routed through a culvert, eliminating the capacity for sediment, nutrient, and toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	As Flow Paths frequently flow through shrubby communities, they are assumed to have woody vegetation.	0	0.5	Numerous occurrences of this class near the road likely will shift from predominantly scrub to dominance by graminoids over time; overall cover and biomass may also decrease (Auerbach et al. 1997, Myers-Smith et al. 2006).	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	1	As Flow Paths are ephemeral drainages, they will have at least a moderage interspersion of vegetation and water during surface flow periods.	0	1	Flow Paths will retain vegetation/surface water interspersion beyond the road footprint. Potential for poor placement of culverts due to difficulty in determining exact location of flow paths (channels are small and may be obscured by vegetation); thus, water may impound on upslope side of road during spring flooding in some areas.	A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	N/A	No data are available.	N/A	N/A	Cannot assess potential change from existing conditions for which there were no data	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	N/A	No data are available.	N/A	N/A	Cannot assess potential change from existing conditions for which there were no data	Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.67		0.00	0.50		

Wetland Functional Class: Flow Paths
Analogous Ecotypes (Jorgenson et al. 2009): N/A
DOWL (2014) Field Plot ID: N/A
HGM Type: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Flow Paths within the footprint of the AMDIAR would be routed through a culvert, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	As Flow Paths frequently flow through shrubby communities, they are assumed to have woody vegetation.	0	0.5	Some localized changes in plant community composition are possible at road-vegetation interface. Plant community composition will likely shift to one dominated by graminoids over time due to impoundments, although overall cover and biomass may decrease (Auerbach et al. 1997, Myers-Smith et al. 2006).	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	N/A	No data are available.	N/A	N/A		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A	Flow Paths do not have shoreline features visible on aerial photography	N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	1		0	0.5		
Max Possible Indicators:	1		1	1		
Score (indicator sum/max possible indicators):	1.00		0.00	0.50		
4. Organic Matter Production and Export					*Direct effects: any Flow Paths within the footprint of the AMDIAR would be routed through a culvert, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	No data, but aerial imagery suggests Flow Paths are well vegetated drainages.	0	0.5	Numerous occurrences of this class near the road likely will shift from predominantly scrub to dominance by (more productive) graminoids over time, although cover and biomass may also decrease (Auerbach et al. 1997, Myers-Smith et al. 2006).	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	Flow Paths are ephemeral drainages.	0	1	Flow paths will remain seasonally flooded. Potential for poor placement of culverts due to difficulty in determining exact location of flow path (channels are small and may be obscured by vegetation); thus, water may impound on upslope side of road during spring flooding in some areas.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Flow Paths are ephemeral drainages, likely to convey water in response to precipitation events during the growing season.	0	0.5	If drainages are blocked by poor culvert placement and/or plugged culverts, surface water outflow has the potential to be reduced.	A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	3		0	2		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	0.67		

Wetland Functional Class: Flow Paths

Analogous Ecotypes (Jorgenson et al. 2009): N/A

DOWL (2014) Field Plot ID: N/A

HGM Type: Slope

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Predicted Post-development Condition Indirect Effects Score	Predicted Post-development Condition Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime					*Direct effects: any Flow Paths within the footprint of the AMDIAR would be routed through a culvert, eliminating the capacity for maintenance of soil thermal regime.*	*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	1	Flow Paths are ephemeral drainages that do not aggrade through the organic mat (Swanson 1995), thus vegetation cover is assumed to be continuous.	0	0.5	Potential for poor placement of culverts due to difficulty in determining exact locations of flow path (channels are small and may be obscured by vegetation); thus water may imound on upslope side of road during spring flooding and concentrated flow at downslope culvert outlets may aggrade through organic mat.	Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	1	Ephemeral drainages are not permanently flooded.	0	0.5	If some drainages are blocked by poor culvert placement and/or plugging by ice, areas where flow path channels are close together could coalesce at the road, creating additional impoundments.	Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	1	Slope HGM class.	0	1		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	1	Flow Paths are ephemeral drainages that do not aggrade through the organic mat (Swanson 1995), thus organic soils are assumed.	0	0.5	There is potential for culverts to concentrate flow, which may then aggrade through the organic mat downstream of crossings.	A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	0		0	0		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	4		0	2.5		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.80		0.00	0.50		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Flow Paths

Analogous Ecotypes (Jorgenson et al. 2009): N/A

DOWL (2014) Field Plot ID: N/A

HGM Type: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Flow Paths within the footprint of the AMDIAR would be routed through a culvert, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.00	Small, ephemeral Flow Paths are not anticipated to provide substantial wildlife habitat on their own.	0.00	0.00		If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.00	Small, ephemeral Flow Paths are not anticipated to provide substantial wildlife habitat on their own.	0.00	0.00		If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	0	As Flow Paths likely have only ephemeral surface water flow, any interspersion of vegetation and water will be temporary, not providing a consistent habitat feature.	0	0		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	1	As Flow Paths frequently flow through shrubby communities, they are assumed to have at least two well-vegetated strata.	0	1		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.30		
8. Fish Habitat Suitability		*Ephemeral Flow Paths do not provide fish habitat.*				*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	N/A		N/A	N/A		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	N/A		N/A	N/A		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	N/A		N/A	N/A		Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	N/A		N/A	N/A		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Flow Paths
Analogous Ecotypes (Jorgenson et al. 2009): N/A
DOWL (2014) Field Plot ID: N/A
HGM Type: Slope

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Flow Paths within the footprint of the AMDIAR would be routed through a culvert, eliminating the capacity to provide rare plant habitat and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Parker (2009) does not list rare plants in the GAAR habitats likely found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Ephemeral drainages are assumed not to support a high diversity of plant species.	0	0		If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
10. Subsistence Use					*Direct effects: any Flow Paths within the footprint of the AMDIAR would be routed through a culvert, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Berry-yielding species are assumed to provide <25% cover in this functional class.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	0	Small, ephemeral Flow Paths are not anticipated to provide substantial wildlife habitat on their own.	0	0		Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		

Wetland Functional Class: Flow Paths

Analogous Ecotypes (Jorgenson et al. 2009): N/A

DOWL (2014) Field Plot ID: N/A

HGM Type: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*The active layer is likely to be shallow in Flow Paths, as near-surface permafrost is believed to keep water in the organic mat and on the ground surface. Accordingly, groundwater discharge is unlikely to occur.*				*In lieu of direct measurements of groundwater discharge (e.g., long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands lacking shallow permafrost.*
1. Wetland in toeslope position.	N/A		N/A	N/A		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	N/A		N/A	N/A		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	N/A		N/A	N/A		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	N/A		N/A	N/A		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	N/A		N/A	N/A		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
12. Groundwater Recharge		*The active layer is likely to be shallow in Flow Paths, as near-surface permafrost is believed to keep water in the organic mat and on the ground surface. Accordingly, groundwater recharge is unlikely to occur.*				*In lieu of direct measurements of groundwater recharge (e.g., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands lacking shallow permafrost.*
1. Depressional HGM class with no outlet.	N/A		N/A	N/A		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	N/A		N/A	N/A		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	N/A		N/A	N/A		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Lakes and Ponds
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Lake, Riverine Lake
DOWL (2014) Field Plot ID: T107-557
HGM: Depressional, Slope, Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Lakes and Ponds within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	N/A		N/A	N/A		Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Lakes and Ponds are a mix of small, shallow waters in wet sedge meadows (HGM Slope) and more well-defined, deeper waters (HGM Depressional), with scattered waters that are dominated by overbank flooding (HGM Riverine). All of these features, regardless of HGM class, are capable of surface water storage.	0	1		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	DOWL (2014) field data do not note indications of variable water levels.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). The vast majority of Lakes and Ponds are HGM Depressional and Slope and receive floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	0	The margins of two lakes (Nutuvukti Lake and an unnamed lake, L1UBH, >20 acres) occur at the edge of the northern road alignment corridor. The remaining 100+ features within the study area are ponds (PUBH, <20 acres).	0	0		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.50		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Lakes and Ponds within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Lakes and Ponds are a mix of small, shallow waters in wet sedge meadows (HGM Slope) and more well-defined, deeper waters (HGM Depressional), with scattered waters that are dominated by overbank flooding (HGM Riverine). All of these features, regardless of HGM class, are capable of surface water storage.	0	1		Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	N/A		N/A	N/A		Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	N/A		N/A	N/A		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	1	No substrate data collected by DOWL (2014). The crosswalked ecotype, Riverine Lakes, will be influenced by depositional processes (Jorgenson et al. 2009).	0	1	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	N/A		N/A			Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	2		2	2		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		

Wetland Functional Class: Lakes and Ponds
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Lake, Riverine Lake
DOWL (2014) Field Plot ID: T107-557
HGM: Depressional, Slope, Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization		*This function is not applicable to Lakes and Ponds, which are not a wetland directly abutting a relatively permanent channelized water.*				*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	N/A		N/A	N/A		Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	N/A		N/A	N/A		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A		N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
4. Organic Matter Production and Export					*Direct effects: any Lakes and Ponds within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	0	Mean herbaceous cover in the crosswalked ecotypes, Lowland Lakes and Riverine Lakes, is 7% and 25%, respectively (Jorgenson et al. 2009). DOWL data at T107-557 shows a well-vegetated pond (Riverine HGM) with well over 10% herbaceous cover; no additional data were collected for PUBH or L1UBH features within GAAR or outside the park and preserve boundaries. The majority of Lakes and Ponds within the study area appear to be analogous to Lowland Lakes (Jorgenson et al. 2009) and hence they are assumed to have <10% mean herbaceous cover.	0	0		As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	N/A		N/A	N/A		Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	While Depressional Lakes and Ponds at the western end of the road alignment have no outlets, the vast majority of lakes and ponds within the study area have either perennial (Large or Small Streams) or ephemeral (Flow Paths) outlets.	0	1		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	2		2	2		
Score (indicator sum/max possible indicators):	0.50		0.00	0.50		

Wetland Functional Class: Lakes and Ponds
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Lake, Riverine Lake
DOWL (2014) Field Plot ID: T107-557
HGM: Depressional, Slope, Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime					*Direct effects: any Lakes and Ponds within the footprint of the AMDIAR would be filled, eliminating the capacity for maintenance of soil thermal regime.*	*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	0	Lakes and Ponds have herbaceous vegetation, but cover is not continuous.	0	0		Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	0	Lakes and Ponds are permanently flooded.	0	0		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	1	The majority of Lakes and Ponds are HGM Depressional or HGM Slope.	0	1		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	0	Soils data are not available for Lake and Ponds, but thick organic mats are unlikely.	0	0		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	0		N/A	0		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	5		4	5		
Score (indicator sum/max possible indicators):	0.20		0.00	0.20		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Lakes and Ponds

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Lake, Riverine Lake

DOWL (2014) Field Plot ID: T107-557

HGM: Depressional, Slope, Riverine

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Predicted Post-development Condition Indirect Effects Score	Predicted Post-development Condition Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Lakes and Ponds within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.07	This class crosswalks to the Lakes and Ponds habitat mapped in this this study, which is expected to support 2 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.0	0.07	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.31	This class crosswalks to the Lakes and Ponds habitat mapped in this this study, which is expected to support 28 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.0	0.31	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	1	Mean herbaceous cover of the crosswalked ecotypes, Lowland Lakes and Riverine Lakes, is 7% and 25%, respectively (Jorgenson et al. 2009). DOWL data at T107-557 shows a well-vegetated pond (Riverine HGM) with well over 10% herbaceous cover; no additional data were collected for PUBH or L1UBH features within GAAR or outside the park and preserve boundaries.	0	1		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	N/A		N/A	N/A		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2.39		0.00	1.89		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.60		0.00	0.47		
8. Fish Habitat Suitability					*Direct effects: any Lakes and Ponds within the footprint of the AMDIAR would be filled, eliminating the capacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	1	Many Lakes and Ponds within the study area are connected to Small Streams, which ultimately connect to the fish-bearing Kobuk River.	0	1		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	With the exception of two small portions of large lakes in the study area, ponds appear to be relatively shallow and likely freeze fast during the winter.	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Mean herbaceous cover of the crosswalked ecotypes, Lowland Lakes and Riverine Lakes, is 7% and 25%, respectively (Jorgenson et al. 2009). DOWL data at T107-557 shows a well-vegetated pond (Riverine HGM) with well over 10% herbaceous cover; no additional data were collected for PUBH or L1UBH features within GAAR or outside park and preserve boundaries.	0	1		Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	The majority of Lakes and Ponds within the study area appear to be relatively shallow with sparse vegetation and are not assumed to provide spawning habitat.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.50		

Wetland Functional Class: Lakes and Ponds
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Lake, Riverine Lake
DOWL (2014) Field Plot ID: T107-557
HGM: Depressional, Slope, Riverine

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Predicted Post-development Condition Indirect Effects Score	Predicted Post-development Condition Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Lakes and Ponds within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Jorgenson et al. (2009) did not record any S1-S3 or G1-G3 plants in the ecotypes crosswalked to this functional class. Parker (2009) does not list any rare plants in the GAAR habitats likely to be found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of plant species per individual plot for the crosswalked ecotype is not within the 4th quartile of all the ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0		If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
10. Subsistence Use					*Direct effects: any Lakes and Ponds within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	No berry-yielding species were documented in this functional class by either DOWL (2014) or Jorgenson et al. (2009).	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Lakes and Ponds habitat mapped in this study, which is expected to be used regularly by ducks, geese, and moose in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Lakes and Ponds
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Lake, Riverine Lake
DOWL (2014) Field Plot ID: T107-557
HGM: Depressional, Slope, Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*The vast majority of Lakes and Ponds in the study area are located in areas where the active layer is likely to be shallow, so this function is not applicable. Exceptions to this are the two larger lakes at the edge of the study area (L1UBH), which are outside of the direct and indirect effects footprints.*				*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	N/A		N/A	N/A		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	N/A		N/A	N/A		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	N/A		N/A	N/A		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	N/A		N/A	N/A		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	N/A		N/A	N/A		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
12. Groundwater Recharge		*The vast majority of Lakes and Ponds in the study area are located in areas where the active layer is likely to be shallow, so this function is not applicable. Exceptions to this are the two larger lakes at the edge of the study area (L1UBH), which are outside of the direct and indirect effects footprints.*				*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	N/A		N/A	N/A		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	N/A		N/A	N/A		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	N/A		N/A	N/A		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Lacustrine Fringe Wet Sedge Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow

DOWL (2014) Field Plot ID: 181

HGM: Lacustrine Fringe

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Lacustrine Fringe Wet Sedge Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	Although the single DOWL (2014) field plot references a tussock-forming sedge (*Eriophorum vaginatum* , the site photos show no tussocks. The crosswalked Lacustrine Wet Sedge Meadow ecotype does not have features that provide surface roughness (Jorgenson et al. 2009).	0	0	Level of sediment deposition in this class is not likely to be sufficient to change the existing plant community. Potential for some decrease in moss cover over time from dust fallout, although that affect may be ameliorated with annual spring flooding (flushing) that likely occurs. Impoundments are unlikely to be common in this class, which does not occur frequently near the road.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	HGM class is Lacustrine Fringe. These sedge-moss meadows include floating mats, and are not believed to have much storage capacity. Storage capacity of adjacent lakes and ponds is assessed in the Lakes and Ponds functional class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	DOWL (2014) data makes no reference to signs of variable water levels.	0	0	Most occurrences are sufficiently far enough away from the road to not be affected by hydrologic changes.	Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A			Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Lacustrine Fringe Wet Sedge Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	HGM class is Lacustrine Fringe. These sedge-moss meadows include floating mats, and are not believed to have much storage capacity. Storage capacity of adjacent lakes and ponds is assessed in the Lakes and Ponds functional class.	0	0		Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	Although the single DOWL (2014) field plot references a tussock-forming sedge (*Eriophorum vaginatum* , the site photos show no tussocks. The crosswalked Lacustrine Wet Sedge Meadow ecotype does not have features that provide surface roughness (Jorgenson et al. 2009).	0	0	Level of sediment deposition in this class is not likely to be sufficient to change the existing plant community. Potential for some decrease in moss cover over time from dust fallout, although that affect may be ameliorated with annual spring flooding (flushing) that likely occurs. Impoundments are unlikely to be common in this class, which does not occur frequently near the road.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	1	Jorgenson et al. (2009) documents mean water cover of 10.1% in the crosswalked ecotype.	0	1	Most occurrences are sufficiently far enough away from the road to not be affected by hydrologic changes.	A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0	No reference to sediment deposits in either the DOWL (2014) or Jorgenson et al. (2009) data.	0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	1	DOWL (2014) documents a histic epipedon. Jorgenson et al. (2009) records a mean depth of nearly 12 inches for surface organics in the crosswalked ecotype.	0	1	Modest risk of change in soil characteristics for one occurrence that is near the road. A slight increase in soil pH from dust deposition is possible, although the likely seasonal flooding (flushing) of these areas may ameliorate this effect. The majority of this functional class is more than 50 m from the road so that dust accumulation unlikely to substantively change soil characteristics in a large number of occurrences of this class.	Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.40		

Wetland Functional Class: Lacustrine Fringe Wet Sedge Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow
DOWL (2014) Field Plot ID: 181
HGM: Lacustrine Fringe

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization		*This function is not applicable as this functional class is not directly abutting a relatively permanent channelized water.*				*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	N/A		N/A	N/A		Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	N/A		N/A	N/A		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A		N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
4. Organic Matter Production and Export					*Direct effects: any Lacustrine Fringe Wet Sedge Meadow occcurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Both DOWL (2014) and Jorgenson et al. (2009) document over 30% cover herbaceous vegetation. Woody plants are predominantly deciduous (Jorgenson et al. 2009).	0	1	Level of sediment deposition in this class is not likely to be sufficient to change the existing plant community. Potential for some decrease in moss cover over time from dust fallout, although that affect may be ameliorated with annual spring flooding (flushing) that likely occurs. Impoundments are unlikely to be common in this class, which does not occur frequently near the road.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	Jorgenson et al. (2009) document mean surface water cover of 10.1%, with a water table typically slightly above or below the ground surface.	0	1	Most occurrences are sufficiently far enough away from the road to not be affected by hydrologic changes.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	The water table in the crosswalked ecotype is typically slightly above or below the ground surface (Jorgenson et al. 2009), which effectively connects this functional class to Lakes and Ponds outside of spring flooding. The waterbodies adjacent to this functional class extend outside of the study area, but imagery review shows that most appear to have at least an ephemeral outlet.	0	1		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		

Wetland Functional Class: Lacustrine Fringe Wet Sedge Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow

DOWL (2014) Field Plot ID: 181

HGM: Lacustrine Fringe

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Predicted Post-development Condition Indirect Effects Score	Predicted Post-development Condition Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime					*Direct effects: any Lacustrine Fringe Wet Sedge Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for maintenance of soil thermal regime.*	*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	1	Vegetation cover, including nonvascular species, is nearly continuous at the single DOWL (2014) field plot in this class. In the crosswalked ecotype, Jorgenson et al. (2009) document a mean total live cover of 87%, of which 60% is vascular.	0	1	Level of sediment deposition in this class is not likely to be sufficient to change the existing plant community. Potential for some decrease in moss cover over time from dust fallout, although that affect may be ameliorated with annual spring flooding (flushing) that likely occurs. Impoundments are unlikely to be common in this class, which does not occur frequently near the road.	Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	0	Lacustrine Fringe Wet Sedge Meadow has a continually saturated water regime, with the water table slightly above or below the ground surface. While significant surface water is not documented by either Jorgenson et al. (2009) or DOWL (2014), there are likely extended periods where the water table is above ground surface.	0	0		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	0	This functional class is HGM Lacustrine Fringe.	0	0		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	1	DOWL (2014) documents a histic epipedon. Jorgenson et al. (2009) records a mean depth of nearly 12 inches for surface organics in the crosswalked ecotype.	0	1	Level of sediment deposition in this class is not likely to be sufficient to substantively change soil characteristics.	A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	0		N/A	0		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	5		4	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.40		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Lacustrine Fringe Wet Sedge Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow

DOWL (2014) Field Plot ID: 181

HGM: Lacustrine Fringe

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Lacustrine Fringe Wet Sedge Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.18	This class crosswalks to the Lacustrine Sedge Meadow habitat mapped in this this study, which is expected to support 5 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.18	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.29	This class crosswalks to the Lacustrine Sedge Meadow habitat mapped in this this study, which is expected to support 26 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.29	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	1	DOWL (2014) references the presence of surface water. Jorgenson et al. (2009) state that water is commonly visible in the crosswalked ecotype and they document a mean cover of 10.1% for surface water.	0	1		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	0	Scattered shrubs occur in this class, but comprise less than 30% total cover.	0	0		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2.47		0.00	1.97		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.49		0.00	0.39		
8. Fish Habitat Suitability					*Direct effects: any Lacustrine Fringe Wet Sedge Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Shallow surface water noted by Jorgenson et al. (2009) in the crosswalked ecotype is insufficient to support fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Shallow surface water noted by Jorgenson et al. (2009) in the crosswalked ecotype likely freezes fast in winter.	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Both DOWL (2014) and Jorgenson et al. (2009) document over 30% cover of herbaceous vegetation.	0	1	Level of sediment deposition in this class is not likely to be sufficient to change the existing plant community. Potential for some decrease in moss cover over time from dust fallout, although that affect may be ameliorated with annual spring flooding (flushing) that likely occurs. Impoundments are unlikely to be common in this class, which does not occur frequently near the road.	Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Shallow surface water noted by Jorgenson et al. (2009) in the crosswalked ecotype is insufficient for spawning.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Lacustrine Fringe Wet Sedge Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow
DOWL (2014) Field Plot ID: 181
HGM: Lacustrine Fringe

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Lacustrine Fringe Wet Sedge Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	1	Jorgenson et al. (2009) observed *Carex lapponica* in the ecotype crosswalked to this functional class. Rare plants noted by Parker (2009) within the GAAR habitats that could occur in this functional class include *Carex heleonastes, C. lapponica,* and *Eriophorum viridicarinatum.*	0	0.5	Potential for some increase in pH for occurrences next to the road, but seasonal flushing may ameliorate this effect. *Carex heleonastes* and *Eriophorum viridicarinatum* are typically associated with more acidic soils, so an increase in soil pH may decrease the rare plant habitat for this functional class.	If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of plant species per individual plot for the crosswalked ecotype is not within the 4th quartile of all the ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0	Risk of colonization by invasive species is negligible for most occurrences of this type, which are at some distance from the road and because of the wet habitat (many invasives more adapted to mesic to dry habitats).	If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	1		0	0.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.17		
10. Subsistence Use					*Direct effects: any Lacustrine Fringe Wet Sedge Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	No berry-yielding species were documented in this functional class by either DOWL (2014) or Jorgenson et al. (2009).	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Lacustrine Sedge Meadow habitat mapped in this study, which is expected to be used regularly by ducks, geese, and moose in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Lacustrine Fringe Wet Sedge Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow

DOWL (2014) Field Plot ID: 181

HGM: Lacustrine Fringe

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*The majority of Lacustrine Fringe Wet Sedge Meadow occurrences in the study area are located in areas where the active layer is likely to be shallow, so this function is not applicable. Exceptions to this are a small lacustrine fringe around Nutuvukti Lake, and a small lacustrine fringe associated with a pond in what appear to be coarse morainal deposits north of Nutuvukti Lake.*				*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	N/A		N/A	N/A		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	N/A		N/A	N/A		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	N/A		N/A	N/A		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	N/A		N/A	N/A		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	N/A		N/A	N/A		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
12. Groundwater Recharge		*The majority of Lacustrine Fringe Wet Sedge Meadow occurrences in the study area are located in areas where the active layer is likely to be shallow, so this function is not applicable. Exceptions to this are a small lacustrine fringe around Nutuvukti Lake, and a small lacustrine fringe associated with a pond in what appear to be coarse morainal deposits north of Nutuvukti Lake.*				*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	N/A		N/A	N/A		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	N/A		N/A	N/A		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	N/A		N/A	N/A		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Depressional Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow
DOWL (2014) Field Plot ID: T104-526
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Depressional Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	DOWL (2014) data forms and photos provide no reference to features that would provide surface roughness. The Lacustrine Wet Sedge Meadow ecotype (crosswalked to this functional class) does not have features that provide surface roughness (Jorgenson et al. 2009).	0	0	One occurrence of this class is next to the road so there is potential for a shift to a more deciduous shrub-dominated community over time if the site were to become drier (from dust fallout) Since these areas are seasonally flooded, however, this will help flush sediment into the adjacent waterbody. The occurrence of this class next to the road has an ephemeral outlet that doesn't cross the road, thus there is a low potential for impoundments.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Depressional HGM class.	0	1		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	DOWL (2014) data makes no reference to signs of variable water levels.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A					Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.50		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Depressional Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Depressional HGM class.	0	1		Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	DOWL (2014) datas forms and photos provide no reference to features that would provide surface roughness. The Lacustrine Wet Sedge Meadow ecotype (crosswalked to this functional class) does not have features that provide surface roughness (Jorgenson et al. 2009).	0	0	One occurrence of this class is next to the road so there is potential for a shift to a more deciduous shrub-dominated community over time if the site were to become drier (from dust fallout) Since these areas are seasonally flooded, however, this will help flush sediment into the adjacent waterbody. The occurrence of this class next to the road has an ephemeral outlet that doesn't cross the road, thus there is a low potential for impoundments.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	1	Jorgenson et al. (2009) documents mean water cover of 10.1% in the crosswalked ecotype.	0	1		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0	No reference to sediment deposits in either DOWL (2014) or Jorgenson et al. (2009) data.	0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	1	No soil pit data in the DOWL (2014) field plot for this class. Jorgenson et al. (2009) records a mean depth of nearly 12 inches for surface organics in the crosswalked ecotype.	0	1	Dust fallout not likely to be substantive enough to change physical soil characteristics.	Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.60		0.00	0.60		

Wetland Functional Class: Depressional Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow
DOWL (2014) Field Plot ID: T104-526
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization		*This function is not applicable as this functional class is not directly abutting a relatively permanent channelized water.*				*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	N/A		N/A	N/A		Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	N/A		N/A	N/A		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A		N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
4. Organic Matter Production and Export					*Direct effects: any Depressional Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Both DOWL (2014) and Jorgenson et al. (2009; in the crosswalked ecotype) document over 30% cover herbaceous vegetation. Woody plants are predominantly deciduous (Jorgenson et al. 2009).	0	1	One occurrence of this class is next to the road so there is potential for a shift to a more deciduous shrub-dominated community over time if the site were to become drier (from dust fallout) Since these areas are seasonally flooded, however, this will help flush sediment into the adjacent waterbody. The occurrence of this class next to the road has an ephemeral outlet that doesn't cross the road, thus there is a low potential for impoundments.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	Jorgenson et al. (2009) documents mean water cover of 10.1% in the crosswalked ecotype, with a water table typically slightly above or below the ground surface.	0	1		Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	All but one occurrence of Depressional Wet Sedge-Shrub Meadow has an ephemeral outlet.	0	1		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		

Wetland Functional Class: Depressional Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow
DOWL (2014) Field Plot ID: T104-526
HGM: Depressional

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime		*Depressional Wet Sedge-Shrub Meadow is located in areas that appear to be underlain by coarse, well-drained morainal deposits and where the active layer is likely to be deep or nonexistent. Maintenance of Soil Thermal Regime is not applicable to wetlands that have a deep active layer or lack permafrost.*				*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	N/A		N/A	N/A		Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	N/A		N/A	N/A		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	N/A		N/A	N/A		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	N/A		N/A	N/A		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	N/A		N/A	N/A		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Depressional Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow
DOWL (2014) Field Plot ID: T104-526
HGM: Depressional

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
7. Bird and Mammal Habitat Suitability					*Direct effects: any Depressional Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.18	This class crosswalks to the Lacustrine Sedge Meadow habitat mapped in this this study, which is expected to support 5 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.18	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.29	This class crosswalks to the Lacustrine Sedge Meadow habitat mapped in this this study, which is expected to support 26 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.29	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	1	DOWL (2014) references the presence of surface water. Jorgenson et al. (2009) states that water is commonly visible in the crosswalked ecotype and documents a mean water cover of 10.1%.	0	1		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	0	Scattered shrubs occur in this class but they comprise less than 30% total cover.	0	0		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2.47		0.00	1.97		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.49		0.00	0.39		
8. Fish Habitat Suitability		*This function is not applicable to Depressional Wet Sedge-Shrub Meadow, as there are only ephemeral connections to fish-bearing waters.*				*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	N/A		N/A	N/A		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	N/A		N/A	N/A		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	N/A		N/A	N/A		Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	N/A		N/A	N/A		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Depressional Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow
DOWL (2014) Field Plot ID: T104-526
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Depressional Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	1	Jorgenson et al. (2009) observed *Carex lapponica* in the ecotype crosswalked to this functional class. Rare plants noted by Parker (2009) within GAAR whose habitat could include this functional class include *Carex heleonastes, C. lapponica,* and *Eriophorum viridicarinatum.*	0	0.5	Potential for some pH increase in the occurrence of this class next to the road, but seasonal flushing may ameliorate this effect. *Carex heleonastes* and *Eriophorum viridicarinatum* are typically associated with more acidic soils, so an increase in soil pH may decrease the rare plant habitat for this functional class.	If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of plant species per individual plot for the crosswalked ecotype is not within the 4th quartile of all the ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0	Limited risk for colonization by invasive species, as habitat is not suitable for the invasive species that would have the potential to establish along the road (i.e., soils are wet and organic-rich, not well-drained and gravelly).	If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	1		0	0.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.17		
10. Subsistence Use					*Direct effects: any Depressional Wet Sedge-Shrub Meadow occurrences within the footprint of AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	No berry-yielding species documented in this functional class by either DOWL (2014) or Jorgenson et al. (2009).	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class cosswalks to the Lacustrine Sedge Meadow habitat mapped in this study, which is expected to be used regularly by ducks, geese, and moose in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Depressional Wet Sedge-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Wet Sedge Meadow

DOWL (2014) Field Plot ID: T104-526

HGM: Depressional

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
11. Groundwater Discharge		*Depressional Wet Sedge-Shrub Meadow is located in areas where the active layer is likely to be deep or nonexistent, in what appear to be coarse, well-drained morainal deposits.*			*Direct effects: any Depressional Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater discharge.*	*In lieu of direct measurements of groundwater discharge (e.g., long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands lacking shallow permafrost.*
1. Wetland in toeslope position.	0	This class is predominantly kettle wetlands, occurring in depressions in coarse morrainal deposits.	0	0		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	0	Depressional HGM class.	0	0		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	0	Saturated to seasonally flooded water regime.	0	0		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	0	No indication of seeps or springs in DOWL field data.	0	0		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	0	Majority of the occurrences of this class have neither inlets nor outlets.	0	0		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
12. Groundwater Recharge		*Depressional Wet Sedge-Shrub Meadow is located in areas where the active layer is likely to be deep or nonexistent, in what appear to be coarse, well-drained morainal deposits.*			*Direct effects: any Depressional Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater discharge.*	*In lieu of direct measurements of groundwater recharge (e.g., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands lacking shallow permafrost.*
1. Depressional HGM class with no outlet.	1	Depressional HGM class.	0	1		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	0		0	0		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	0	Majority of the occurrences of this class have neither inlets nor outlets.	0	0		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Depressional Saturated Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Bluejoint Meadow
DOWL (2014) Field Plot ID: 179
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Depressional Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	DOWL (2014) datas forms and photos provide no reference to features that would provide surface roughness. The Lacustrine Bluejoint Meadow ecotype (crosswalked to this functional class) does not have features that provide surface roughness (Jorgenson et al. 2009).	0	0	Overall cover and biomass may decrease in the numerous occurrences of this class near the road due to dust effects, but surface roughness is likely not to change as these areas are expected to remain graminoid-dominated (Auerbach et al. 1997, Myers-Smith et al. 2006). Localized impoundments likely, few instances where these habitats intersect the road edge and they do not appear to be associated with drainage features.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Depressional HGM class.	0	1		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	1	DOWL (2014) data document an algal mat.	0	1		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.75		0.00	0.75		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Depressional Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Depressional HGM class.	0	1		Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	DOWL (2014) data forms and photos provide no reference to features that would provide surface roughness. The Lacustrine Bluejoint Meadow ecotype (crosswalked to this functional class) does not have features that provide surface roughness (Jorgenson et al. 2009).	0	0	Overall cover and biomass may decrease in the numerous occurrences of this class near the road due to dust effects, but surface roughness is likely not to change as these areas are expected to remain graminoid-dominated (Auerbach et al. 1997, Myers-Smith et al. 2006). Localized impoundments likely, few instances where these habitats intersect the road edge and they do not appear to be associated with drainage features.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	1	No surface water was observed by DOWL (2014), but the mean surface water cover (7.5 +/- 21.2%) documented by Jorgenson et al. (2009) in the crosswalked ecotype and dried algal mats observed by DOWL indicate that a substantial cover of surface water is seasonally present.	0	1		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0		0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	0	Neither DOWL (2014) nor Jorgenson et al. (2009) document thick surface organics.	0	0		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.40		

Wetland Functional Class: Depressional Saturated Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Bluejoint Meadow
DOWL (2014) Field Plot ID: 179
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization		*This function is not applicable as this functional class is not directly abutting a relatively permanent channelized water.*				*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	N/A		N/A	N/A		Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	N/A		N/A	N/A		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A		N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
4. Organic Matter Production and Export					*Direct effects: any Depressional Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Both DOWL (2014) and Jorgenson et al. (2009) document well over 30% cover herbaceous vegetation.	0	1	Numerous occurrences near road (within first 50 m), overall cover and biomass may decrease (Auerbach et al. 1997, Myers-Smith et al. 2006), substantial shift in community composition is not anticipated.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	No surface water was observed by DOWL (2014), but the mean surface water cover (7.5 +/- 21.2%) documented by Jorgenson et al. (2009) in the crosswalked ecotype and dried algal mats observed by DOWL indicate that a substantial cover of surface water is seasonally present.	0	1		Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	0	The vast majority of these features do not have an outlet.	0	0		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.67		0.00	0.67		

Wetland Functional Class: Depressional Saturated Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Bluejoint Meadow
DOWL (2014) Field Plot ID: 179
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime		*Depressional Saturated Graminoid-Shrub Meadow is located in areas that appear to be underlain by coarse, well-drained morainal deposits and where the active layer is likely to be deep or nonexistent. Maintenance of Soil Thermal Regime is not applicable to wetlands that have a deep active layer or lack permafrost.*				*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	N/A		N/A	N/A		Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	N/A		N/A	N/A		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	N/A		N/A	N/A		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	N/A		N/A	N/A		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	N/A		N/A	N/A		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Depressional Saturated Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Bluejoint Meadow
DOWL (2014) Field Plot ID: 179
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Depressional Saturated Graminoid-Shrub Meadow occurrences within the footprint of AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.11	This class crosswalks to the Upland and Lowland Grass-Shrub Meadow habitat mapped in this this study, which is expected to support 3 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.11	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.10	This class crosswalks to the Upland and Lowland Grass-Shrub Meadow habitat mapped in this this study, which is expected to support 9 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.10	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	1	No surface water was observed by DOWL (2014), but the mean surface water cover (7.5 +/- 21.2%) documented by Jorgenson et al. (2009) in crosswalked ecotype and dried algal mats observed by DOWL indicate that a substantial cover of surface water is seasonally present (likely during the bird breeding season).	0	1		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	0	Scattered shrubs occur in this class but they comprise less than 30% total cover.	0	0		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2.21		0.00	1.71		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.44		0.00	0.34		
8. Fish Habitat Suitability		*This function is not applicable to Depressional Saturated Graminoid-Shrub Meadow, as there are no connections to fish-bearing waters.*				*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	N/A		N/A	N/A		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	N/A		N/A	N/A		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	N/A		N/A	N/A		Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	N/A		N/A	N/A		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Depressional Saturated Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Bluejoint Meadow
DOWL (2014) Field Plot ID: 179
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Depressional Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Jorgenson et al. (2009) did not record any S1-S3 or G1-G3 plants in the ecotype crosswalked to this functional class. Parker (2009) does not list rare plants in the GAAR habitats likely found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of plant species per individual plot for crosswalked ecotype is not within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0	Some risk for colonization by invasive species near the road, which often reduces species diversity.	If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
10. Subsistence Use					*Direct effects: any Depressional Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	No berry-yielding species documented in this functional class by either DOWL (2014) or Jorgenson et al. (2009).	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Upland and Lowland Grass-Shrub Meadow habitat mapped in this study, which is expected to be used regularly by moose in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Depressional Saturated Graminoid-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Bluejoint Meadow

DOWL (2014) Field Plot ID: 179

HGM: Depressional

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
11. Groundwater Discharge		*Depressional Saturated Graminoid-Shrub Meadow is located in areas where the active layer is likely to be deep or nonexistent , in what appear to be coarse morainal deposits.*			*Direct effects: any Depressional Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater discharge.*	*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	0	Predominantly kettle wetlands, depressions in coarse morrainal deposits.	0	0		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	0	Depressional HGM class.	0	0		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	0	Saturated to seasonally flooded water regime.	0	0		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	0	No indication of seeps or springs in DOWL field data.	0	0		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	0	Majority of the occurrences of this class have neither inlets nor outlets.	0	0		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
12. Groundwater Recharge		*Depressional Saturated Graminoid-Shrub Meadow is located in areas where the active layer is likely to be deep or nonexistent , in what appear to be coarse morainal deposits.*			*Direct effects: any Depressional Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater recharge.*	*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	1	Depressional HGM	0	1		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	0		0	0		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	0	Majority of the occurrences of this class have neither inlets nor outlets.	0	0		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Depressional Saturated Deciduous Shrub
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Willow Shrub
DOWL (2014) Field Plot ID: None
HGM: Depressional

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Depressional Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Dense willow shrubs are characteristic of this functional class.	0	1	Numerous occurrences near road (within first 50 m), overall cover and biomass may decrease (Auerbach et al. 1997, Myers-Smith et al. 2006), substantial shift in community composition is not anticipated.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Depressional HGM class.	0	1		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	1	There are no indications of variable water levels in the available data. However, observations of algal mats in adjacent Depressional Saturated Graminoid-Shrub suggests that variable and seasonal water levels likely occur in this functional class as well.	0	1		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A			Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	4		0	4		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Depressional Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Depressional HGM class.	0	1		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Dense willow shrubs are characteristic of this functional class.	0	1	Numerous occurrences near road (within first 50 m), overall cover and biomass may decrease (Auerbach et al. 1997, Myers-Smith et al. 2006), substantial shift in community composition is not anticipated.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	0	No DOWL (2014) data, but the mean surface water cover (0.7 +/- 1.6%) documented by Jorgenson et al. (2009) in the crosswalked ecotype indicates that a substantial cover of surface water is not present.	0	0		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0	No DOWL (2014) data. Jorgenson et al. (2009) did not track sediment deposits.	0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	0	Jorgenson et al. (2009) did not observe thick surface organics in the crosswalked ecotype.	0	0		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.40		

Wetland Functional Class: Depressional Saturated Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Willow Shrub

DOWL (2014) Field Plot ID: None

HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization		*This function is not applicable as this functional class is not directly abutting a relatively permanent channelized water.*				*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	N/A		N/A	N/A		Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	N/A		N/A	N/A		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A		N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
4. Organic Matter Production and Export					*Direct effects: any Depressional Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Dense willow shrubs are characteristic of this functional class.	0	1	Numerous occurrences near road (within first 50 m), overall cover and biomass may decrease (Auerbach et al. 1997, Myers-Smith et al. 2006), substantial shift in community composition is not anticipated.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	0	No DOWL (2014) data, but the mean surface water cover (0.7 +/- 1.6%) documented by Jorgenson et al. (2009) in the crosswalked ecotype indicates that a substantial cover of surface water is not present.	0	0		Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	0	The majority of Depressional Saturated Deciduous Shrub is has neither inlets nor outlets.	0	0		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Depressional Saturated Deciduous Shrub
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Willow Shrub
DOWL (2014) Field Plot ID: None
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime		*Depressional Saturated Deciduous Shrub is located in areas that appear to be underlain by coarse, well-drained morainal deposits and where the active layer is likely to be deep or nonexistent. Maintenance of Soil Thermal Regime is not applicable to wetlands that have a deep active layer or lack permafrost.*				*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	N/A		N/A	N/A		Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	N/A		N/A	N/A		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	N/A		N/A	N/A		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	N/A		N/A	N/A		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	N/A		N/A	N/A		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Depressional Saturated Deciduous Shrub
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Willow Shrub
DOWL (2014) Field Plot ID: None
HGM: Depressional

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
7. Bird and Mammal Habitat Suitability					*Direct effects: any Depressional Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.63	This class crosswalks to the Upland and Lowland Low Willow Scrub and Upland and Lowland Tall Alder-Willow Scrub habitats mapped in this this study, which are expected to support 17 and 18, respectively, of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.63	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.26	This class crosswalks to the Upland and Lowland Low Willow Scrub and Upland and Lowland Tall Alder-Willow Scrub habitats mapped in this this study, which are expected to support 25 and 21, respectively, of the 89 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.26	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	1	No surface water was observed by DOWL (2014), but the mean surface water cover (7.5 +/- 21.2%) documented by Jorgenson et al. (2009) in the crosswalked ecotype and dried algal mats observed by DOWL indicate that a substantial cover of surface water is seasonally present.	0	1		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	1	Jorgenson et al. (2009) documents mean cover values >30% each for shrubs and herbaceous vegetation in the crosswalked ecotype.	0	0.5	Numerous occurrences of this class near the road will likely shift to dominance by graminoids over time due to dust effects; overall cover and biomass may also decrease (Auerbach et al. 1997, Myers-Smith et al. 2006). Impoundments in this class are unlikely as this wetland functional class does not directly abut the road.	Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	3.88		0.00	2.88		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.78		0.00	0.58		
8. Fish Habitat Suitability		*This function is not applicable to Depressional Saturated Graminoid-Shrub Meadow, as there are no connections to fish-bearing waters.*				*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	N/A		N/A	N/A		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	N/A		N/A	N/A		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	N/A		N/A	N/A		Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	N/A		N/A	N/A		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Depressional Saturated Deciduous Shrub
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Willow Shrub
DOWL (2014) Field Plot ID: None
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Depressional Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Jorgenson et al. (2009) did not record any S1-S3 or G1-G3 plants in the ecotype crosswalked with this functional class. Parker (2009) does not list rare plants in the GAAR habitats likely found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of species per individual plot for associated ecotypes is not within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0	Some risk for colonization by invasive species near the road, which often reduces species diversity.	If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
10. Subsistence Use					*Direct effects: any Depressional Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	No berry-yielding species documented in this functional class by either DOWL (2014) or Jorgenson et al. (2009).	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Upland and Lowland Low Willow Scrub and Upland and Lowland Tall Alder-Willow Scrub habitats mapped in this study, which are expected to be used regularly by ducks, moose, and caribou in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Depressional Saturated Deciduous Shrub
Analogous Ecotypes (Jorgenson et al. 2009): Lacustrine Willow Shrub
DOWL (2014) Field Plot ID: None
HGM: Depressional

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
11. Groundwater Discharge		*Depressional Saturated Deciduous Shrub is located in areas where the active layer is likely to be deep or nonexistent , in what appear to be coarse morainal deposits.*			*Direct effects: any Depressional Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater discharge.*	*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	0	Predominantly kettle wetlands, depressions in coarse morrainal deposits.	0	0		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	0	Depressional HGM class.	0	0		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	0	Saturated to seasonally flooded water regime.	0	0		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	0	No indication of seeps or springs in DOWL field data.	0	0		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	0	Majority of the occurrences of this class have neither inlets nor outlets.	0	0		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
12. Groundwater Recharge		*Depressional Saturated Deciduous Shrub is located in areas where the active layer is likely to be deep or nonexistent , in what appear to be coarse morainal deposits.*			*Direct effects: any Depressional Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater recharge.*	*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	1	Depressional HGM class.	0	1		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	0		0	0		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	0	Majority of the occurrences of this class have neither inlets nor outlets.	0	0		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Slope Wet Sedge-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Sedge Fen, Lowland Sedge-Willow Fen

DOWL (2014) Field Plot ID: 221, T100-500, T100-506, T106-547, T108-550, T109-564, T35-195

HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Slope Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	Low shrubs are present, but not dominant, in this functional class.	0	0	Small drainage channels are often associated with this functional class, which could result in impoundments from improper culvert function. Localized changes near the road would mostly be due to impoundments (i.e., conversion from seasonally flooded to semipermanently or permanently flooded) on the upslope side of the road, and possible drying downslope. Dust impacts are expected to be minimal because of seasonal flushing of water.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	1	Jorgenson et al. (2009) document variable mean total cover of water for the crosswalked Lowland Sedge Fen (32.0 +/- 33.4%) and Lowland Sedge-Willow Fen (21.0 +/- 23.1%). DOWL 2014) data also document variable surface water presence.	0	1		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.50		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Slope Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	Low shrubs are present, but not dominant, in this functional class.	0	0	Small drainage channels are often associated with this functional class, which could result in impoundments from improper culvert function. Localized changes near the road would mostly be due to impoundments (i.e., conversion from seasonally flooded to semipermanently or permanently flooded) on the upslope side of the road, and possible drying downslope. Dust impacts are expected to be minimal because of seasonal flushing of water.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	1	Jorgenson et al. (2009) document variable mean total cover of water for the crosswalked Lowland Sedge Fen (32.0 +/- 33.4%) and Lowland Sedge-Willow Fen (21.0 +/- 23.1%). DOWL 2014) data also document variable surface water presence.	0	1		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0	DOWL (2014) data did not document sediment deposits. Jorgenson et al. (2009) did not track sediment deposits.	0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	1	Both DOWL (2014) and Jorgenson et al. (2009; in the crosswalked ecotypes) data document thick surface organics.	0	1		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.40		

Wetland Functional Class: Slope Wet Sedge-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Sedge Fen, Lowland Sedge-Willow Fen

DOWL (2014) Field Plot ID: 221, T100-500, T100-506, T106-547, T108-550, T109-564, T35-195

HGM: Slope

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Predicted Post-development Condition Indirect Effects Score	Predicted Post-development Condition Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Slope Wet Sedge-Shrub Meadow occurrencs within the footprint of the AMDIAR would be filled, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	As documented by both DOWL (2014) and Jorgenson et al. (2009), this is a well-vegetated wetland functional class.	0	0.5	Small drainage channels are often associated with this functional class, which could result in impoundments from improper culvert function. Localized changes near the road would mostly be due to impoundments (i.e., conversion from seasonally flooded to semipermanently or permanently flooded) on the upslope side of the road, and possible drying downslope. Dust impacts are expected to be minimal because of seasonal flushing of water.	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	1	Thick organic deposits documented by both DOWL (2014) and Jorgenson et al. (2009).	0	1		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A	Slope Wet Sedge-Shrub Meadow borders Small Streams, which were not easily visible in the imagery and thus shoreline stability could not be assessed.	N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	2		2	2		
Score (indicator sum/max possible indicators):	1.00		0.00	0.75		
4. Organic Matter Production and Export					*Direct effects: any Slope Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Both DOWL (2014) and Jorgenson et al. (2009) document >30% herbaceous cover with associated deciduous woody species.	0	0.5	Potential for localized changes in plant community composition near the road include impoundments upslope of road potentially converting to semipermanently or permanently flooded water regime, and drying downslope of road.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	Jorgenson et al. (2009) document variable mean total cover of water for the crosswalked Lowland Sedge Fen (32.0 +/- 33.4%) and Lowland Sedge-Willow Fen (21.0 +/- 23.1%). DOWL 2014) data also document variable surface water presence.	0	0.5	Potential for localized changes in plant community composition near the road include impoundments upslope of road potentially converting to semipermanently or permanently flooded water regime, and drying downslope of road.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Many Slope Wet Sedge-Shrub Meadow wetlands have perennial or ephemeral outlets.	0	0.5	If poor culvert placement and/or poor culvert management leads to impoundments, there will be less surface water outflow throughout the year.	A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	3		0	1.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	0.50		

Wetland Functional Class: Slope Wet Sedge-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Sedge Fen, Lowland Sedge-Willow Fen

DOWL (2014) Field Plot ID: 221, T100-500, T100-506, T106-547, T108-550, T109-564, T35-195

HGM: Slope

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
5. Maintenance of Soil Thermal Regime					*Direct effects: any Slope Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for maintenance of soil thermal regime.*	*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	1	Both DOWL (2014) and Jorgenson et al. (2014) document continuous vegetation cover.	0	0.5	Potential for localized changes in plant community composition near the road include impoundments upslope of road potentially converting to semipermanently or permanently flooded water regime, and drying downslope of road.	Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	0	DOWL (2014) observed and mapped seasonally to permanently flooded water regimes.	0	0		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	1	Slope HGM class.	0	1		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	1	Both DOWL (2014) and Jorgenson et al. (2009; in the crosswalked ecotypes) document thick organic deposits.	0	1		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	0		0	0		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	3		0	2.5		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.60		0.00	0.50		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Wet Sedge-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Sedge Fen, Lowland Sedge-Willow Fen

DOWL (2014) Field Plot ID: 221, T100-500, T100-506, T106-547, T108-550, T109-564, T35-195

HGM: Slope

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
7. Bird and Mammal Habitat Suitability					*Direct effects: any Slope Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.18	This class crosswalks to the Upland and Lowland Sedge-Shrub Meadow habitat mapped in this this study, which is expected to support 5 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.18	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.40	This class crosswalks to the Upland and Lowland Sedge-Shrub Meadow habitat mapped in this this study, which is expected to support 36 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.40	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	1	Jorgenson et al. (2009) document variable mean total cover of water for the crosswalked Lowland Sedge Fen (32.0 +/- 33.4%) and Lowland Sedge-Willow Fen (21.0 +/- 23.1%). DOWL 2014) data also document variable surface water presence.	0	1		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	0	Low shrubs are present, but not dominant, in this functional class.	0	0		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2.58		0.00	2.08		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.52		0.00	0.42		
8. Fish Habitat Suitability					*Direct effects: any Slope Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Very shallow surface water insufficient for supporting fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Shallow mean water depths documented by Jorgenson et al. (2009; in the crosswalked ecotypes) would freeze fast in winter. Little to no surface water documented by DOWL (2014).	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Both DOWL (2014) and Jorgenson et al. (2009) document ample herbaceous vegetation in the wetlands in this functional class.	0	1	Potential for localized changes in plant community composition near the road include impoundments upslope of road potentially converting to semipermanently or permanently flooded water regime, and drying downslope of road.	Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Very shallow surface water insufficient for spawning areas.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Slope Wet Sedge-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Sedge Fen, Lowland Sedge-Willow Fen

DOWL (2014) Field Plot ID: 221, T100-500, T100-506, T106-547, T108-550, T109-564, T35-195

HGM: Slope

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Slope Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	1	Jorgenson et al. (2009) document *Eriophorum viridicarinatum* in the ecotypes crosswalked with this functional class. Rare plants noted by Parker (2009) within GAAR whose habitat could include this functional class include *Carex heleonastes, C. lapponica,* and *Eriophorum viridicarinatum.*	0	0.5	Potential for some pH increase in occurrences of this class next to the road, but seasonal flushing may ameliorate this effect. *Carex heleonastes* and *Eriophorum viridicarinatum* are typically associated with more acidic soils, so an increase in soil pH may decrease the rare plant habitat for this functional class.	If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of species per individual plot for the crosswalked ecotypes is not within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0		If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	1		0	0.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.17		
10. Subsistence Use					*Direct effects: any Slope Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Neither DOWL (2014) nor Jorgenson et al. (2009) document at least 25% cover of berry-yielding plants in this functional clas.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Upland and Lowland Sedge-Shrub Meadow habitat mapped in this study, which is expected to be used regularly by ducks, geese, and caribou in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Slope Wet Sedge-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Sedge Fen, Lowland Sedge-Willow Fen

DOWL (2014) Field Plot ID: 221, T100-500, T100-506, T106-547, T108-550, T109-564, T35-195

HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*Slope Wet Sedge-Shrub Meadow is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	N/A		N/A	N/A		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	N/A		N/A	N/A		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	N/A		N/A	N/A		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	N/A		N/A	N/A		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	N/A		N/A	N/A		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
12. Groundwater Recharge		*Slope Wet Sedge-Shrub Meadow is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	N/A		N/A	N/A		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	N/A		N/A	N/A		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	N/A		N/A	N/A		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Wet Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Willow Low Shrub

DOWL (2014) Field Plot ID: 183, 187, 188, 200, 201, 209, T101-512, T104-531, T106-540, T107-542, T35-224

HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Slope Wet Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Low to tall shrub is characteristic for this functional class.	0	0.5	Small drainage channels are often associated with this functional class, which could result in impoundments from improper culvert function. Localized changes to plant community composition (shift to graminoids) would be confined to the road edge where impoundments could form upslope of the road and drying of habitats could occur downslope. Dust impacts are expected to be minimal because of seasonal flushing of water.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	DOWL (2014) did not document dried algal mats at any of their field plots in this functional class. Jorgenson et al. (2009) did not track signs of variable storage.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.38		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Slope Wet Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Low to tall shrub is characteristic for this functional class.	0	0.5	Small drainage channels are often associated with this functional class, which could result in impoundments from improper culvert function. Localized changes to plant community composition (shift to graminoids) would be confined to the road edge where impoundments could form upslope of the road and drying of habitats could occur downslope. Dust impacts are expected to be minimal because of seasonal flushing of water.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	1	Both DOWL (2014) and Jorgenson et al. (2009) document variable amounts of surface water associated with the wetlands in this functional class.	0	1		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0	DOWL (2014) data did not document sediment deposits. Jorgenson et al. (2009) did not track sediment deposits.	0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	0	Thick surface organics were not documented by Jorgenson et al. (2009) in the crosswalked ecotypes, and in the majority of DOWL's (2014) field plots in this class only thin to moderately thick surface organics were recorded.	0	0		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.30		

Wetland Functional Class: Slope Wet Deciduous Shrub
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Willow Low Shrub
DOWL (2014) Field Plot ID: 183, 187, 188, 200, 201, 209, T101-512, T104-531, T106-540, T107-542, T35-224
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Slope Wet Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	As documented by both DOWL (2014) and Jorgenson et al. (2009), this is a well-vegetated wetland functional class.	0	0.5	Small drainage channels are often associated with this functional class, which could result in impoundments from improper culvert function. Localized changes to plant community composition (shift to graminoids) would be confined to the road edge where impoundments could form upslope of the road and drying of habitats could occur downslope. Dust impacts are expected to be minimal because of seasonal flushing of water.	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	1	Both DOWL (2014) and Jorgenson et al. (2009) document loamy soils in the wetlands in this functional class.	0	1		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A	Slope Wet Deciduous Shrub borders Small Streams, which were not easily visible in the imagery and thus shoreline stability could not be assessed.	N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	2		2	2		
Score (indicator sum/max possible indicators):	1.00		0.00	0.75		
4. Organic Matter Production and Export					*Direct effects: any Slope Wet Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Both DOWL (2014) and Jorgenson et al. (2009) document >30% herbaceous cover in the wetlands in this scrub-dominated class.	0	0.5	Small drainage channels are often associated with this functional class, which could result in impoundments from improper culvert function. Localized changes to plant community composition (shift to graminoids) would be confined to the road edge where impoundments could form upslope of the road and drying of habitats could occur downslope. Dust impacts are expected to be minimal because of seasonal flushing of water.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	Both DOWL (2014) and Jorgenson et al. (2009) document variable amounts of surface water associated with these wetlands.	0	1	For areas where small drainage channels occur in this class, there is the potential for poor placement of culverts due to difficulty in determining exact location of drainages; thus, water may impound on upslope side of road during spring flooding.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Ephemeral and perennial waters flow through this wetland functional class.	0	0.5	If poor culvert placement and/or poor culvert management leads to impoundments, there will be less surface water outflow throughout the year.	A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	3		0	2		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	0.67		

Wetland Functional Class: Slope Wet Deciduous Shrub
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Willow Low Shrub
DOWL (2014) Field Plot ID: 183, 187, 188, 200, 201, 209, T101-512, T104-531, T106-540, T107-542, T35-224
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime					*Direct effects: any Slope Wet Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for maintenance of soil thermal regime.*	*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	1	Both DOWL (2014) and Jorgenson et al. (2014) document continuous vegetation cover in the wetlands in this functional class.	0	0.5	Small drainage channels are often associated with this functional class, which could result in impoundments from improper culvert function. Localized changes to plant community composition would be confined to the road edge where impoundments could form upslope of the road and drying of habitats could occur downslope. Dust impacts are expected to be minimal because of seasonal flushing of water.	Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	1	All DOWL (2014) field plots and the majority of mapped polygons in this functional classs had seasonally flooded to saturated water regimes.	0	0.5	For areas where small drainage channels occur in this class, there is the potential for poor placement of culverts due to difficulty in determining exact location of drainages; thus, water may impound on upslope side of road during spring flooding.	Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	1	Slope HGM class.	0	1		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	0	Thick surface organics were not documented by Jorgenson et al. (2009) in the crosswalked ecotype, and the majority of DOWL's (2014) field plots in this functional class showed only thin to moderately thick surface organics.	0	0		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	0		0	0		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	3		0	2		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.60		0.00	0.40		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Wet Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Willow Low Shrub

DOWL (2014) Field Plot ID: 183, 187, 188, 200, 201, 209, T101-512, T104-531, T106-540, T107-542, T35-224

HGM: Slope

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Slope Wet Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.61	This class crosswalks to the Upland and Lowland Low Willow Scrub habitat mapped in this this study, which is expected to support 17 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.61	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.28	This class crosswalks to the Upland and Lowland Low Willow Scrub habitat mapped in this this study, which is expected to support 25 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.28	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	1	Jorgenson et al. (2009) did not document much surface water for the crosswalked ecotype. DOWL's (2014) field data document variable amounts of surface water associated with these wetlands.	0	1		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	1	Jorgenson et al. (2009) documents mean cover values for shrubs and herbaceous vegetation >30% each for the crosswalked ecotype.	0	1	Changes to plant community composition would be confined to the road edge where impoundments form.	Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	3.89		0.00	3.39		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.78		0.00	0.68		
8. Fish Habitat Suitability					*Direct effects: any Slope Wet Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the apacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Very shallow surface water insufficient for supporting fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Shallow mean water depths documented by Jorgenson et al. (2009) and DOWL (2014) would freeze fast in winter.	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Both DOWL (2014) and Jorgenson et al. (2009) document ample herbaceous vegetation in the wetlands in this functional class.	0	1		Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Very shallow surface water insufficient for spawning areas.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Slope Wet Deciduous Shrub
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Willow Low Shrub
DOWL (2014) Field Plot ID: 183, 187, 188, 200, 201, 209, T101-512, T104-531, T106-540, T107-542, T35-224
HGM: Slope

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Slope Wet Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Jorgenson et al. (2009) did not record any S1-S3 or G1-G3 plants in the ecotypes crosswalked with this functional class. Parker (2009) does not list rare plants in the GAAR habitats likely to be found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of species per individual plot for the crosswalked ecotype is not within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0		If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
10. Subsistence Use					*Direct effects: any Slope Wet Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Jorgenson et al. (2009) does not document at least 25% cover of berry-yielding plants in this functional class. DOWL (2014) only documents >25% cover of berry-yielding species at two field plots.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This type srosswalks to the Upland and Lowland Low Willow Scrub habitat, which is expected to be used regularly by ducks, moose, and caribou in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Slope Wet Deciduous Shrub
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Willow Low Shrub
DOWL (2014) Field Plot ID: 183, 187, 188, 200, 201, 209, T101-512, T104-531, T106-540, T107-542, T35-224
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*Slope Wet Deciduous Shrub is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	N/A		N/A	N/A		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	N/A		N/A	N/A		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	N/A		N/A	N/A		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	N/A		N/A	N/A		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	N/A		N/A	N/A		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
12. Groundwater Recharge		*Slope Wet Deciduous Shrub is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	N/A		N/A	N/A		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	N/A		N/A	N/A		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	N/A		N/A	N/A		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Saturated Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Upland Bluejoint Meadow
DOWL (2014) Field Plot ID: T104-534, T106-551
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Slope Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	Low shrubs are present, but not dominant, in this functional class.	0	0	Localized changes in plant community composition are possible near the road due to dust fallout, but the changes are expected to be limited as deciduous shrubs will help mitigate the impact of dust deposition by capturing dust in shrub canopy. More robust growth of existing species due to warmer soil temperatures near the road is also possible. Impoundment effects likely will be limited because there are few occurrences of this class at the road edge and they do not appear to be associated with drainage features.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	DOWL (2014) did not document dried algal mats or other signs of storage at any of the field plots in this functional class. Jorgenson et al. (2009) did not track signs of variable storage.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Slope Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	Low shrubs are present, but not dominant, in this functional class.	0	0	Localized changes in plant community composition are possible near the road due to dust fallout, but the changes are expected to be limited as deciduous shrubs will help mitigate the impact of dust deposition by capturing dust in shrub canopy. More robust growth of existing species due to warmer soil temperatures near the road is also possible. Impoundment effects likely will be limited because there are few occurrences of this class at the road edge and they do not appear to be associated with drainage features.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	0	Jorgenson et al. (2009) document <1% mean total cover of water for the crosswalked ecotype. DOWL (2014) data do not document any surface water.	0	0		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0	DOWL (2014) data did not document sediment deposits. Jorgenson et al. (2009) did not track sediment deposits.	0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	0	Jorgenson et al. (2009) document thin surface organics and thick, dense root mats. DOWL (2014) document thin surface organics and a mix of organics with mineral soil.	0	0		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		

Wetland Functional Class: Slope Saturated Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Upland Bluejoint Meadow
DOWL (2014) Field Plot ID: T104-534, T106-551
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Slope Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	As documented by both DOWL (2014) and Jorgenson et al. (2009), this is a well-vegetated wetland functional class.	0	1	Localized changes in plant community composition are possible near the road due to dust fallout, but the changes are expected to be limited as deciduous shrubs will help mitigate the impact of dust deposition by capturing dust in shrub canopy. More robust growth of existing species due to warmer soil temperatures near the road is also possible. Impoundment effects likely will be limited because there are few occurrences of this class at the road edge and they do not appear to be associated with drainage features.	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	1	Soil textures documented by Jorgenson et al. (2009) and DOWL (2014) are variable, but are not sandy or silty.	0	1		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A	Slope Saturated Graminoid-Shrub Meadow borders Small Streams, which were not easily visible in the imagery and thus shoreline stability could not be assessed.	N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	2		2	2		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		
4. Organic Matter Production and Export					*Direct effects: any Slope Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Both DOWL (2014) and Jorgenson et al. (2009) document >30% herbaceous cover with associated deciduous woody species.	0	1	Localized changes in plant community composition are possible near the road due to dust fallout, but the changes are expected to be limited as deciduous shrubs will help mitigate the impact of dust deposition by capturing dust in shrub canopy. More robust growth of existing species due to warmer soil temperatures near the road is also possible. Impoundment effects likely will be limited because there are few occurrences of this class at the road edge and they do not appear to be associated with drainage features.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	0	Jorgenson et al. (2009) document <1% mean total cover of water for the crosswalked ecotype. DOWL (2014) data do not document any surface water.	0	0.5	For areas where small drainage channels occur in this class, there is the potential for poor placement of culverts due to difficulty in determining exact location of drainages. Thus, water may impound on upslope side of road during spring flooding.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Many Slope Saturated Graminoid-Shrub Meadow wetlands have perennial or ephemeral outlets.	0	0.5	If poor culvert placement and/or poor culvert management leads to impoundments, there will be less surface water outflow throughout the year.	A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.67		0.00	0.67		

Wetland Functional Class: Slope Saturated Graminoid-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Upland Bluejoint Meadow

DOWL (2014) Field Plot ID: T104-534, T106-551

HGM: Slope

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime					*Direct effects: any Slope Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for maintenance of soil thermal regime.*	*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	1	Both DOWL (2014) and Jorgenson et al. (2014) document continuous vegetation cover.	0	1	Localized changes in plant community composition are possible near the road due to dust fallout, but the changes are expected to be limited as deciduous shrubs will help mitigate the impact of dust deposition by capturing dust in shrub canopy. More robust growth of existing species due to warmer soil temperatures near the road is also possible. Impoundment effects likely will be limited because there are few occurrences of this class at the road edge and they do not appear to be associated with drainage features.	Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	1	DOWL (2014) observed and mapped saturated to seasonally flooded water regimes.	0	0.5	For areas where small drainage channels occur in this class, there is the potential for poor placement of culverts due to difficulty in determining exact location of drainages. Thus, water may impound on upslope side of road during spring flooding.	Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	1	Slope HGM class.	0	1		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	0	Neither DOWL (2014) nor Jorgenson et al. (2009) document thick organic deposits.	0	0		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	0		0	0		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	3		0	2.5		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.60		0.00	0.50		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Saturated Graminoid-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Upland Bluejoint Meadow

DOWL (2014) Field Plot ID: T104-534, T106-551

HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Slope Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.11	This class crosswalks to the Upland and Lowland Grass-Shrub Meadow habitat mapped in this this study, which is expected to support 3 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.11	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.10	This class crosswalks to the Upland and Lowland Grass-Shrub Meadow habitat mapped in this this study, which is expected to support 9 of the 89 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.10	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	0	Neither DOWL (2014) nor Jorgenson et al. (2009) document substantial surface water.	0	0		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	0	Low shrubs are present, but not dominant, in this functional class.	0	0		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	1.21		0.00	0.71		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.24		0.00	0.14		
8. Fish Habitat Suitability					*Direct effects: any Slope Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Very shallow surface water insufficient for supporting fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Shallow mean water depths documented by Jorgenson et al. (2009) would freeze fast in winter. No surface water documented by DOWL (2014).	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Both DOWL (2014) and Jorgenson et al. (2009) document ample herbaceous vegetation.	0	1		Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Very shallow surface water insufficient for spawning areas.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Slope Saturated Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Upland Bluejoint Meadow
DOWL (2014) Field Plot ID: T104-534, T106-551
HGM: Slope

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Slope Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	1	Jorgenson et al. (2009) document *Schizachne purpurascens* in the ecotype associated with this functional class. Rare plants noted by Parker (2009) within GAAR habitats that could occur in this functional class include *Schizachne purpurascens* and *Viola selkirkii.*	0	1	Potential changes in soil characteristics from dust deposition (lower organic content and higher pH) could occur. Grasses (*Schizachne purpurascens*) generally are not very sensitive to disturbance. *Viola selkirkii* is an understory species and the vegetation canopy will help mediate dust effects.	If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	1	Mean count of species per individual plot for the crosswalked ecotype is within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so Slope Saturated Graminoid-Shrub Meadow is considered to support a high diversity of species.	0	0.5	Risk for colonization by invasive species and loss of species diversity, due to mesic water regime and proximity to road.	If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.67		0.00	0.50		
10. Subsistence Use					*Direct effects: any Slope Saturated Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Neither DOWL (2014) nor Jorgenson et al. (2009) document at least 25% cover of berry-yielding plants in this functional clas.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Upland and Lowland Grass-Shrub Meadow habitat mapped in this study, which is expected to be used regularly by moose in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Slope Saturated Graminoid-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Upland Bluejoint Meadow

DOWL (2014) Field Plot ID: T104-534, T106-551

HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*Slope Saturated Graminoid-Shrub Meadow is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	N/A		N/A	N/A		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	N/A		N/A	N/A		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	N/A		N/A	N/A		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	N/A		N/A	N/A		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	N/A		N/A	N/A		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
12. Groundwater Recharge		*Slope Saturated Graminoid-Shrub Meadow is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	N/A		N/A	N/A		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	N/A		N/A	N/A		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	N/A		N/A	N/A		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Saturated Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Upland Birch-Ericaceous Low Shrub, Upland Birch-Willow Low Shrub, Upland Dwarf Birch-Tussock Shrub, Upland Willow Low Shrub, Upland Alder-Willow Tall Shrub

DOWL (2014) Field Plot ID: 186, 195, 196, 197, 199, 215, 220, T100-502, T104-527, T104-529, T106-536, T106-538, T107-555

HGM: Slope

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
1. Flood Flow Regulation (Storage)					*Direct effects: any Slope Saturated Deciduous Shrub occcurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Low to tall woody vegetation is characteristic of this functional class. Tussocks are present in some areas.	0	0.5	Localized changes in plant community composition are possible near the road in this HGM slope class mostly due to impoundments (i.e., conversion from saturated to semipermanently or permanently flooded); also potentially more robust growth of existing species due to warmer soil temperatures near the road. Dust impacts expected to be limited, as deciduous shrubs will help mitigate the impact of dust deposition.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	DOWL (2014) did not document any signs of variable surface water. Jorgenson et al. (2009) did not track indications of variable surface water storage.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.38		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Slope Saturated Deciduous Shrub occurrrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Low to tall woody vegetation is characteristic of this functional class. Tussocks are present in some areas.	0	0.5	Localized changes in plant community composition are possible near the road in this HGM slope class mostly due to impoundments (i.e., conversion from saturated to semipermanently or permanently flooded); also potentially more robust growth of existing species due to warmer soil temperatures near the road. Dust impacts expected to be limited, as deciduous shrubs will help mitigate the impact of dust deposition.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	0	Neither DOWL (2014) nor Jorgenson et al. (2009) document substantial surface water in the wetlands in this functional class.	0	0		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0	Sediment deposits observed at only one DOWL (2014) field plot; they do not appear to be typical of this community.	0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	0	Thin to moderately thick surface organics documented by both DOWL (2014) and Jorgenson et al. (2009).	0	0		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	1		0	0.5		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.20		0.00	0.10		

Wetland Functional Class: Slope Saturated Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Upland Birch-Ericaceous Low Shrub, Upland Birch-Willow Low Shrub, Upland Dwarf Birch-Tussock Shrub, Upland Willow Low Shrub, Upland Alder-Willow Tall Shrub

DOWL (2014) Field Plot ID: 186, 195, 196, 197, 199, 215, 220, T100-502, T104-527, T104-529, T106-536, T106-538, T107-555

HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Slope Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	Both DOWL (2014) and Jorgenson et al. (2009) document dense vegetation in this functional class, which often borders small streams.	0	0.5	Localized changes in plant community composition are possible near the road in this HGM slope class mostly due to impoundments (i.e., conversion from saturated to semipermanently or permanently flooded); also potentially more robust growth of existing species due to warmer soil temperatures near the road. Dust impacts expected to be limited, as deciduous shrubs will help mitigate the impact of dust deposition.	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	1	Soils are typically loamy (DOWL 2014, Jorgenson et al. 2009).	0	1		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A	Slope Saturated Deciduous Shrub borders Small Streams, which were not easily visible in the imagery and thus shoreline stability could not be assessed.	N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	2		2	2		
Score (indicator sum/max possible indicators):	1.00		0.00	0.75		
4. Organic Matter Production and Export					*Direct effects: any Slope Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Half of DOWL (2014) field plots and Jorgenson et al. (2009) ecotypes crosswalked with this functional class have 30% or greater herbaceous cover. Shrubs are predominantly deciduous at all DOWL (2014) field plots and in the Jorgenson et al. (2009) ecotypes.	0	0.5	Localized changes in plant community composition are possible near the road in this HGM slope class mostly due to impoundments (i.e., conversion from saturated to semipermanently or permanently flooded); also potentially more robust growth of existing species due to warmer soil temperatures near the road. Dust impacts expected to be limited, as deciduous shrubs will help mitigate the impact of dust deposition.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	0	DOWL (2014) and Jorgenson et al. (2009) document scattered surface water, but at <10% cover.	0	0.5	For areas where small drainage channels occur in this class, there is the potential for poor placement of culverts due to difficulty in determining exact location of drainages; thus, water may impound on upslope side of road during spring flooding.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Ephemeral and perennial waters flow through this wetland functional class.	0	0.5	If poor culvert placement and/or poor culvert management leads to impoundments, there will be less surface water outflow throughout the year.	A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.67		0.00	0.50		

Wetland Functional Class: Slope Saturated Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Upland Birch-Ericaceous Low Shrub, Upland Birch-Willow Low Shrub, Upland Dwarf Birch-Tussock Shrub, Upland Willow Low Shrub, Upland Alder-Willow Tall Shrub

DOWL (2014) Field Plot ID: 186, 195, 196, 197, 199, 215, 220, T100-502, T104-527, T104-529, T106-536, T106-538, T107-555

HGM: Slope

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
5. Maintenance of Soil Thermal Regime					*Direct effects: any Slope Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for maintenance of soil thermal regime.*	*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	1	Both DOWL (2014) and Jorgenson et al. (2014) document continuous vegetation cover.	0	0.5	Localized changes in plant community composition are possible near the road in this HGM slope class mostly due to impoundments (i.e., conversion from saturated to semipermanently or permanently flooded); also potentially more robust growth of existing species due to warmer soil temperatures near the road. Dust impacts expected to be limited, as deciduous shrubs will help mitigate the impact of dust deposition.	Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	1	All DOWL (2014) data points and the majority of mapped polygons were seasonally flooded to saturated water regimes.	0	0.5	For areas where small drainage channels occur in this class, there is the potential for poor placement of culverts due to difficulty in determining exact location of drainages; thus, water may impound on upslope side of road during spring flooding.	Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	1	Slope HGM class.	0	0		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	0	Thick surface organics were not documented by Jorgenson et al. (2009), and the majority of DOWL's (2014) field plots showed thin to moderately thick surface organics.	0	0		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	0		0	0		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	3		0	1		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.60		0.00	0.20		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Saturated Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Upland Birch-Ericaceous Low Shrub, Upland Birch-Willow Low Shrub, Upland Dwarf Birch-Tussock Shrub, Upland Willow Low Shrub, Upland Alder-Willow Tall Shrub

DOWL (2014) Field Plot ID: 186, 195, 196, 197, 199, 215, 220, T100-502, T104-527, T104-529, T106-536, T106-538, T107-555

HGM: Slope

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Slope Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.61	This class crosswalks to the Upland and Lowland Low Birch Ericaceous Scrub, Upland and Lowland Low Willow Scrub, Tussock Tundra, Upland and Lowland Seral Spruce Woodland-Tall Scrub, and Upland and Lowland Tall Alder-Willow Scrub habitats mapped in this study, which are expected to support 17, 17, 15, 18, and 18, respectively, of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area, respectively.	0.00	0.61	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.23	This class crosswalks to the Upland and Lowland Low Birch Ericaceous Scrub, Upland and Lowland Low Willow Scrub, Tussock Tundra, Upland and Lowland Seral Spruce Woodland-Tall Scrub, and Upland and Lowland Tall Alder-Willow Scrub habitats mapped in this study, which are expected to support 14, 25, 17, 24, and 21, respectively, of 89 bird species likely to occur regularly in the AMDIAR/GAAR study area, respectively.	0.00	0.23	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	0	DOWL (2014) and Jorgenson et al. (2009) document scattered surface water, but at <10% cover.	0	0		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	1	Jorgenson et al. (2009) documents >30% mean cover each for shrubs and herbaceous vegetation in the crosswalked ecotypes.	0	0.5	Localized changes in plant community composition are possible near the road in this HGM slope class mostly due to impoundments (i.e., conversion from saturated to semipermanently or permanently flooded); also potentially more robust growth of existing species due to warmer soil temperatures near the road. Dust impacts expected to be limited, as deciduous shrubs will help mitigate the impact of dust deposition.	Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2.83		0.00	1.83		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.57		0.00	0.37		
8. Fish Habitat Suitability					*Direct effects: any Slope Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Very shallow surface water insufficient for supporting fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Shallow mean water depths documented by DOWL (2014) would freeze fast in winter.	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Both DOWL (2014) and Jorgenson et al. (2009) document ample herbaceous vegetation.	0	1		Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Very shallow surface water insufficient for spawning areas.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Slope Saturated Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Upland Birch-Ericaceous Low Shrub, Upland Birch-Willow Low Shrub, Upland Dwarf Birch-Tussock Shrub, Upland Willow Low Shrub, Upland Alder-Willow Tall Shrub

DOWL (2014) Field Plot ID: 186, 195, 196, 197, 199, 215, 220, T100-502, T104-527, T104-529, T106-536, T106-538, T107-555

HGM: Slope

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Slope Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Jorgenson et al. (2009) did not record any S1-S3 or G1-G3 plants in the ecotypes crosswalked to this functional class. Parker (2009) does not list rare plants in the GAAR habitats likely found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	1	Mean counts of species per individual plot for the crosswalked Upland Birch Willow Low Shrub and Upland Willow Low Shrub are within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this functional class is considered to support a high diversity of species.	0	1	Limited risk for colonization by invasives, due to shrub canopy and leaf litter.	If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		
10. Subsistence Use					*Direct effects: any Slope Saturated Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Jorgenson et al. (2009) does not document at least 25% cover of berry-yielding plants in this functional class. DOWL (2014) documents >25% cover of berry-yielding species at less than half of the field plots for this functional class.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Upland and Lowland Low Birch Ericaceous Scrub, Upland and Lowland Low Willow Scrub, Tussock Tundra, Upland and Lowland Seral Spruce Woodland-Tall Scrub, and Upland and Lowland Tall Alder-Willow Scrub habitats mapped in this study, which are expected to be used regularly by ducks, moose, and caribou in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Slope Saturated Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Upland Birch-Ericaceous Low Shrub, Upland Birch-Willow Low Shrub, Upland Dwarf Birch-Tussock Shrub, Upland Willow Low Shrub, Upland Alder-Willow Tall Shrub

DOWL (2014) Field Plot ID: 186, 195, 196, 197, 199, 215, 220, T100-502, T104-527, T104-529, T106-536, T106-538, T107-555

HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*Slope Wet Deciduous Shrub is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	N/A		N/A	N/A		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	N/A		N/A	N/A		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	N/A		N/A	N/A		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	N/A		N/A	N/A		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	N/A		N/A	N/A		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
12. Groundwater Recharge		*Slope Wet Deciduous Shrub is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	N/A		N/A	N/A		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	N/A		N/A	N/A		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	N/A		N/A	N/A		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Saturated Shrub Peatland
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Ericaceous Shrub Bog
DOWL (2014) Field Plot ID: 189, 207, 210, T100-501
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Slope Saturated Shrub Peatland occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Low woody vegetation is characteristic of this functional class.	0	0.5	Dust accumulation can reduce moss cover and evergreen (ericaceous) shrub cover through soil calcification; over time this may result in greater cover of grasses. Upslope impoundment and downslope drying effects are expected to be limited, as occurrences of this class are in low-gradient areas not associated with drainage features.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	DOWL (2014) did not document any signs of variable surface water. Jorgenson et al. (2009) did not track indications of variable surface water storage.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A			Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.38		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Slope Saturated Shrub Peatland occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Low woody vegetation is characteristic of this functional class.	0	0.5	Dust accumulation can reduce moss cover and evergreen (ericaceous) shrub cover through soil calcification; over time this may result in greater cover of grasses. Upslope impoundment and downslope drying effects are expected to be limited, as occurrences of this class are in low-gradient areas not associated with drainage features.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	0	Neither DOWL (2014) nor Jorgenson et al. (2009) document substantial surface water in the wetlands in this functional class.	0	0	Increased surface water from impoundments expected to be limited, as occurrences of this class are in low-gradient areas not associated with drainage features.	A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0	DOWL (2014) data did not document sediment deposits. Jorgenson et al. (2009) did not track sediment deposits.	0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	1	Thick surface organics documented by both DOWL (2014) and Jorgenson et al. (2009).	0	1	Perhaps some thinning of the organic horizon near the road from dust fallout, but unlikely to substantially reduce thick surface organics.	Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.30		

Wetland Functional Class: Slope Saturated Shrub Peatland
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Ericaceous Shrub Bog
DOWL (2014) Field Plot ID: 189, 207, 210, T100-501
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization		*Slope Saturated Shrub Peatland does not typically abut relatively permanently waters, thus this function is not applicable.*				*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	N/A		N/A	N/A		Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	N/A		N/A	N/A		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A		N/A	N/A		Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
4. Organic Matter Production and Export					*Direct effects: any Slope Saturated Shrub Peatland occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Both DOWL (2014) and Jorgenson et al. (2009) document >30% herbaceous cover and associated woody species that are predominantly deciduous.	0	0.5	Dust accumulation can reduce moss cover and evergreen (ericaceous) shrub cover through soil calcification; over time this may result in greater cover of grasses. Upslope impoundment and downslope drying effects are expected to be limited, as occurrences of this class are in low-gradient areas not associated with drainage features.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	0	Both DOWL (2014) and Jorgenson et al. (2009) document a near surface water table, but only scattered surface water.	0	0	Increased surface water from impoundments expected to be limited, as occurrences of this class are in low-gradient areas not associated with drainage features.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Wetlands in this functional class often have ephemeral waters flowing through them.	0	1		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	2		0	1.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.67		0.00	0.50		

Wetland Functional Class: Slope Saturated Shrub Peatland
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Ericaceous Shrub Bog
DOWL (2014) Field Plot ID: 189, 207, 210, T100-501
HGM: Slope

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Predicted Post-development Condition Indirect Effects Score	Predicted Post-development Condition Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime					*Direct effects: any Slope Saturated Shrub Peatland occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for maintenance of soil thermal regime.*	*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	1	Both DOWL (2014) and Jorgenson et al. (2014) document continuous vegetation cover.	0	0.5	Dust accumulation can reduce moss cover and evergreen (ericaceous) shrub cover through soil calcification; over time this may result in greater cover of grasses. Upslope impoundment and downslope drying effects are expected to be limited, as occurrences of this class are in low-gradient areas not associated with drainage features.	Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	1	DOWL (2014) field plots describe saturated water regimes; the map polygons in the study area range from saturated to seasonally flooded.	0	1	Increased surface water from impoundments expected to be limited, as occurrences of this class are in low-gradient areas not associated with drainage features.	Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	1	Slope HGM class.	0	1		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	1	Half of DOWL (2014) field plots for this functional class describe histosols/histic epipedons. Jorgenson et al. (2009) document organic soils.	0	1	Perhaps some thinning of the organic horizon near the road from dust fallout, but unlikely to substantially reduce thick surface organics.	A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	0		0	0		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	4		0	3.5		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.80		0.00	0.70		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Saturated Shrub Peatland
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Ericaceous Shrub Bog
DOWL (2014) Field Plot ID: 189, 207, 210, T100-501
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Slope Saturated Shrub Peatland occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.61	This class crosswalks to the Upland and Lowland Low Birch-Ericaceous Scrub habitat mapped in this study, which is expected to support 17 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.61	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.28	This class crosswalks to the Upland and Lowland Low Birch-Ericaceous Scrub habitat mapped in this study, which is expected to support 25 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.28	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	0	DOWL (2014) and Jorgenson et al. (2009) document scattered surface water, but <10% cover.	0	0		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	1	Low woody vegetation is characteristic of this functional class.	0	0.5	Dust accumulation can reduce moss cover and evergreen (ericaceous) shrub cover through soil calcification; over time this may result in greater cover of grasses. Upslope impoundment and downslope drying effects are expected to be limited, as occurrences of this class are in low-gradient areas not associated with drainage features.	Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2.89		0.00	1.89		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.58		0.00	0.38		
8. Fish Habitat Suitability		*Slope Saturated Shrub Peatland wetlands only have a direct connection to ephemeral waters, thus this function is not applicable.*				*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	N/A		N/A	N/A		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	N/A		N/A	N/A		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	N/A		N/A	N/A		Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	N/A		N/A	N/A		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Saturated Shrub Peatland
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Ericaceous Shrub Bog
DOWL (2014) Field Plot ID: 189, 207, 210, T100-501
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Slope Saturated Shrub Peatland occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	1	Jorgenson et al. (2009) document *Eriophorum viridicarinatum* in the ecotype crosswalked to this functional class. Rare plants noted by Parker (2009) within the GAAR habitats that could occur in this functional class include *Carex heleonastes, C. lapponica,* and *Eriophorum viridicarinatum.*	0	0.5	Potential for some pH increase in occurrences of this class next to the road, but seasonal flushing may ameliorate this effect. *Carex heleonastes* and *Eriophorum viridicarinatum* are typically associated with more acidic soils, so an increase in soil pH may decrease the rare plant habitat for this functional class.	If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of species per individual plot for the crosswalked ecotype is not within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0		If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	1		0	0.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.17		
10. Subsistence Use					*Direct effects: any Slope Saturated Shrub Peatland occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Jorgenson et al. (2009) does not document at least 25% cover of berry-yielding plants in this functional class. DOWL (2014) documents >25% cover of berry-yielding species at less than half of the field plots for this functional class.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class cosswalks to the Upland and Lowland Low Birch-Ericaceous Scrub habitat mapped in this study, which is expected to be used regularly by caribou in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Slope Saturated Shrub Peatland
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Ericaceous Shrub Bog
DOWL (2014) Field Plot ID: 189, 207, 210, T100-501
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*Slope Saturated Shrub Peatland is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	N/A		N/A	N/A		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	N/A		N/A	N/A		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	N/A		N/A	N/A		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	N/A		N/A	N/A		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	N/A		N/A	N/A		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
12. Groundwater Recharge		*Slope Saturated Shrub Peatland is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	N/A		N/A	N/A		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	N/A		N/A	N/A		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	N/A		N/A	N/A		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Saturated Spruce Forest

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Black Spruce Forest

DOWL (2014) Field Plot ID: 178, 182, 184, 202, 203, 205, 206.2, 212, 213, 214, 217, 222, 223, 226, T100-503, T101-514, T103-223, T103-520, T103-525, T104-533, T104-535, T106-545, T106-549, T107-553, T108-552, T108-554, T108-556, T109-558, T109-560, T109-562, T35-193, T35-222, T35-

HGM: Slope

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Slope Saturated Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Trees and shrubs are characteristic of this functional class.	0	1	Localized changes in plant community composition are possible in this class, which occurs extensively adjacent to the road. Dust impacts are expected to be limited as forest and shrub canopy will help capture dust fallout. A slightly higher cover of graminoids could develop over time near the road from dust effects and localized impoundments.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	DOWL (2014) did not document any signs of variable surface water. Jorgenson et al. (2009) did not track indications of variable surface water storage.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	1	Most runoff in the upper Kobuk River basin occurs in the spring associated with snowmelt (Brabets 2001). This functional class receives floodwaters as sheetflow.	0	1		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.50		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Slope Saturated Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Slope HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Trees and shrubs are characteristic of this functional class.	0	1	Localized changes in plant community composition are possible in this class, which occurs extensively adjacent to the road. Dust impacts are expected to be limited as forest and shrub canopy will help capture dust fallout. A slightly higher cover of graminoids could develop over time near the road from dust effects and localized impoundments.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	0	Neither DOWL (2014) nor Jorgenson et al. (2009) document substantial surface water in this community.	0	0		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	0	DOWL (2014) data did not document sediment deposits. Jorgenson et al. (2009) did not track sediment deposits.	0	0	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	1	Thick surface organics were documented by both DOWL (2014) and Jorgenson et al. (2009).	0	1		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.40		

Wetland Functional Class: Slope Saturated Spruce Forest

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Black Spruce Forest

DOWL (2014) Field Plot ID: 178, 182, 184, 202, 203, 205, 206.2, 212, 213, 214, 217, 222, 223, 226, T100-503, T101-514, T103-223, T103-520, T103-525, T104-533, T104-535, T106-545, T106-549, T107-553, T108-552, T108-554, T108-556, T109-558, T109-560, T109-562, T35-193, T35-222, T35-

HGM: Slope

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Slope Saturated Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	Both DOWL (2014) and Jorgenson et al. (2009) document continuous, dense vegetation.	0	1	Localized changes in plant community composition are possible near the road. Dust impacts are expected to be limited as forest and shrub canopy will help capture dust fallout. A slightly higher cover of graminoids could develop over time near the road from dust effects and localized impoundments.	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	1	Both DOWL (2014) and Jorgenson et al. (2009) document thick organics with loamy soils.	0	1		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	N/A	Slope Saturated Spruce Forest borders Small Streams, which were not easily visible in the imagery and thus shoreline stability could not be assessed.	N/A	N/A	Inappropriate to consider only pre-construction conditions, thus retained existing condition score for indirect effects.	Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	2		2	2		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		
4. Organic Matter Production and Export					*Direct effects: any Slope Saturated Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	0	Jorgenson et al. (2009) document less than 30% herbaceous cover. Half of DOWL's (2014) field plots document less than 30% herbaceous cover for this functional class.	0	0	Localized changes in plant community composition are possible in this class, which occurs extensively adjacent to the road. Dust impacts are expected to be limited as forest and shrub canopy will help capture dust fallout. A slightly higher cover of graminoids could develop over time near the road from dust effects and localized impoundments.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	0	Neither DOWL (2014) nor Jorgenson et al. (2009) document substantial surface water.	0	0.5	For areas where small drainage channels occur in this class, there is the potential for poor placement of culverts due to difficulty in determining exact location of drainages; thus, water may impound on upslope side of road during spring flooding.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Ephemeral and perennial waters flow through this wetland functional class.	0	0.5	If poor culvert placement and/or poor culvert management leads to impoundments, there will be less surface water outflow throughout the year.	A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Slope Saturated Spruce Forest
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Black Spruce Forest
DOWL (2014) Field Plot ID: 178, 182, 184, 202, 203, 205, 206.2, 212, 213, 214, 217, 222, 223, 226, T100-503, T101-514, T103-223, T103-520, T103-525, T104-533, T104-535, T106-545, T106-549, T107-553, T108-552, T108-554, T108-556, T109-558, T109-560, T109-562, T35-193, T35-222, T35-
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime					*Direct effects: any Slope Saturated Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for maintenance of soil thermal regime.*	*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	1	Both DOWL (2014) and Jorgenson et al. (2014) document continuous vegetation cover.	0	1	Localized changes in plant community composition are possible in this class, which occurs extensively adjacent to the road. Dust impacts are expected to be limited as forest and shrub canopy will help capture dust fallout. A slightly higher cover of graminoids could develop over time near the road from dust effects and localized impoundments.	Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	1	DOWL (2014) datapoints describe saturated water regimes, map polygons are predominantly saturated.	0	0.5	This habitat is extensive immediately adjacent to the road. For areas where small drainage channels occur in this class, there is the potential for poor placement of culverts due to difficulty in determining exact location of drainages. Thus, water may impound on upslope side of road during spring flooding.	Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	1	Slope HGM class.	0	1		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	1	The majority of DOWL (2014) datapoints for this functional class describe histosols/histic epipedons. Jorgenson et al. (2009) document moderately thick to thick surface organics.	0	1		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	0		0	0		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	4		0	3.5		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.80		0.00	0.70		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Slope Saturated Spruce Forest

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Black Spruce Forest

DOWL (2014) Field Plot ID: 178, 182, 184, 202, 203, 205, 206.2, 212, 213, 214, 217, 222, 223, 226, T100-503, T101-514, T103-223, T103-520, T103-525, T104-533, T104-535, T106-545, T106-549, T107-553, T108-552, T108-554, T108-556, T109-558, T109-560, T109-562, T35-193, T35-222, T35-

HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Slope Saturated Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.61	This class crosswalks to the Upland and Lowland Spruce Forest habitat mapped in this study, which is expected to support 17 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.61	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.44	This class crosswalks to the Upland and Lowland Spruce Forest habitat mapped in this study, which is expected to support 39 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.44	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	0	DOWL (2014) and Jorgenson et al. (2009) document scattered surface water, but at <10% cover.	0	0		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	1	Jorgenson et al. (2009) documents >30% mean cover each for shrubs and herbaceous vegetation in the crosswalked ecotype.	0	1		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	3.05		0.00	2.55		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.61		0.00	0.51		

Wetland Functional Class: Slope Saturated Spruce Forest

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Black Spruce Forest

DOWL (2014) Field Plot ID: 178, 182, 184, 202, 203, 205, 206.2, 212, 213, 214, 217, 222, 223, 226, T100-503, T101-514, T103-223, T103-520, T103-525, T104-533, T104-535, T106-545, T106-549, T107-553, T108-552, T108-554, T108-556, T109-558, T109-560, T109-562, T35-193, T35-222, T35-

HGM: Slope

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
8. Fish Habitat Suitability					*Direct effects: any Slope Saturated Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity ro provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Very shallow surface water insufficient for supporting fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Shallow mean water depths documented by DOWL (2014) would freeze fast in winter.	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Jorgenson et al. (2009) document less than 30% herbaceous cover, but 50% deciduous shrub cover. Half of DOWL's (2014) field plots document less than 30% herbaceous cover, but the majority of their field plots document over 50% deciduous shrub cover for this functional class.	0	1	Localized changes in plant community composition are possible in this class, which occurs extensively adjacent to the road. Dust impacts are expected to be limited as forest and shrub canopy will help capture dust fallout. A slightly higher cover of graminoids could develop over time near the road from dust effects and localized impoundments.	Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Very shallow surface water insufficient for spawning areas.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Slope Saturated Spruce Forest
Analogous Ecotypes (Jorgenson et al. 2009): Lowland Black Spruce Forest
DOWL (2014) Field Plot ID: 178, 182, 184, 202, 203, 205, 206.2, 212, 213, 214, 217, 222, 223, 226, T100-503, T101-514, T103-223, T103-520, T103-525, T104-533, T104-535, T106-545, T106-549, T107-553, T108-552, T108-554, T108-556, T109-558, T109-560, T109-562, T35-193, T35-222, T35-
HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Slope Saturated Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	1	Jorgenson et al. (2009) document no rare plants in the ecotype associated with this functional class. Rare plants noted by Parker (2009) within the GAAR habitats that could include this functional class include *Cypripedium parviflorum.*	0	1	Based on limited field data, soils tend to have thick organic horizons, which suggest that changes in soil characteristics would be limited. A local, thin mineral layer near the road could develop from dust fallout over time, but likely it would not result in substantive changes to soils.	If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of species per individual plot for the crosswalked ecotype is not within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0		If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		
10. Subsistence Use					*Direct effects: any Slope Saturated Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	1	Jorgenson et al. (2009) documents >25% cover of berry-yielding plants in this functional class. DOWL (2014) documents >25% cover of berry-yielding species at the majority of the data points for this functional class.	0	1	Localized changes in plant community composition are possible in this class, which occurs extensively adjacent to the road. Dust impacts are expected to be limited as forest and shrub canopy will help capture dust fallout. A slightly higher cover of graminoids could develop over time near the road from dust effects and localized impoundments.	Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class cosswalks to the Upland and Lowland Spruce Forest habitat mapped in this study, which is expected to be used regulary by moose and caribou in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.67		0.00	0.67		

Wetland Functional Class: Slope Saturated Spruce Forest

Analogous Ecotypes (Jorgenson et al. 2009): Lowland Black Spruce Forest

DOWL (2014) Field Plot ID: 178, 182, 184, 202, 203, 205, 206.2, 212, 213, 214, 217, 222, 223, 226, T100-503, T101-514, T103-223, T103-520, T103-525, T104-533, T104-535, T106-545, T106-549, T107-553, T108-552, T108-554, T108-556, T109-558, T109-560, T109-562, T35-193, T35-222, T35-

HGM: Slope

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*Slope Saturated Spruce Forest is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	N/A		N/A	N/A		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	N/A		N/A	N/A		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	N/A		N/A	N/A		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	N/A		N/A	N/A		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	N/A		N/A	N/A		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
12. Groundwater Recharge		*Slope Saturated Spruce Forest is located in areas where the active layer is likely to be shallow, so this function is not applicable.*				*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	N/A		N/A	N/A		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	N/A		N/A	N/A		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	N/A		N/A	N/A		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Riverine Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Riverine Wet Sedge Meadow
DOWL (2014) Field Plot ID: None
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	Sparse shrubs and tussock forming sedges (*Tricophorum caespitosum*) documented by Jorgenson et al. (2009) in the crosswalked ecotype.	0	0	Localized changes in plant community compostion likely are limited to one occurrence of this class associated with a planned culvert outlet where overbank flooding may be limited. Otherwise, this class is associated with overbank flooding by Major Rivers and Large Streams, resulting in little opportunity for development of impoundments. Seasonal flooding expected to ameliorate the effects of any dust fallout from the road.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Riverine HGM class, but this wetland functional class is often located in flood basins (old oxbows, depressional features).	0	1		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	Jorgenson et al. (2009) did not track indications of variable surface water storage.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	0	Riverine HGM classes are more likely to interact with channelized flow than sheet flow.	0	0		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Riverine HGM class, but this wetland functional class is often located in flood basins (old oxbows, depressional features).	0	1		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	0	Sparse shrubs and tussock forming sedges (*Tricophorum caespitosum*) documented by Jorgenson et al. (2009) in the crosswalked ecotype.	0	0	Localized changes in plant community compostion likely are limited to one occurrence of this class associated with a planned culvert outlet where overbank flooding may be limited. Otherwise, this class is associated with overbank flooding by Major Rivers and Large Streams, resulting in little opportunity for development of impoundments. Seasonal flooding expected to ameliorate the effects of any dust fallout from the road.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	0	<10% mean cover of water documented by Jorgenson et al. (2009) in the crosswalked ecotype, Riverine Wet Sedge Meadow.	0	0	This wetland functional class is associated with overbank flooding by Major Rivers and Large Streams, resulting in little opportunity for development of impoundments.	A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	1	Buried organics documented throughout the soil profile in the crosswalked ecotype are related to riverine transport and deposition processes (Jorgenson et al. 2009).	0	1	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	0	Jorgenson et al. (2009) document thin surface organics in the crosswalked ecotype.	0	0		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.40		

Wetland Functional Class: Riverine Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Riverine Wet Sedge Meadow
DOWL (2014) Field Plot ID: None
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	Jorgenson et al. (2009) document over 75% herbaceous cover, dominated by robust sedges (*Eriophorum angustifolium, Carex aquatilis, C. arcta, C. rostrata,* and *C. saxatilis*), which have the potential to absorb energy.	0	1	Localized changes in plant community compostion likely are limited to one occurrence of this class associated with a planned culvert outlet where overbank flooding may be limited. Otherwise, this class is associated with overbank flooding by Major Rivers and Large Streams, resulting in little opportunity for development of impoundments. Seasonal flooding expected to ameliorate the effects of any dust fallout from the road.	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	1	Loamy soils documented by Jorgenson et al. (2009).	0	1		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	1	Riverine Wet Sedge-Shrub Meadow borders Low-gradient Small Streams, Large Streams, and Major Rivers. Major Rivers and Large Streams are visible in historical imagery and the shorelines appear to be stable (see Riverine Functional Assessment).	0	1	Inappropriate to consider only pre-construction conditions, thus retained existing condition score for indirect effects.	Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		
4. Organic Matter Production and Export					*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Jorgenson et al. (2009) document over 75% herbaceous cover.	0	1	Localized changes in plant community compostion likely are limited to one occurrence of this class associated with a planned culvert outlet where overbank flooding may be limited. Otherwise, this class is associated with overbank flooding by Major Rivers and Large Streams, resulting in little opportunity for development of impoundments. Seasonal flooding expected to ameliorate the effects of any dust fallout from the road.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	Although the mean cover of surface water documented by Jorgenson et al. (2009) was <10%, this is a Riverine HGM wetland class that seasonally floods. DOWL (2014) mapped the wetland types in this functional class as seasonally flooded.	0	1	Associated with a range of stream crossing structures, but predominantly medium to large bridges. Some potential for at least temporary impoundments if culverts are not propoerly installed and maintained.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Riverine Wet Sedge-Shrub Meadow borders Small Streams, Large Streams, and Major Rivers and would contribute flow to those features.	0	1		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		

Wetland Functional Class: Riverine Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Riverine Wet Sedge Meadow
DOWL (2014) Field Plot ID: None
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer. Maintenance of Soil Thermal Regime is not applicable to wetlands that have a deep active layer or lack permafrost.*				*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	N/A		N/A	N/A		Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	N/A		N/A	N/A		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	N/A		N/A	N/A		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	N/A		N/A	N/A		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	N/A		N/A	N/A		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Riverine Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Riverine Wet Sedge Meadow
DOWL (2014) Field Plot ID: None
HGM: Riverine

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.07	This class crosswalks to the Riverine Sedge-Shrub Meadow habitat mapped in this study, which is expected to support 2 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.07	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.11	This class crosswalks to the Riverine Sedge-Shrub Meadow habitat mapped in this study, which is expected to support 10 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.11	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	0	DOWL (2014) and Jorgenson et al. (2009) document scattered surface water, but at <10% cover.	0	0		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	0	Sparse shrubs documented by Jorgenson et al. (2009) in the crosswalked ecotype.	0	0		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	1.18		0.00	0.68		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.24		0.00	0.14		
8. Fish Habitat Suitability					*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Very shallow surface water insufficient for supporting fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Shallow surface water (1.5 cm above ground) documented by Jorgenson et al. (2009) in the crosswalked ecotype.	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Jorgenson et al. (2009) document over 75% herbaceous vegetation, and <10% bare soil.	0	1	Localized changes in plant community compostion likely are limited to one occurrence of this class associated with a planned culvert outlet where overbank flooding may be limited. Otherwise, this class is associated with overbank flooding by Major Rivers and Large Streams, resulting in little opportunity for development of impoundments. Seasonal flooding expected to ameliorate the effects of any dust fallout from the road.	Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Very shallow surface water insufficient to provide spawning habitat.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Riverine Wet Sedge-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Riverine Wet Sedge Meadow

DOWL (2014) Field Plot ID: None

HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Jorgenson et al. (2009) did not record any S1-S3 or G1-G3 plants in the ecotype crosswalked to this functional class. Parker (2009) does not list any rare plants in the GAAR habitats likely to be found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of species per individual plot for the crosswalked ecotype is not within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0		If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
10. Subsistence Use					*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Neither Jorgenson et al. (2009) nor DOWL (2014) document at least 25% cover of berry-yielding plants in this functional class.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	0	This class crosswalks to the Riverine Sedge-Shrub Meadow habitat mapped in this study, which is not expected to be used regularly by important subsistence species in the AMDIAR/GAAR study area.	0	0		Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		

Wetland Functional Class: Riverine Wet Sedge-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Riverine Wet Sedge Meadow
DOWL (2014) Field Plot ID: None
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer.*			*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater discharge.*	*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	0	Riverine Wet Sedge-Shrub Meadow is located in active floodplains of Major Rivers, Large Streams, and Low-gradient Small Streams.	0	0		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	0	Riverine HGM class.	0	0		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	0	DOWL (2014) maps wetlands in this functional class as seasonally flooded.	0	0		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	0	No reference to seeps or springs in Jorgenson et al. (2009).	0	0		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	0	Wetlands either have both an inlet and an outlet, or border active channels.	0	0		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
12. Groundwater Recharge		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer.*			*Direct effects: any Riverine Wet Sedge-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater recharge.*	*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	0	Riverine HGM class.	0	0		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	0		0	0		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	0	Wetlands either have both an inlet and an outlet, or border active channels.	0	0		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		

Wetland Functional Class: Riverine Seasonally Flooded Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Riverine Bluejoint Meadow
DOWL (2014) Field Plot ID: T103-521
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Jorgenson et al. (2009) document >10% shrub vegetation in the crosswalked ecotpye, and DOWL's (2014) field plot data document >30% shrub vegetation.	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Riverine HGM class, but this wetland functional class is predominantly located in flood basins (old oxbows, depressional features).	0	1		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	0	DOWL (2014) did not document any signs of variable surface water. Jorgenson et al. (2009) did not track indications of variable surface water storage.	0	0		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	0	Riverine HGM classes are more likely to interact with channelized flow than sheet flow.	0	0		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.50		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	1	Riverine HGM class, but this wetland functional class is predominantly located in flood basins (old oxbows, depressional features).	0	1		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Jorgenson et al. (2009) document >10% shrub vegetation in the crosswalked ecotpye, and DOWL's (2014) field plot data document >30% shrub vegetation.	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	0	Jorgenson et al. (2009) does not document surface water in this community. DOWL (2014) references pockets of inundation, which are assumed to comprise <10% cover.	0	0	This wetland functional class is associated with overbank flooding by Major Rivers and Large Streams, resulting in little opportunity for development of impoundments.	A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	1	Buried organics documented throughout the soil profile in the crosswalked ecotype are related to riverine transport and deposition processes (Jorgenson et al. 2009).	0	1	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	0	Jorgenson et al. (2009) document thin surface organics. DOWL (2014) documents an organic-rich mineral layer.	0	0		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.60		0.00	0.60		

Wetland Functional Class: Riverine Seasonally Flooded Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Riverine Bluejoint Meadow
DOWL (2014) Field Plot ID: T103-521
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	Both Jorgenson et al. (2009) and DOWL (2014) document extensive cover of a dense, robust grass (*Calamagrostis canadensis*).	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	1	Jorgenson et al. (2009) document loamy soils. DOWL (2014) documents an organic-rich clay.	0	1		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	1	Riverine Seasonally Flooded Graminoid-Shrub Meadow borders Low-gradient Small Streams, Large Streams, and Major Rivers. Major Rivers and Large Streams are visible in historical imagery and the shorelines appear to be stable (see Riverine Functional Assessment).	0	1	Inappropriate to consider only pre-construction conditions, thus retained existing condition score for indirect effects.	Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		
4. Organic Matter Production and Export					*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Both DOWL (2014) and 'Jorgenson et al. (2009) document >95% cover herbaceous vegetation.	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	Although neither Jorgenson et al. (2009) nor DOWL (2014) document substantial surface water, this is a Riverine HGM seasonally flooded wetland type. DOWL (2014) mapped the wetland types in this functional class as seasonally flooded.	0	1	Associated with a range of stream crossing structures, but predominantly medium to large bridges. Some potential for at least temporary impoundments if culverts are not propoerly installed and maintained.	Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Riverine Seasonally Flooded Graminoid-Shrub Meadow borders Small Streams, Large Streams, and Major Rivers and would contribute flow to those features.	0	1		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		

Wetland Functional Class: Riverine Seasonally Flooded Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Riverine Bluejoint Meadow
DOWL (2014) Field Plot ID: T103-521
HGM: Riverine

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
5. Maintenance of Soil Thermal Regime		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer. Maintenance of Soil Thermal Regime is not applicable to wetlands that have a deep active layer or lack permafrost.*				*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	N/A		N/A	N/A		Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	N/A		N/A	N/A		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	N/A		N/A	N/A		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	N/A		N/A	N/A		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	N/A		N/A	N/A		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Riverine Seasonally Flooded Graminoid-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Riverine Bluejoint Meadow

DOWL (2014) Field Plot ID: T103-521

HGM: Riverine

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.14	This class crosswalks to the Riverine Grass-Shrub Meadow habitat mapped in this study, which is expected to support 4 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.14	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.11	This class crosswalks to the Riverine Grass-Shrub Meadow habitat mapped in this study, which is expected to support 10 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.11	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	0	DOWL (2014) and Jorgenson et al. (2009) document scattered surface water, but at <10% cover.	0	0		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	1	Jorgenson et al. (2009) document >10% shrub vegetation in the crosswalked ecotpye, and DOWL's (2014) field plot data document >30% shrub vegetation.	0	1		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2.26		0.00	1.76		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.45		0.00	0.35		
8. Fish Habitat Suitability					*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Very shallow surface water insufficient for supporting fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Jorgenson et al. (2009) does not document surface water in the crosswalked ecotype. DOWL (2014) references pockets of inundation, which are assumed to be shallow and comprise <10% cover.	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Both DOWL (2014) and Jorgenson et al. (2009) document >95% cover herbaceous vegetation.	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Very shallow surface water insufficient to provide spawning habitat.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Riverine Seasonally Flooded Graminoid-Shrub Meadow

Analogous Ecotypes (Jorgenson et al. 2009): Riverine Bluejoint Meadow

DOWL (2014) Field Plot ID: T103-521

HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Jorgenson et al. (2009) did not record any S1-S3 or G1-G3 plants in the ecotypes crosswalked with this functional class. Parker (2009) does not list any rare plants in the GAAR habitats likely to be found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	0	Mean count of species per individual plot for the crosswalked ecotype is not within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this class is not considered to support a high diversity of species.	0	0		If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
10. Subsistence Use					*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Neither Jorgenson et al. (2009) nor DOWL (2014) document at least 25% cover of berry-yielding plants in this functional class.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Riverine Grass-Shrub Meadow habitat mapped in this study, which is expected to be used regularly by moose in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Riverine Seasonally Flooded Graminoid-Shrub Meadow
Analogous Ecotypes (Jorgenson et al. 2009): Riverine Bluejoint Meadow
DOWL (2014) Field Plot ID: T103-521
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer.*			*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater discharge.*	*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	0	Riverine Seasonally Flooded Graminoid-Shrub Meadow is located in active floodplains of Major Rivers, Large Streams, and Low-gradient Small Streams.	0	0		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	0	Riverine HGM class.	0	0		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	0	DOWL (2014) maps this as seasonally flooded.	0	0		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	0	No reference to seeps or springs by Jorgenson et al. (2009) or DOWL (2014).	0	0		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	0	Wetlands either have both an inlet and an outlet, or border active channels.	0	0		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
12. Groundwater Recharge		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer.*			*Direct effects: any Riverine Seasonally Flooded Graminoid-Shrub Meadow occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater recharge.*	*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	0	Riverine HGM class.	0	0		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	0		0	0		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	0	Wetlands either have both an inlet and an outlet, or border active channels.	0	0		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		

Wetland Functional Class: Riverine Seasonally Flooded Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Riverine Birch-Willow Low Shrub, Riverine Willow Low Shrub, Riverine Moist Willow Tall Shrub, Riverine Wet Willow Tall Shrub

DOWL (2014) Field Plot ID:

HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrencs within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Both Jorgenson et al. (2009) and DOWL (2014) document substantial low to tall woody vegetation.	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Riverine HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	1	The single DOWL (2014) field plot in this class documents water marks and drift deposits.	0	1		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	0	Riverine HGM classes are more likely to interact with channelized flow than sheet flow.	0	0		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.50		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Riverine HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Both Jorgenson et al. (2009) and DOWL (2014) document substantial low to tall woody vegetation.	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	0	Neither Jorgenson et al. (2009) nor DOWL (2014) document substantial surface water.	0	0		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	1	Buried organics documented throughout the soil profile in the crosswalked ecotypes are related to riverine transport and deposition processes (Jorgenson et al. 2009).	0	1	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	0	Both Jorgenson et al. (2009) and DOWL (2014) document thin surface organic horizons.	0	0		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.40		

Wetland Functional Class: Riverine Seasonally Flooded Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Riverine Birch-Willow Low Shrub, Riverine Willow Low Shrub, Riverine Moist Willow Tall Shrub, Riverine Wet Willow Tall Shrub

DOWL (2014) Field Plot ID:

HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	Both DOWL (2014) and Jorgenson et al. (2009) document dense shrub vegetation.	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	1	Variable textures (gravelly, sandy, or loamy) are documented by Jorgenson et al. (2009) for the crosswalked riverine willow ecotypes, and loamy soils for other riverine shrub ecotypes. DOWL (2014) data point documents sandy loam soils.	0	1		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	1	Riverine Seasonally Flooded Deciduous Shrub borders Low-gradient Small Streams, Large Streams, and Major Rivers. Major Rivers and Large Streams are visible in historical imagery and the shorelines appear to be stable (see Riverine Functional Assessment).	0	1	Inappropriate to consider only pre-construction conditions, thus retained existing condition score for indirect effects.	Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		
4. Organic Matter Production and Export					*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	DOWL (2014) documents 65% cover herbaceous vegetation, and Jorgenson et al. (2009) document over 30% cover herbaceous vegetation, for 3 out of the 4 crosswalked ecotypes.	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	Although neither Jorgenson et al. (2009) nor DOWL (2014) document substantial surface water, this is a Riverine HGM seasonally flooded wetland type. DOWL (2014) predominantly mapped the wetland types in this functional class as seasonally flooded.	0	1		Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Riverine Seasonally Flooded Deciduous Shrub borders Major Rivers, Large Streams, and Low-gradient Small Streams and would contribute flow to those features.	0	1		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		

Wetland Functional Class: Riverine Seasonally Flooded Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Riverine Birch-Willow Low Shrub, Riverine Willow Low Shrub, Riverine Moist Willow Tall Shrub, Riverine Wet Willow Tall Shrub

DOWL (2014) Field Plot ID:

HGM: Riverine

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Predicted Post-development Condition Indirect Effects Score	Predicted Post-development Condition Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer. Maintenance of Soil Thermal Regime is not applicable to wetlands that have a deep active layer or lack permafrost.*				*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	N/A		N/A	N/A		Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	N/A		N/A	N/A		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	N/A		N/A	N/A		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	N/A		N/A	N/A		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	N/A		N/A	N/A		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Riverine Seasonally Flooded Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Riverine Birch-Willow Low Shrub, Riverine Willow Low Shrub, Riverine Moist Willow Tall Shrub, Riverine Wet Willow Tall Shrub

DOWL (2014) Field Plot ID:

HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
7. Bird and Mammal Habitat Suitability					*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.55	This class crosswalks to the Riverine Low Birch-Ericaceous Scrub, Riverine Low Willow Scrub, and Riverine Tall Alder-Willow Scrub habitats mapped in this study, which are expected to support 14, 16, and 16, respectively, of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.55	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.21	This class crosswalks to the Riverine Low Birch-Ericaceous Scrub, Riverine Low Willow Scrub, and Riverine Tall Alder-Willow Scrub habitats mapped in this study, which are expected to support 13, 21, and 23, respectively, of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.21	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	0	DOWL (2014) and Jorgenson et al. (2009) document scattered surface water, but at <10% cover.	0	0		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	1	Both Jorgenson et al. (2009) and DOWL (2014) document substantial low to tall woody vegetation.	0	1		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	2.76		0.00	2.26		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.55		0.00	0.45		
8. Fish Habitat Suitability					*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Very shallow surface water insufficient for supporting fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Neither Jorgenson et al. (2009) nor DOWL (2014) document substantial surface water in this functional class.	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Both DOWL (2014) and Jorgenson et al. (2009) document >50% cover deciduous shrub.	0	1	This class is associated with a range of stream crossing structures, but predominantly medium to large bridges. Some localized changes in plant community composition are likely in vicinity of culvert installations (overbank flooding will be more limited). Extent of change will depend on degree to which culvert effectively manages stream flow. Seasonal flooding expected to ameliorate the effects of any dust outfall from the road.	Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Very shallow surface water insufficient to provide spawning habitat.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Riverine Seasonally Flooded Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Riverine Birch-Willow Low Shrub, Riverine Willow Low Shrub, Riverine Moist Willow Tall Shrub, Riverine Wet Willow Tall Shrub

DOWL (2014) Field Plot ID:

HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Jorgenson et al. (2009) did not record any S1-S3 or G1-G3 plants in the ecotypes crosswalked to this functional class. Parker (2009) does not list any rare plants in the GAAR habitats likely to be found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	1	Mean count of species per individual plot for the crosswalked Riverine Willow Low Shrub is within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this functional class is considered to support a high diversity of species.	0	0.5	Moderate risk for colonization by invasive species as substrate is likely better drained than other wetlands, attracting species such as Sweet Clover (*Melilotus* spp.), although relatively dense shrub cover makes it more difficult for invasives to establish. Colonization by invasive species typically reduces species diversity.	If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	1		0	0.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.17		
10. Subsistence Use					*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Neither Jorgenson et al. (2009) nor DOWL (2014) document at least 25% cover of berry-yielding plants in this functional class.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Riverine Low Birch-Ericaceous Scrub, Riverine Low Willow Scrub, and Riverine Tall Alder-Willow Scrub jhabitats mapped in this study, which are expected to be used regularly by moose and caribou in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Riverine Seasonally Flooded Deciduous Shrub

Analogous Ecotypes (Jorgenson et al. 2009): Riverine Birch-Willow Low Shrub, Riverine Willow Low Shrub, Riverine Moist Willow Tall Shrub, Riverine Wet Willow Tall Shrub

DOWL (2014) Field Plot ID:

HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
11. Groundwater Discharge		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer.*			*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater discharge.*	*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	0	Riverine Seasonally Flooded Deciduous Shrub is located in active floodplains of Major Rivers, Large Streams, and Low-gradient Small Streams.	0	0		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	0	Riverine HGM class.	0	0		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	0	DOWL (2014) maps this functional class as seasonally flooded.	0	0		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	0	No reference to seeps or springs by Jorgenson et al. (2009) or DOWL (2014).	0	0		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	0	Wetlands either have both an inlet and an outlet, or border active channels.	0	0		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
12. Groundwater Recharge		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer.*			*Direct effects: any Riverine Seasonally Flooded Deciduous Shrub occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater recharge.*	*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	0	Riverine HGM class.	0	0		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	0		0	0		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	0	Wetlands either have both an inlet and an outlet, or border active channels.	0	0		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		

Wetland Functional Class: Riverine Seasonally Flooded Spruce Forest
Analogous Ecotypes (Jorgenson et al. 2009): Riverine White Spruce-Willow Forest
DOWL (2014) Field Plot ID: 194, 227, T34-187, T34-216, T34-218
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Predicted Post-development Condition: Indirect Effects Score	Predicted Post-development Condition: Rationale	Regional Rationale
1. Flood Flow Regulation (Storage)					*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for flood flow regulation.*	*Flood flow regulation assesses the ability of wetlands to store runoff or delay downslope movement of surface water. The conventional view that subsurface water storage is an effective modulator of stormflow is a misconception in permafrost regions (Woo 2012), althout surface water storage can be significant, depending on the structural characteristics of the vegetation and surface microtopography. Riverine and estuarine waters below the OHWM do not perform this function (and are treated as N/A).*
1. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Both DOWL (2014) and Jorgenson et al. (2009) document substantial woody vegetation (trees and shrubs).	0	1	This class is associated with Major Rivers and Large Streams, to be crossed by bridges and one major culvert (minor culverts cross Flow Paths and Small Streams within the floodplains of Major Rivers and Large Streams). Some localized changes in plant community composition are likely in the vicinity of culverts or bridges (overbank flooding will be more limited in association with culverts). Extent of change will depend on degree to which culverts effectively manages stream flow and BMPs are in place during bridge construction. Seasonal flooding is expected to ameliorate the effects of any dust fallout from the road.	Tussocks, low to tall (>20 cm height) woody stems, and polygonal features provide surface roughness, which delays downslope movement of floodwaters by slowing velocity. These are persistent features, present during spring snowmelt-generated flooding.
2. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Riverine HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012).
3. Wetland or water shows signs of storage (e.g., fluctuating water levels, algal mats, and/or lodged debris).	1	DOWL (2014) documents water marks, sediment deposits, and drift deposits at field plot 227.	0	1		Visible signs of storage indicate that a wetland is capable of, and has in the past, retained additional water.
4. Floodwaters enter and flow through wetland predominantly as sheet flow rather than channel flow.	0	Riverine HGM classes are more likely to interact with channelized flow than sheet flow.	0	0		Floodwater entering as sheet flow, rather than channelized flow, is more likely to interact with surface roughness features.
5. Waterbody is lake (>20 acres) (N/A if assessing wetlands).	N/A		N/A	N/A		Lakes (>20 acres) have substantial storage capacities, and modulate snowmelt-dominated streamflow regimes (Arp et al. 2012, Woo 2012).
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.50		0.00	0.50		
2. Sediment, Nutrient (N and P), Toxicant Removal					*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for sediment, nutrient, or toxicant removal.*	*Cold soil temperatures limit the ability of Arctic wetlands to perform denitrification, thus the assessment of the sediment, nutrient, and toxicant removal function focuses on the removal of inorganic sediments and adsorbed toxicants and nutrients through settlement. Sediment retention is used as a proxy for toxicant removal because many toxicants adsorb to sediments, and sediment retention is relatively easy to assess.*
1. Wetland or water is a depressional HGM class or has depressional features capable of storage.	0	Riverine HGM class.	0	0		HGM depressions occur in topographic depressions with closed contours, and flow vectors are from surrounding areas toward the center of the depression, allowing the accumulation of surface water. Ice-rich, raised polygonal rims act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012, Woo 2012). Slow or still-moving water in depressional features allows sediments and adsorbed toxicants to settle out of the water column, as opposed to swift-moving water that suspends sediments/toxicants.
2. Dense tussocks, low to tall woody vegetation present, or raised polygonal rims are present (N/A if assessing waters).	1	Both DOWL (2014) and Jorgenson et al. (2009) document substantial woody vegetation (trees and shrubs).	0	1	This class is associated with Major Rivers and Large Streams, to be crossed by bridges and one major culvert (minor culverts cross Flow Paths and Small Streams within the floodplains of Major Rivers and Large Streams). Some localized changes in plant community composition are likely in the vicinity of culverts or bridges (overbank flooding will be more limited in association with culverts). Extent of change will depend on degree to which culverts effectively manages stream flow and BMPs are in place during bridge construction. Seasonal flooding is expected to ameliorate the effects of any dust fallout from the road.	Tussocks and low to tall (>20cm height) woody stems provide surface roughness, which slows water velocity and allows sediments and adsorbed nutrients and toxicants to settle out of the water column (Helmers et al. 2008). Raised polygonal rims provide surface roughness, which delays downslope movement of floodwaters by slowing velocity, and also act as micro-depressions for long-term storage over the growing season (Liljedahl et al. 2012). These are persistent features, present during spring snowmelt-generated flooding.
3. At least moderate interspersion of vegetation and water is present. Surface water patches should account for >10% areal coverage (N/A if assessing waters).	0	Neither Jorgenson et al. (2009) nor DOWL (2014) document surface substantial water.	0	0		A productive cover of rooted vegetation typically reflects physical, chemical, and biological soil characteristics that help plants take up nutrients in the form of biomass (Lee et al. 1975), sorbing nutrients to sediments (Khlaid et al. 1977), and promoting denitrification (Lowrance et al. 1984).
4. Sediment deposits are present, providing evidence of deposition during natural flood events.	1	DOWL (2014) documents water marks, sediment deposits, and drift deposits at field plot 227. Buried organics documented throughout the soil profile in the crosswalked ecotypes are related to riverine transport and deposition processes (Jorgenson et al. 2009).	0	1	Cannot assess potential for future observations of sediment deposits, retained existing condition score.	Visible signs of sedimentation indicate that a wetland is capable of, and has in the past, allowed sediments and presumably adsorbed nutrients and toxicants to settle out of the water column.
5. Thick surface organic horizon and/or abundant fine organic litter is present (N/A if assessing waters).	0	Jorgenson et al. (2009) and DOWL (2014) document thin surface organic horizons.	0	0		Organic soils are effective at retaining heavy metals, some of which can be bound into long-term complexes with peat, particularly in cool climates.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.40		0.00	0.40		

Wetland Functional Class: Riverine Seasonally Flooded Spruce Forest
Analogous Ecotypes (Jorgenson et al. 2009): Riverine White Spruce-Willow Forest
DOWL (2014) Field Plot ID: 194, 227, T34-187, T34-216, T34-218
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
3. Erosion Control and Shoreline Stabilization					*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for erosion control and shoreline stabilization.*	*Assesses the ability of a wetland to stabilize banks through anchoring soils and dissipating erosive forces. This function is typically only performed by wetlands directly abutting a relatively permanent channelized water.*
1. Wetland has dense, energy absorbing vegetation bordering the watercourse and no evidence of erosion.	1	Both DOWL (2014) and Jorgenson et al. (2009) document substantial woody vegetation (trees and shrubs).	0	1	This class is associated with Major Rivers and Large Streams, to be crossed by bridges and one major culvert (minor culverts cross Flow Paths and Small Streams within the floodplains of Major Rivers and Large Streams). Some localized changes in plant community composition are likely in the vicinity of culverts or bridges (overbank flooding will be more limited in association with culverts). Extent of change will depend on degree to which culverts effectively manages stream flow and BMPs are in place during bridge construction. Seasonal flooding is expected to ameliorate the effects of any dust fallout from the road.	Plants bind soils with their root systems, and slow incoming waves or currents through increased surface roughness.
2. Soils are not predominantly sandy or silty, and are not ice rich.	0	Jorgenson et al. (2009) document loamy or sandy soils. DOWL (2014) has soils data for 3 field plots, 2 of which are sands.	0	0		Sandy and silty soils and ice rich permafrost are more susceptible to erosion.
3. Historical aerial photography (if available) indicates stable shoreline features.	1	Riverine Seasonally Flooded Spruce Forest borders Major Rivers and Large Streams. Major Rivers and Large Streams are visible in historical imagery and the shorelines appear to be stable (see Riverine Functional Assessment).	0	1	Inappropriate to consider only pre-construction conditions, thus retained existing condition score for indirect effects.	Visible evidence of stable shorelines indicates a lack of historical erosion, which may be due any one or a combination of factors including bank erodability, erosive force, or protection afforded by adjacent wetlands.
Sum of Indicators Present:	2		0	2		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.67		0.00	0.67		
4. Organic Matter Production and Export					*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for organic matter production and export.*	*Organic matter production and export assesses primary production and subsequent flushing of organic material to downstream waters. Wetlands that are not flooded at least every other year do not perform this function as flooding is the transport mechanism for moving organics to downstream waters. If no flooding occurs, production may be high but no carbon is exported.*
1. Wetland has at least 30%, or water has at least 10%, cover herbaceous vegetation. Woody plants are predominantly deciduous.	1	Jorgenson et al. (2009) document mean cover of <30% for herbaceous species, but nearly all of the 80% shrub cover is deciduous. DOWL (2014) documents >50% shrub cover at all field plots with vegetation data, and the shrub cover is predominantly deciduous.	0	1	This class is associated with Major Rivers and Large Streams, to be crossed by bridges and one major culvert (minor culverts cross Flow Paths and Small Streams within the floodplains of Major Rivers and Large Streams). Some localized changes in plant community composition are likely in the vicinity of culverts or bridges (overbank flooding will be more limited in association with culverts). Extent of change will depend on degree to which culverts effectively manages stream flow and BMPs are in place during bridge construction. Seasonal flooding is expected to ameliorate the effects of any dust fallout from the road.	As summarized by Adamus et al. (1991) herbaceous vegetation is generally more productive than aquatic bed, scrub-shrub, or forested wetland vegetation. Higher productivity generates more carbon available for export. Deciduous woody species produce higher quality litter than evergreen woody species, which have recalcitrant litter with high concentrations of lignin and phenolic compounds (Wardle 2002).
2. At least 10% of wetland is seasonally flooded (N/A for waters).	1	Although neither Jorgenson et al. (2009) nor DOWL (2014) document substantial surface water, this is a Riverine HGM seasonally flooded wetland type. DOWL (2014) predominantly mapped the wetland types in this functional class as seasonally flooded.	0	1		Surface water controls many differences between wetland types, including decomposition (Bayley and Mewhort 2004, Treplin and Zimmer 2012). Surface water promotes increased decomposition, which may facilitate carbon export (Adamus 2013).
3. Surface water outflow occurs outside of spring flooding.	1	Riverine Seasonally Flooded Spruce Forest borders Major Rivers and Large Streams and would contribute flow to those features.	0	1		A longer duration of surface water outflow provides more opportunity for organic matter export. While the vast majority of wetlands flood during spring breakup, fewer have surface water outflow later in the growing season, when small beaded streams can stop flowing and waterbodies become disconnected.
Sum of Indicators Present:	3		0	3		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	1.00		0.00	1.00		

Wetland Functional Class: Riverine Seasonally Flooded Spruce Forest
Analogous Ecotypes (Jorgenson et al. 2009): Riverine White Spruce-Willow Forest
DOWL (2014) Field Plot ID: 194, 227, T34-187, T34-216, T34-218
HGM: Riverine

Function and Indicators	Existing Condition Score	Existing Condition Rationale	Predicted Post-development Condition Direct Effects Score	Predicted Post-development Condition Indirect Effects Score	Predicted Post-development Condition Rationale	Regional Rationale
5. Maintenance of Soil Thermal Regime		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer. Maintenance of Soil Thermal Regime is not applicable to wetlands that have a deep active layer or lack permafrost.*				*Assesses the degree to which a given wetland type maintains a shallow active layer and underlying permafrost throughout the growing season.*
1. Vegetation cover is continuous.	N/A		N/A	N/A		Sites with stable, shallow active layers are usually well vegetated. The shade cast by erect vegetation, and the high albedo of herbaceous plant litter reduces radiative heat transfer to the active layer and underlying permafrost during summer (Blok et al. 2010). Mosses such as Sphagnum have very low thermal conductivity, buffering permafrost from summer air temperatures (Blok et al. 2011).
2. Wetland functional class does not have a permanently flooded hydrologic regime, and/or does not store a significant amount of floodwater.	N/A		N/A	N/A		Surface water strongly absorbs radiant energy, and deep waterbodies (≥ ~2m) are typically underlain by taliks (thaw bulbs) or lack permafrost altogether (Brosten et al. 2006). Flowing water also adds significant heat to the active layer and areas receiving large amounts of spring runoff are prone to active-layer deepening and thermal erosion (Putkonen 1998).
3. Wetland functional class is not within the riverine, lacustrine fringe, or estuarine fringe HGM classes.	N/A		N/A	N/A		Vegetation types that are seasonally inundated by overbank flooding from lakes and rivers typically have deep active layers or lack permafrost (Brosten et al. 2006).
4. Wetland soil profile is a histosol or histic epipedon.	N/A		N/A	N/A		A deep surface organic layer provides insulation to the subsurface and is a good predictor of shallow permafrost. Frozen, saturated peat has very high thermal conductivity and promotes recharge of permafrost during the winter.
5. If in a discontinuous permafrost zone, wetland is located on a north-facing aspect (N/A for wetlands in continuous permafrost zones).	N/A		N/A	N/A		North-facing slopes receive less solar insolation and often support shallow permafrost in the discontinuous permafrost zone (Yi et al. 2009).
6. Wetland occupied by geomorphic features indicative of high ground-ice content.	N/A		N/A	N/A		Periglacial features, such as low-centered polygons, palsas, and pingos are indicators of underlying bodies of massive ice. The high specific heat capacity of shallow ground-ice protects underlying permafrost from thawing. Ice-rich features are also highly prone to degradation and thaw settlement if the local thermal regime is disrupted.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		
6. Threatened and Endangered Species Support		*Threatened and Endangered Species Support is not applicable to wetlands and waters within the study area, as no species listed under the Endangered Species Act or in the State of Alaska's list of threatened or endangered species have ranges that include the study area.*				*Assesses the ability of a wetland or water to support Threatened or Endangered Species (TES) as listed under the Endangered Species Act (ESA), and threatened or endangered species or subspecies of fish or wildlife in Alaska as recognized by the Alaska Department of Fish and Game (ADF&G) under Alaska Statute 16.20.190.*
1. Wetland or water contains documented occurrence of a state or federally listed threatened or endangered species.	N/A		N/A	N/A		A documented occurrence confirms use by TES for at least some aspect of life history, even if the community isn't a preferred or designated critical habitat.
2. Wetland or water contains documented critical habitat, designated by the U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries).	N/A		N/A	N/A		NOAA Fisheries and USFWS, the two federal agencies responsible for administering the ESA, are required to designate critical habitat for listed species. Critical habitats are specific geographic areas containing features essential to the conservation of an endangered or threatened species, including areas not currently occupied but necessary for recovery.
3. Wetland or water is a known preferred habitat for state or federally listed threatened or endangered species.	N/A		N/A	N/A		If specific data on habitat preference in the study area is not available, a literature review is used to identify habitat preferences.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	0		0	0		
Score (indicator sum/max possible indicators):	N/A		N/A	N/A		

Wetland Functional Class: Riverine Seasonally Flooded Spruce Forest
Analogous Ecotypes (Jorgenson et al. 2009): Riverine White Spruce-Willow Forest
DOWL (2014) Field Plot ID: 194, 227, T34-187, T34-216, T34-218
HGM: Riverine

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
7. Bird and Mammal Habitat Suitability					*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide bird and mammal habitat.*	*Assesses whether the wetland or water supports a high diversity of birds and mammals. Habitat characteristics of the wetland or water, such as landscape setting, documented species richness, and habitat preference are considered.*
1. Wetland or water is undisturbed by human habitation or development.	1	The study area is within the undeveloped GAAR.	0	0.5	After construction of AMDIAR, wetlands and waters within the study area will be adjacent to an industrial access road. Level of disturbance will vary depending on the species and spatially with distance from the road.	Anthropogenic disturbance tends to reduce the diversity of birds and mammals using an area.
2. Wetland or water is used by a high diversity of mammal species.	0.68	This class crosswalks to the Riverine Spruce Forest habitat mapped in this study, which is expected to support 19 of the 28 mammal species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.68	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic wildlife surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
3. Wetland or water is used by a high diversity of avian species.	0.42	This class crosswalks to the Riverine Spruce Forest habitat mapped in this study, which is expected to support 37 of the 89 bird species likely to occur regularly in the AMDIAR/GAAR study area.	0.00	0.42	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	If no systematic avian surveys were conducted in the project area or near vicinity, a review of previous wildlife studies will identify which species are likely to regularly occur and what habitats they occupy.
4. Interspersion of vegetation and water is at least moderate (surface water patches accounting for 5–10% areal cover, or continuous cover of surface water with a well-developed emergent component).	0	DOWL (2014) and Jorgenson et al. (2009) document scattered surface water, but at <10% cover.	0	0		A greater variety of vegetation and cover types is present in communities with high vegetation-water interspersion. Communities with high vegetation water interspersion may support species adapted to open water, edge environments, and well-vegetated components of the community.
5. Wetland has 2 or more vegetation strata with at least 30% total cover each (N/A for waters).	1	Both Jorgenson et al. (2009) and DOWL (2014) document substantial trees and shrubs, with DOWL documenting >30% cover.	0	1		Complexity of vegetation structure is important to wildlife species common to Interior Alaska (Spindler and Kessel 1980, Kessel 1998).
Sum of Indicators Present:	3.09		0.00	2.59		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.62		0.00	0.52		
8. Fish Habitat Suitability					*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide fish habitat.*	*Applicable to all waters, and wetlands with perennial or intermittent surface water connection to a fish bearing water. Sheet flow during spring snowmelt is not considered a sufficiently reliable connection to fish-bearing waters for this function to be applicable.*
1. Fish are known to be present, or assumed present based on surface water connections to other fish-bearing waters.	0	Very shallow surface water insufficient for supporting fish.	0	0		A documented occurrence confirms use by fish for at least some aspect of life history.
2. Sufficient size and depth of open water so as not to freeze completely during winter, thus potentially providing overwintering habitat.	0	Neither Jorgenson et al. (2009) nor DOWL (2014) document substantial surface water in this wetland type.	0	0		Assessing whether the wetland or water provides overwintering habitat.
3. Herbaceous and/or woody vegetation is present in wetland and/or water to provide cover, shade, and/or detrital matter.	1	Both DOWL (2014) and Jorgenson et al. (2009) document >50% cover deciduous shrub.	0	1	This class is associated with Major Rivers and Large Streams, to be crossed by bridges and one major culvert (minor culverts cross Flow Paths and Small Streams within the floodplains of Major Rivers and Large Streams). Some localized changes in plant community composition are likely in the vicinity of culverts or bridges (overbank flooding will be more limited in association with culverts). Extent of change will depend on degree to which culverts effectively manages stream flow and BMPs are in place during bridge construction. Seasonal flooding is expected to ameliorate the effects of any dust fallout from the road.	Overhanging vegetation provides refuge from predators, shade to maintain water temperatures, and detrital matter contributions to the food web.
4. Suitable spawning areas are present.	0	Very shallow surface water insufficient to provide spawning habitat.	0	0		Assesses the presence of suitable spawning habitat, including aquatic vegetation, deep lakes, mixed gravels.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	4		4	4		
Score (indicator sum/max possible indicators):	0.25		0.00	0.25		

Wetland Functional Class: Riverine Seasonally Flooded Spruce Forest
Analogous Ecotypes (Jorgenson et al. 2009): Riverine White Spruce-Willow Forest
DOWL (2014) Field Plot ID: 194, 227, T34-187, T34-216, T34-218
HGM: Riverine

Function and Indicators	Existing Condition: Score	Existing Condition: Rationale	Predicted Post-development Condition: Direct Effects Score	Indirect Effects Score	Rationale	Regional Rationale
9. Rare Plant Habitat and Native Plant Diversity					*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity to provide rare plant habitats and native plant diversity.*	*Assessing the species richness of a wetland or water, including whether a wetland or water is known to support rare or imperiled plants.*
1. Wetland contains plant(s) ranked S1–S3 or G1–G3 as compiled by ACCS.	0	DOWL (2014) data do not identify any S1-S3 or G1-G3 plants within the study area in GAAR.	0	0		The Alaska Center for Conservation Science (ACCS, formerly the Alaska Natural Heritage Program) develops and maintains the Alaska Rare Plant List, comprising rare, disjunct, threatened, or biologically sensitive plants and lichens. Species are assigned a state conservation rank (S rank) at ACCS and a global conservation rank (G rank) by NatureServe. S/G ranks 1–3 identify species that are critically imperiled, imperiled, or rare.
2. Wetland contains habitats for plant(s) ranked S1–S3 or G1–G3 as compiled by ACSS.	0	Jorgenson et al. (2009) did not record any S1-S3 or G1-G3 plants in the ecotype crosswalked to this functional class. Parker (2009) does not list any rare plants in the GAAR habitats likely to be found within this functional class.	0	0		If no rare plant surveys have been conducted, review potential rare plant habitats within the study area.
3. Wetland supports a high diversity of plant species	1	Mean count of species per individual plot for the crosswalked Riverine White Spruce-Willow Forest is within the 4th quartile of all ecotypes within ARCN (Jorgenson et al. 2009), so this functional class is considered to support a high diversity of species.	0	0.5	Colonization by invasive species (with the potential to lower overall diversity) could be a concern as substrate is likely better drained that other wetlands, attracting species such as Sweet Clover (*Melilotus* spp.). Extent of risk depends on whether forest becomes more shrubby over time due to hydrologic changes associated with poor culvert installation and maintenance. Lack of barren substrate, however, would make it more difficult for invasives to establish.	If comprehensive species lists and cover values are available, compare evenness and richness among wetlands within the project area.
Sum of Indicators Present:	1		0	0.5		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.17		
10. Subsistence Use					*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for subsistence use.*	*In lieu of a site-specific subsistence study involving community input, evaluating the presence of resources with known subsistence value in conjunction with evidence of access can be used to indicate likely high value subsistence areas.*
1. Visible trails or known access points.	0	No visible trails or access points.	0	0	Use of the AMDIAR will initially be restricted to industrial traffic. However, if the access road eventually opens to all users, it will potentially provide an access point for both subsistence and recreational hunting and fishing, with the potential to diminish subsistence harvests (Guettabi et al. 2016).	Visible trails or known access points indicate that a wetland or water may have been used to access subsistence resources.
2. Wetland or water contains over 25% cover of berry-yielding species.	0	Jorgenson et al. (2009) document <25% cover of berry-yielding plants in the ecotype crosswalked to this functional class.	0	0		Wetland functional classes with high cover of berry-yielding species (*Vaccinium uliginosum, V. idis-idaea, V. microcarpus, Rubus chamaemorus*) may be important subsistence harvest areas.
3. Wetland encompasses high-value habitat for important subsistence species (moose, caribou, ducks, geese).	1	This class crosswalks to the Riverine Spruce Forest habitat mapped in this study, which is expected to be used regularly by moose in the AMDIAR/GAAR study area.	0	1	Some disturbance displacement is likely for most wildlife species as a result of construction of the road. This is expected to be limited and we assume that habitats will be available for use when traffic is not present.	Wetland functional classes encompassing high-value habitats for species likely to be subsistence harvested (moose, caribou, ducks, geese) may be important subsistence harvest areas.
Sum of Indicators Present:	1		0	1		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.33		0.00	0.33		

Wetland Functional Class: Riverine Seasonally Flooded Spruce Forest
Analogous Ecotypes (Jorgenson et al. 2009): Riverine White Spruce-Willow Forest
DOWL (2014) Field Plot ID: 194, 227, T34-187, T34-216, T34-218
HGM: Riverine

	Existing Condition		Predicted Post-development Condition			
Function and Indicators	**Score**	**Rationale**	**Direct Effects Score**	**Indirect Effects Score**	**Rationale**	**Regional Rationale**
11. Groundwater Discharge		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer.*			*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater discharge.*	*In lieu of direct measurements of groundwater discharge (i.e. long-term groundwater well or peizometer data), indicators of groundwater discharge are evaluated for wetlands without shallow permafrost.*
1. Wetland in toeslope position.	0	Riverine Seasonally Flooded Spruce Forest is located in active floodplains of Major Rivers, Large Streams, and Low-gradient Small Streams.	0	0		A break in slope may allow the water table to intersect the land surface, resulting in a groundwater discharge wetland (Winter et al. 1998).
2. Slope HGM class.	0	Riverine HGM class.	0	0		Slope HGM class wetlands have groundwater discharge as the dominant water source (Smith et al. 1995).
3. Wetland has semi-permanently or permanently flooded water regime.	0	DOWL (2014) maps this as seasonally flooded.	0	0		High water tables and stable hydrographs have been shown to be associated with greater groundwater discharge (Hunt et al. 1999).
4. Seeps or springs are observed.	0	No reference to seeps or springs by Jorgenson et al. (2009) or DOWL (2014).	0	0		Seeps and springs are direct observations of groundwater discharge.
5. Wetland has a surface water outlet but no inlet.	0	Wetlands either have both an inlet and an outlet, or border active channels.	0	0		Observation of surface water leaving a wetland, but not entering a wetland, suggest groundwater discharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	5		5	5		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		
12. Groundwater Recharge		*This functional class is associated with Major Rivers and Large Streams, which are likely to have a deep active layer.*			*Direct effects: any Riverine Seasonally Flooded Spruce Forest occurrences within the footprint of the AMDIAR would be filled, eliminating the capacity for groundwater recharge.*	*In lieu of direct measurements of groundwater recharge (i.e., long-term groundwater well or peizometer data), indicators of groundwater recharge are evaluated for wetlands without shallow permafrost.*
1. Depressional HGM class with no outlet.	0	Riverine HGM class.	0	0		Spring snowmelt will fill depressions, which may then recharge the aquifer later in the growing season.
2. Wetland is located in the upper 1/3 of its watershed.	0		0	0		Topographically high areas are more likely to serve as groundwater recharge points.
3. Wetland has a surface water inlet but no outlet.	0	Wetlands either have both an inlet and an outlet, or border active channels.	0	0		Observation of surface water entering a wetland, but not leaving a wetland, suggest groundwater recharge.
Sum of Indicators Present:	0		0	0		
Max Possible Indicators:	3		3	3		
Score (indicator sum/max possible indicators):	0.00		0.00	0.00		

Appendix E. Riverine functional assessment scoring sheets

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **Major Rivers** Named Rivers and Streams: Kobuk River, Reed River

Available Data: Lemke et al (2014), ABR (2014b), DOWL (2014) datapoints T33-185, T34-189

Stream Function Pyramid Level 1 Hydrology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Runoff	1. Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments, however, measures are in place to protect resources	Potential for concentrated flow/impairments to reach site and no treatments are in place	*Existing conditions:* no point-souce discharges to Major Rivers within the assessment area. *Short-term effects:* point-source discharges (dewatering) will likely be created with material site development adjacent to the Kobuk River in the southern alignment. It is assumed that all discharges will have adequate control measures in place throug Storm Water Pollution Protection Plans (SWPPP). *Long-term effects:* no point-source discharges are anticipated associated with long-term use of the road.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			
	2. Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover less than 6%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover 7 - 15%	Flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover greater than 15%	The flow regime of the Kobuk and Reed rivers, while flashy, is driven by landscape characteristics and underlying permafrost. Impervious cover in the watershed will not rise above 6% with construction of the Ambler Road.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	6	6	**1.00**
Proposed Short-Term Effects	5	6	**0.83**
Proposed Long-term Effects	6	6	**1.00**

Stream Function Pyramid Level 2 Hydraulics

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Floodplain Connectivity (Vertical Stability)	1. Floodplain Engagement	Channel likely to engage the floodplain at least annually		Channel unlikely to engage the floodplain at least annually	*Existing conditions:* as a field effort to collect data on bank height ratios and entrenchment was not possible, aerial imagery and detailed contours were reviewed to assess whether a river or stream was likely to engage the floodplain at least annually. *Short-term effects:* construction best management practices will likley require bridge installation during low-flow periods. Regardless, if a flood event occurs during construction Major Rivers will likely engage their floodplain even if there are diversions, etc. in place. *Long-term effects:* road construction is not anticipated to affect floodplain engagement outside of the direct effects footprint for Major Rivers within the study area.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			
	2. Floodplain Drainage	no concentrated flow; runoff is primarily sheet flow; hillslopes <10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented	runoff is equally sheet and concentrated flow (minor gully and rill erosion occurring); hillslopes 10–40%; hillslopes 50–200 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented	concentrated flows present (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or absent	*Existing conditions:* runoff primarily sheetflow, floodplain hillslopes <10%, and riparian wetlands within floodplain are well represented. *Short-term and long-term effects:* runoff will be a combination of sheet and concentrated flow (anticipate erosion at culvert outlets), no anticipated changes to floodplain hillslopes or riparian wetlands within floodplain. The northern alignment design info indicates major and minor culverts within the Kobuk River floodplain, and additional culverts discharging into the floodplain. The southern alignment indicates multiple culverts discharging to the Kobuk River floodplain. The southern alignment corridor parallels the Reed River for nearly one mile, and design info indicates over 20 minor culverts will discharge to Reed River floodplain.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		
	3. Vertical Stability Extent	Stable	Localized Instability	Widespread Instability	*Existing conditions:* Major Rivers within the study area are vertically stable. *Short-term and long-term effects:* large bridges are proposed for crossing all Major Rivers within the study area, and typicals indicate that they will require pilings placed within the channel with abutments of riprap or wing walls. Pilings add roughness to the channel and have the potential to affect channel flow velocity and channel depth and width. Replacing riparian vegetation with hardened banks can increase flow velocity and potential for scour and substrate coarsening (Millar and Quick 1998), and bank armoring can increase downstream erosion by transferring energy (Cramer et al. 2003).
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	9	9	**1.00**
Proposed Short-Term Effects	7	9	**0.78**
Proposed Long-term Effects	7	9	**0.78**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **Major Rivers** Named Rivers and Streams: Kobuk River, Reed River

Available Data: Lemke et al (2014), ABR (2014b), DOWL (2014) datapoints T33-185, T34-189

Stream Function Pyramid Level 3 Geomorphology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Riparian Vegetation	1. Riparian Vegetation Zone (EPA 1999, modified)	Riparian zone extends to a width of >100 feet; good vegetation community diversity and density; human activities do not impact zone; invasive species not present or sparse	Riparian zone extends to a width of 25-100 feet; species composition is dominated by 2 or 3 species; human activities greatly impact zone; invasive species well represented and alter the community	Riparian zone extends to a width of <25 feet; little or no riparian vegetation due to human activities; majority of vegetation is invasive	*Existing conditions:* the undisturbed riparian zone extends beyond 100 feet for all Major River crossings expect the Kobuk River southern route. No invasive species were observed in the Major River riparian zone during 2012-2013 field efforts (DOWL 2014), although *Taraxacum officinale* was documented at the nearby (and upstream) Walker Lake (McKee 2002). *Short-term effects:* human activities are anticipated to impact the riparian zone during construction, during placement of road fill, bridge abutments, and riprap within the road footprint. *Long-term effects:* see indirect effects to wetlands for anticipated changes to riparian vegetation in the vicinity of the road. Within both the northern and southern alignments, the riparian zone will extend >100 feet. We assume that the project will develop an Invasive Species Management Plan, which will include best management practices to prevent the introduction and spread of invasive species during construction (e.g., equipment will be washed prior to entering the construction zone) and operations (e.g., vehicles will be washed prior to entering the Ambler Road from the Dalton Highway). However, if this road becomes public (as has been the case with other industrial development roads in Alaska), It is unlikely that stringent invasive species protocols will be maintained and the likelihood of invasive species altering the community is much greater.
	Left Bank Existing Conditions	3			
	Left Bank Predicted--Short-term Effects		2		
	Left Bank Predicted--Long-term Effects		2		
	Right Bank Existing Conditions	3			
	Right Bank Predicted--Short-term Effects		2		
	Right Bank Predicted--Long-term Effects		2		
Lateral Stability	2. Lateral Stability Extent	Stable	Localized Instability	Widespread Instability	Existing conditions: as evaluated by ABR (2014b) comparison of contemporary and historical imagery. Short-term effects: temporary instability anticipated during installation of bridges and culverts. Long-term effects: large bridge typicals indicate bank armoring, which can increase downstream erosion by transferring energy (Cramer et al. 2003).
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		
Bedform Diversity (Do not complete if stream is ephemeral)	3. Shelter for Fish and Macroinvertebrates (EPA 1999)	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, rubble, gravel, cobble and large rocks, or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	20-70% mix of stable habitat; suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale)	Less than 20% mix of stable habitat; lack of habitat availability less than desirables obvious; substrate unstable or lacking	Existing conditions: as recorded by ABR (2014b) and Durand et al. (2009). Major Rivers generally lack shallows with large rocks for colonization. Fish cover (large woody debris, undercut banks, etc) is present but not abundant. Short-term effects: temporary loss of macroinvertebrate and fish habitat anticipated during bridge installation. Long-term effects: localized changes in habitat stability may occur as a result of bank hardening and piling placement, which affect velocity and thus substrate materials. These changes are not anticipated to be extensive enough to have a substantial effect on fish shelter or macroinvertebrate habitat.
	Existing Conditions		2		
	Predicted--Short-term Effects			1	
	Predicted--Long-term Effects		2		
	4. Habitat Heterogeneity	Reach contains a mix of 3 or more habitats (riffles, runs, pools, and glides).		Reach contains a mix of 2 or fewer habitats (riffles, runs, pools, and glides).	Existing conditions: assessment based on habitat mapping performed by ABR (2014b), as quantitative measurements habitat heterogeneity (pool to pool spacing, pool max depth, pool depth variability, etc.) are not available for this desktop evaluation. Northern alignment Kobuk River crossing reach contains riffle and run. Southern alignment Reed River crossing reach contains riffle, run and pool. Southern alignment Kobuk River crossing contains riffle, run, and glide. Short-term effects: temporary loss of habitat heterogeneity if the channel is diverted to facilitate bridge installation during construction. Long-term effects: while localized instability is likely, it is unlikely to be extensive enough to substantially alter habitats.
	Existing Conditions	3			
	Predicted--Short-term Effects			1	
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	14	15	**0.93**
Proposed Short-Term Effects	8	15	**0.53**
Proposed Long-term Effects	11	15	**0.73**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **Major Rivers** Named Rivers and Streams: Kobuk River, Reed River

Available Data: Lemke et al (2014), ABR (2014b), DOWL (2014) datapoints T33-185, T34-189

Stream Function Pyramid Level 4 Physicochemical

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Water Quality and Nutrients (Do not complete if stream is ephemeral)	1. Water Quality	Meets state surface water quality standards, including no oil sheen on surface.	May not meet state surface water quality standards at least seasonally. For example, high turbidity following storm events, or high temperature during the summer).	Does not meet state surface water quality standards. Year-long changes in ambient water conditions (increased turbidity, low DO, etc.) Obvious pollutants may be present, including a petroleum sheen.	Existing conditions: water quality within the Kobuk and Reed rivers met 2016 State of Alaska Surface Water Quality Standards for the growth and propoagation of Fish, Shellfish, Other Aquatic Life, and Wildlife for the parameters temperature, dissolved oxygen, and pH; no sheen was observed; and macrophytes were noted (ABR 2014b). Short-term effects: changes in turbidity, total suspended solids, and total dissolved solids may occur with runoff during road construction and bridge installation. Pollutants may enter Major Rivers from the roadway, or from spills during bridge installation. Long-term effects: summer operations will likely have dust deposition in nearby waters, and pollutants may enter Major Rivers from the roadway, but these are anticipated to be relatively minor inputs without substantial effects to Major Rivers.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			
	2. Detritus (Petersen, 1992)	Mainly consisting of leaves and wood without sediment covering it	Leaves and wood scarce; fine organic debris without sediment	Fine organic sediment - black in color and foul odor (anaerobic) or detritus absent	*Existing conditions:* no data are available on detritus within Major Rivers in the study area, but the high velocity waters are likely to have wood without sediment. *Short-term and long-term effects:* While sediment loads are likely to increase with road construction, it is unlikely that enough sediment will be added to the high-velocity waters to bury detritus.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	6	6	**1.00**
Proposed Short-Term Effects	5	6	**0.83**
Proposed Long-term Effects	6	6	**1.00**

Stream Function Pyramid Level 5 Biology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Biology (Do not complete if stream is ephemeral)	1. Macroinvertebrate Presence	Abundant	Sparse	Not present	*Existing conditions:* Durand et al (2011) found main channel habitat of the Kobuk River invertebrate communities to be relatively depauperate as compared to off-channel habitats. *Short-term and long-term effects:* no changes are anticipated due to direct and indirect effects.
	Existing Conditions		2		
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		
	2. Fish Presence	Abundant	Sparse	Not present	Existing conditions: resident and anadromous fish were documented in the Kobuk River by Durand et al. (2011) and ABR (2014b), and in the Reed River by ABR (2014b). Based on field observations, Lemke et al. (2014) proposed nearly 50 additional kilometers of the Kobuk River and 30 additional kilometers of the Reed River to be added to the Anadromous Waters Catalog. Short-term effects: instream construction activities could have short-term impacts by causing mortality of small, larval, or juvenile fish from equipment used in the stream, particularly any driving on the streambed (Surface Transportation Board 2009). We assume that construction will occur during low-water events, outside of spawning periods, and thus anticipate no substantial change in fish use of habitat. Long-term effects: large bridges are proposed for all Major River crossings in the study area, which should have minimal effects to fish passage or habitat.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	5	6	**0.83**
Proposed Short-Term Effects	5	6	**0.83**
Proposed Long-term Effects	5	6	**0.83**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **Large Streams** Named Rivers and Streams: 6 unnamed tributaries to Kobuk River, Reed River, and Kichaiakalea Creek

Available Data: Lemke et al (2014), ABR (2014b), DOWL (2014) datapoints T33-185, T34-189

Stream Function Pyramid Level 1 Hydrology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Runoff	1. Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments, however, measures are in place to protect resources	Potential for concentrated flow/impairments to reach site and no treatments are in place	*Existing conditions:* no point-souce discharges to Large Streams within the assessment area. *Short-term effects:* point source discharges (dewatering) will likely be created with material site development in the northern alignment. It is assumed that all discharges will have adequate control measures in place through Storm Water Pollution Protection Plans (SWPPP). *Long-term effects:* no point source discharges are anticipated associated with long-term use of the road.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			
	2. Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover less than 6%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover 7 - 15%	Flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover greater than 15%	The flow regime of Large Streams in the study area, while flashy, is driven by landscape characteristics and underlying permafrost. Impervious cover in the watershed will not rise above 6% with construction of the Ambler Road.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	6	6	**1.00**
Proposed Short-Term Effects	5	6	**0.83**
Proposed Long-term Effects	6	6	**1.00**

Stream Function Pyramid Level 2 Hydraulics

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Floodplain Connectivity (Vertical Stability)	1. Floodplain Engagement	Channel likely to engage the floodplain at least annually		Channel unlikely to engage the floodplain at least annually	*Existing conditions:* as a field effort to collect data on bank height ratios and entrenchment was not possible, aerial imagery and detailed contours were reviewed to assess whether a the river or stream was likely to engage the floodplain at least annually. *Short-term effects:* construction best management practices will likley require bridge and culvert installation during low-flow periods. Regardless, if a flood event occurs during construction Large Streams will likely engage their floodplain even if there are diversions, etc. in place. *Long-term effects:* road construction is not anticipated to affect floodplain engagement outside of the direct effects footprint for Large Streams within the study area.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			
	2. Floodplain Drainage	no concentrated flow; runoff is primarily sheet flow; hillslopes <10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented	runoff is equally sheet and concentrated flow (minor gully and rill erosion occurring); hillslopes 10–40%; hillslopes 50–200 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented	concentrated flows present (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or absent	*Existing conditions:* runoff primarily sheetflow, floodplain hillslopes <10%, and riparian wetlands within floodplain are well represented. *Short-term and long-term effects:* no anticipated changes to floodplain hillslopes or riparian wetlands within floodplain. Anticipate some erosion at culvert outlets, but most Large Streams are oriented perpendicular to the alignments with relatively few culverts discharging into their floodplains.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			
	3. Vertical Stability Extent	Stable	Localized Instability	Widespread Instability	*Existing conditions:* Large Streams within the study area are vertically stable. *Short-term and long-term effects:* medium bridges are proposed for all Large Stream crossings except for one in the southern alignment, whose crossing is proposed as a major culvert. Medium bridge typicals indicate no pilings will be placed in the channel, and abutments will be either riprap or wing walls. Replacing riparian vegetation with hardened banks can increase flow velocity and potential for scour and substrate coarsening (Millar and Quick 1998), and bank armoring can increase downstream erosion by transferring energy (Cramer et al. 2003). Major culvert typicals indicate that the 10 to 20-foot culverts will be embedded in the stream with reconstructed bed and banks. Localized instability may occur at culvert outlets.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	9	9	**1.00**
Proposed Short-Term Effects	8	9	**0.89**
Proposed Long-term Effects	8	9	**0.89**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine
Functional Class: **Large Streams** Named Rivers and Streams: 6 unnamed tributaries to Kobuk River, Reed River, and Kichaiakalea Creek

Available Data: Lemke et al (2014), ABR (2014b), DOWL (2014) datapoints T33-185, T34-189

Stream Function Pyramid Level 3 Geomorphology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Riparian Vegetation	1. Riparian Vegetation Zone (EPA 1999, modified)	Riparian zone extends to a width of >100 feet; good vegetation community diversity and density; human activities do not impact zone; invasive species not present or sparse	Riparian zone extends to a width of 25-100 feet; species composition is dominated by 2 or 3 species; human activities greatly impact zone; invasive species well represented and alter the community	Riparian zone extends to a width of <25 feet; little or no riparian vegetation due to human activities; majority of vegetation is invasive	*Existing conditions:* the undisturbed riparian zone extends beyond 100 feet for all Large Stream crossings expect the one on the southern alignment. No invasive species were observed in the Large Stream riparian zone during 2012-2013 field efforts (DOWL 2014), although *Taraxacum officinale* was documented at the nearby (and upstream) Walker Lake (McKee 2002). *Short-term effects:* human activities are anticipated to impact the riparian zone during construction, during placement of road fill, bridge abutments, and riprap within the road footprint. *Long-term effects:* see indirect effects to wetlands for anticipated changes to riparian vegetation in the vicinity of the road. Within both the northern and southern alignments, the riparian zone will extend >100 feet. We assume that the project will develop an Invasive Species Management Plan, which will include best management practices to prevent the introduction and spread of invasive species during construction (e.g., equipment will be washed prior to entering the construction zone) and operations (e.g., vehicles will be washed prior to entering the Ambler Road from the Dalton Highway). However, if this road becomes public (as has been the case with other industrial development roads in Alaska), It is unlikely that stringent invasive species protocols will be maintained and the likelihood of invasive species altering the community is much greater.
	Left Bank Existing Conditions	3			
	Left Bank Predicted--Short-term Effects		2		
	Left Bank Predicted--Long-term Effects		2		
	Right Bank Existing Conditions	3			
	Right Bank Predicted--Short-term Effects		2		
	Right Bank Predicted--Long-term Effects		2		
Lateral Stability	2. Lateral Stability Extent	Stable	Localized Instability	Widespread Instability	*Existing conditions:* as evaluatedby comparing contemporary and historical imagery. Large Streams whose channels were not visible in the imagery were evaluated by comparing shrubby swales obscuring the channel. *Short-term effects:* temporary instability anticipated during installation of bridges and culverts. Long-term effects: large bridge typicals indicate bank armoring, which can increase downstream erosion by transferring energy (Cramer et al. 2003).
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		
Bedform Diversity (Do not complete if stream is ephemeral)	3. Shelter for Fish and Macroinvertebrates (EPA 1999)	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, rubble, gravel, cobble and large rocks, or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	20-70% mix of stable habitat; suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale)	Less than 20% mix of stable habitat; lack of habitat availability less than desirables obvious; substrate unstable or lacking	*Existing conditions:* as documented in photographs by Lemke et al. (2014) at survey reaches UN32 through UN38. *Short-term effects:* temporary loss of macroinvertebrate and fish habitat anticipated during bridge and culvert installation. *Long-term effects:* localized changes in habitat stability may occur as a result of bank hardening and piling placement, which affect velocity and thus substrate materials. These changes are not anticipated to be extensive enough to have a substantial effect on fish shelter or macroinvertebrate habitat.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			
	4. Habitat Heterogeneity	Reach contains a mix of 3 or more habitats (riffles, runs, pools, and glides).		Reach contains a mix of 2 or fewer habitats (riffles, runs, pools, and glides).	*Existing conditions:* review of aerial imagery and site photographs suggest that most Large Streams are sinuous, and contain at least 2, if not 3, habitat types. *Short-term effects:* medium bridges are proposed for all Large Stream crossings except for one in the southern alignment, whose crossing is proposed as a major culvert. The installation of medium bridges will have minimal impact on habitat heterogeneity (no instream structures, stream diversion unlikely), but the installation of major culverts will likely result in short-term loss of habitat heterogeneity due to instream work. *Long-term effects:* medium bridges, with no in-stream structures, are proposed for all but one Large Stream crossing and are anticipated to have minimal effects on habitat heterogeneity. While localized instability is likely, it is unlikely to be extensive enough to substantially alter habitats.
	Existing Conditions	3			
	Predicted--Short-term Effects			1	
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	15	15	**1.00**
Proposed Short-Term Effects	9	15	**0.60**
Proposed Long-term Effects	12	15	**0.80**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **Large Streams** Named Rivers and Streams: 6 unnamed tributaries to Kobuk River, Reed River, and Kichaiakalea Creek

Available Data: Lemke et al (2014), ABR (2014b), DOWL (2014) datapoints T33-185, T34-189

Stream Function Pyramid Level 4 Physicochemical

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Water Quality and Nutrients (Do not complete if stream is ephemeral)	1. Water Quality	Meets state surface water quality standards, including no oil sheen on surface.	May not meet state surface water quality standards at least seasonally. For example, high turbidity following storm events, or high temperature during the summer).	Does not meet state surface water quality standards. Year-long changes in ambient water conditions (increased turbidity, low DO, etc.) Obvious pollutants may be present, including a petroleum sheen.	*Existing conditions:* water quality within Large Streams in the study area met 2016 State of Alaska Surface Water Quality Standards for the growth and propoagation of Fish, Shellfish, Other Aquatic Life, and Wildlife for the parameters temperature, dissolved oxygen, and turbidity; pH was not measured; no sheen was observed (Lemke et al. 2014). *Short-term effects:* changes in turbidity, total suspended solids, and total dissolved solids may occur with runoff during road construction and bridge and culvert installation. Pollutants may enter Large Streams from the roadway, or from spills during bridge installation. *Long-term effects:* summer operations will likely have dust deposition in nearby waters, and pollutants may enter Large Streams from the roadway, but these are anticipated to be relatively minor inputs without substantial effects to Large Streams
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			
	2. Detritus (Petersen, 1992)	Mainly consisting of leaves and wood without sediment covering it	Leaves and wood scarce; fine organic debris without sediment	Fine organic sediment - black in color and foul odor (anaerobic) or detritus absent	*Existing conditions:* no data are available on detritus within Large Streams in the study area, but the high velocity waters are likely to have wood without sediment. *Short-term and long-term effects:* while sediment loads are likely to increase with road construction, it is unlikely that enough sediment will be added to the high-velocity waters to bury detritus.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	6	6	**1.00**
Proposed Short-Term Effects	5	6	**0.83**
Proposed Long-term Effects	6	6	**1.00**

Stream Function Pyramid Level 5 Biology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Biology (Do not complete if stream is ephemeral)	1. Macroinvertebrate Presence	Abundant	Sparse	Not present	*Existing conditions:* no data are available for macroinvertebrate communities within Large Streams in the study area, but these are likely to be similar to Major Rivers. *Short-term and long-term effects:* bridge installation and long-term operations unlikley to have substantial affects to macroinvertebrate community.
	Existing Conditions		2		
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		
	2. Fish Presence	Abundant	Sparse	Not present	*Existing conditions:* resident and anadromous fish were documented in Large Streams and extensions to the Anadromous Waters Catalog were proposed by Lemke et al. (2014). *Short-term effects:* Instream construction activities could have short-term impacts by causing mortality of small, larval, or juvenile fish from equipment used in the stream, particularly any driving on the streambed (Surface Transportation Board 2009). *Long-term effects:* medium bridges and major culverts are proposed for all Large Stream crossings, which should have minimal effect on fish passage.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	5	6	**0.83**
Proposed Short-Term Effects	5	6	**0.83**
Proposed Long-term Effects	5	6	**0.83**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **Low-gradient Small Streams** Named Rivers and Streams: ____________

Available Data: N/A

Stream Function Pyramid Level 1 Hydrology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Runoff	1. Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments however, measures are in place to protect resources	Potential for concentrated flow/impairments to reach site and no treatments are in place	*Existing conditions:* no point-souce discharges to Low-gradient Small Streams within the assessment area. *Short-term effects:* point source discharges (dewatering) will likely be created with material site development in the southern alignment. It is assumed that all discharges will have adequate control measures in place through Storm Water Pollution Protection Plans (SWPPP). *Long-term effects:* no point source discharges are anticipated associated with long-term use of the road.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			
	2. Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover less than 6%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover 7 - 15%	Flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover greater than 15%	The flow regime of streams in the study area, while flashy, is driven by landscape characteristics and underlying permafrost. Impervious cover in the watershed will n rise above 6% with construction of the Ambler Road.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	6	6	**1.00**
Proposed Short-Term Effects	5	6	**0.83**
Proposed Long-term Effects	6	6	**1.00**

Stream Function Pyramid Level 2 Hydraulics

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Floodplain Connectivity (Vertical Stability)	1. Floodplain Engagement	Channel likely to engage the floodplain at least annually		Channel unlikely to engage the floodplain at least annually	*Existing conditions:* as a field effort to collect data on bank height ratios and entrenchment was not possible, aerial imagery and detailed contours were reviewed to assess whether a the river or stream was likely to engage the floodplain at least annually. *Short-term effects:* construction best management practices will likley require bridge and culvert installation during low-flow periods. Regardless, if a flood event occurs during construction Large Streams will likely engage their floodplain even if there are diversions, etc. in place. *Long-term effects:* minor culverts are proposed for the majority of Low-gradient Small Stream crossings. Minor culvert typicals indicate that the 36-inch culverts will not be embedded in the stream. The invert will be placed at streambed level, with riprap at the outlet. Smaller, non-embedded culverts are more prone to plugging with debris, disconnecting them from downstream riparian corridors. We assume that appropriate maintenance will be conducted, and that streams will maintain continuity with downstream environments.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			
	2. Floodplain Drainage	no concentrated flow; runoff is primarily sheet flow; hillslopes <10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented	runoff is equally sheet and concentrated flow (minor gully and rill erosion occurring); hillslopes 10-40%; hillslopes 50–200 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented	concentrated flows present (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or absent	*Existing conditions:* runoff primarily sheetflow, floodplain hillslopes <10%, and riparian wetlands within floodplain are well represented. *Short-term and long-term effects:* no anticipated changes to floodplain hillslopes or riparian wetlands within floodplain.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			
	3. Vertical Stability Extent	Stable	Localized Instability	Widespread Instability	*Existing conditions:* Low-gradient Small Streams within the study area are vertically stable. *Short-term and long-term effects:* minor culverts are proposed for the majority of Low-gradient Small Stream crossings. Minor culvert typicals indicate that the 36-inch culverts will not be embedded in the stream. The invert will be placed at streambed level, with riprap at the outlet. Localized vertical instability may occur at culvert outlets.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	9	9	**1.00**
Proposed Short-Term Effects	8	9	**0.89**
Proposed Long-term Effects	8	9	**0.89**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **Low-gradient Small Streams** Named Rivers and Streams: ____________

Available Data: N/A

Stream Function Pyramid Level 3 Geomorphology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Riparian Vegetation	1. Riparian Vegetation Zone (EPA 1999, modified)	Riparian zone extends to a width of >100 feet; good vegetation community diversity and density; human activities do not impact zone; invasive species not present or sparse	Riparian zone extends to a width of 25-100 feet; species composition is dominated by 2 or 3 species; human activities greatly impact zone; invasive species well represented and alter the community	Riparian zone extends to a width of <25 feet; little or no riparian vegetation due to human activities; majority of vegetation is invasive	*Existing conditions:* the undisturbed riparian zone extends beyond <100 feet for Lo gradient Small Streams. No invasive species were observed in the Large Stream riparian zone during 2012-2013 field efforts (DOWL 2014), although *Taraxacum officinale* was documented at the nearby (and upstream) Walker Lake (McKee 2002). *Short-term effects:* human activities are anticipated to impact the riparian zone during construction, during placement of road fill, bridge abutments, and riprap within the road footprint. *Long-term effects:* see indirect effects to wetlands for anticipated changes to riparian vegetation in the vicinity of the road. Within both the northern and southern alignments, the riparian zone will extend >100 feet. We assume that the project will develop an Invasive Species Management Plan, which will include best manageme practices to prevent the introduction and spread of invasive species during construction (e.g., equipment will be washed prior to entering the construction zone) and operations (e.g., vehicles will be washed prior to entering the Ambler Road from the Dalton Highway). However, if this road becomes public (as has been the case with other industrial development roads in Alaska), It is unlikely that stringent invasive species protocols will be maintained and the likelihood of invasive species altering the community is much greater. Also, minor culverts have a higher liklelihoo of plugging, with upstream flooding affecting riparian vegetation.
	Left Bank Existing Conditions	3			
	Left Bank Predicted--Short-term Effects		2		
	Left Bank Predicted--Long-term Effects		2		
	Right Bank Existing Conditions	3			
	Right Bank Predicted--Short term Effects		2		
	Right Bank Predicted--Long term Effects		2		
Lateral Stability	2. Lateral Stability Extent	Stable	Localized Instability	Widespread Instability	Small Streams are not readily discernable in contemporary or historical imagery, thus no assessment of lateral stability could be made.
	Existing Conditions				
	Predicted--Short-term Effects				
	Predicted--Long-term Effects				
Bedform Diversity (Do not complete if stream is ephemeral)	3. Shelter for Fish and Macroinvertebrates (EPA 1999)	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, rubble, gravel, cobble and large rocks, or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	20-70% mix of stable habitat; suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale)	Less than 20% mix of stable habitat; lack of habitat availability less than desirables obvious; substrate unstable or lacking	*Existing conditions:* no data on fish and macroinvertebrate shelter is available, but review of site photographs suggests ample cover and habitat features within small streams. *Short-term effects:* temporary reduction of macroinvertebrate and fish habitat durin culvert installation. *Long-term effects:* minor culvert typicals show no streambed material within the culvert, and riprap extending beyond culvert inlets and outlets.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		
	4. Habitat Heterogeneity	Reach contains a mix of 3 or more habitats (riffles, runs, pools, and glides).		Reach contains a mix of 2 or fewer habitats (riffles, runs, pools, and glides).	Insufficient data are available to assess habitat heterogeneity for this stream type
	Existing Conditions				
	Predicted--Short-term Effects				
	Predicted--Long-term Effects				

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	9	9	**1.00**
Proposed Short-Term Effects	6	9	**0.67**
Proposed Long-term Effects	6	9	**0.67**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **Low-gradient Small Streams** Named Rivers and Streams: ____________

Available Data: N/A

Stream Function Pyramid Level 4 Physicochemical

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Water Quality and Nutrients (Do not complete if stream is ephemeral)	1. Water Quality	Meets state surface water quality standards, including no oil sheen on surface.	May not meet state surface water quality standards at least seasonally. For example, high turbidity following storm events, or high temperature during the summer).	Does not meet state surface water quality standards. Year-long changes in ambient water conditions (increased turbidity, low DO, etc.) Obvious pollutants may be present, including a petroleum sheen.	*Existing conditions:* water quality data are not available for Low-gradient Small Streams. DOWL (2014) field data do not indicate sheens, films, or turbid water. *Short-term effects:* changes in turbidity, total suspended solids, and total dissolved solids may occur with runoff during road construction and culvert installation. Pollutants may enter Low-gradient Small Streams from the roadway, or from spills during culvert installation. *Long-term effects:* summer operations will have dust deposition in nearby waters, and pollutants may enter Low-gradient Small Streams from the roadway, but these are anticipated to be relatively minor inputs without substantial effects to streams.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			
	2. Detritus (Petersen, 1992)	Mainly consisting of leaves and wood without sediment covering it	Leaves and wood scarce; fine organic debris without sediment	Fine organic sediment - black in color and foul odor (anaerobic) or detritus absent	*Existing conditions:* no data are available on detritus within Low-gradient Small Streams in the study area, but site photographs suggest they are likely to have wood and leaves without sediment. *Short-term effects:* sediment loads are likely to increase with road construction, and may bury detritus in these low-gradient, lower velocity small streams. *Long-term effects:* summer operations will have dust deposition in nearby waters, but these are anticipated to be relatively minor inputs without substant effects to streams.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	6	6	**1.00**
Proposed Short-Term Effects	4	6	**0.67**
Proposed Long-term Effects	6	6	**1.00**

Stream Function Pyramid Level 5 Biology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Biology (Do not complete if stream is ephemeral)	1. Macroinvertebrate Presence	Abundant	Sparse	Not present	*Existing Conditions:* while no data are available for macroinvertebrates in small streams, we assume abundant macroinvertebrates are present due to likely high oxygen levels, low gradient, and undisturbed nature of the system. *Short-term effects:* the installation of minor culverts and disturbance related to instream work will likely result in a decrease in macroinvertebrates within the construction zone and immediate downstream waters. *Long-term effects:* while localized instability is possible with minor culverts, it is not anticipated to be widespread enough to substantially affect macroinvertebrate communities.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			
	2. Fish Presence	Abundant	Rare	Not present	*Existing conditions:* while no fish surveys have been conducted in Low-gradient Small Streams, we assume that they habitat for resident and anadromous fish based on their downstream connections to waters supporting anadromy and the lack of obvious barriers to fish. *Short-term effects:* instream construction activities could have short-term impacts by causing mortality of small, larval, or juvenile fish from equipment used in the stream, particularly any driving on the streambed (Surface Transportation Board 2009). *Long-term effects:* typicals for minor culverts show that they will not be embedded, that there will be riprap at culvert inlets and outlets, and that there will be no bed material within culverts. While sufficient for maintaining hydrologic connectivity across the road, these culverts have the potential to negatively effect fish passage (e.g., smaller fish during high flow events) even with proper maintenance.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	6	6	**1.00**
Proposed Short-Term Effects	4	6	**0.67**
Proposed Long-term Effects	5	6	**0.83**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **High-gradient Small Streams** Named Rivers and Streams:

Available Data: N/A

Stream Function Pyramid Level 1 Hydrology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Runoff	1. Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments, however, measures are in place to protect resources	Potential for concentrated flow/impairments to reach site and no treatments are in place	*Existing conditions:* no point-souce discharges to High-gradient Small Streams within the assessment area. *Short-term and long-term effects:* no High-gradient Small Streams are in the vicinity of proposed material sites, no point source discharges are anticipated associated with long-term use of the road.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			
	2. Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover less than 6%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover 7 - 15%	Flashy flow regime as a result of rainfall patterns, geology, and soils; impervious cover greater than 15%	The flow regime of streams in the study area, while flashy, is driven by landscape characteristics and underlying permafrost. Impervious cover in the watershed will not rise above 6% with construction of the Ambler Road.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	6	6	**1.00**
Proposed Short-Term Effects	6	6	**1.00**
Proposed Long-term Effects	6	6	**1.00**

Stream Function Pyramid Level 2 Hydraulics

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Floodplain Connectivity (Vertical Stability)	1. Floodplain Engagement	Channel likely to engage the floodplain at least annually		Channel unlikely to engage the floodplain at least annually	*Existing conditions:* as a field effort to collect data on bank height ratios and entrenchment was not possible, aerial imagery and detailed contours were reviewed to assess whether a the river or stream was likely to engage the floodplain at least annually. *Short-term effects:* construction best management practices will likley require bridge and culvert installation during low-flow periods. Regardless, if a flood event occurs during construction Large Streams will likely engage their floodplain even if there are diversions, etc. in place. *Long-term effects:* minor culverts are proposed for the majority of Low-gradient Small Stream crossings. Minor culvert typicals indicate that the 36-inch culverts will not be embedded in the stream. The invert will be placed at streambed level, with riprap at the outlet. Smaller, non-embedded culverts are more prone to plugging with debris, disconnecting them from downstream riparian corridors. We assume that appropriate maintenance will be conducted, and that streams will maintain continuity with downstream environments.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			
	2. Floodplain Drainage	no concentrated flow; runoff is primarily sheet flow; hillslopes <10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented	runoff is equally sheet and concentrated flow (minor gully and rill erosion occurring); hillslopes 10–40%; hillslopes 50–200 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented	concentrated flows present (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or absent	*Existing conditions:* runoff primarily sheetflow, floodplain hillslopes <10%, and riparian wetlands within floodplain are well represented. *Short-term and long-term effects:* no anticipated changes to floodplain hillslopes or riparian wetlands within floodplain.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			
	3. Vertical Stability Extent	Stable	Localized Instability	Widespread Instability	*Existing conditions:* High-gradient Small Streams within the study area are vertically stable. *Short-term and long-term effects:* minor culverts are proposed for the majority of High-gradient Small Stream crossings. Minor culvert typicals indicate that the 36-inch culverts will not be embedded in the stream. The invert will be placed at streambed level, with riprap at the outlet. Localized vertical instability may occur at culvert outlets.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	9	9	**1.00**
Proposed Short-Term Effects	8	9	**0.89**
Proposed Long-term Effects	8	9	**0.89**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **High-gradient Small Streams** Named Rivers and Streams: ____________

Available Data: N/A

Stream Function Pyramid Level 3 Geomorphology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Riparian Vegetation	1. Riparian Vegetation Zone (EPA 1999, modified)	Riparian zone extends to a width of >100 feet; good vegetation community diversity and density; human activities do not impact zone; invasive species not present or sparse	Riparian zone extends to a width of 25-100 feet; species composition is dominated by 2 or 3 species; human activities greatly impact zone; invasive species well represented and alter the community	Riparian zone extends to a width of <25 feet; little or no riparian vegetation due to human activities; majority of vegetation is invasive	*Existing conditions:* the undisturbed riparian zone extends < 100 feet for all High-gradient Small Stream crossings. No invasive species were observed in the Large Stream riparian zone during 2012-2013 field efforts (DOWL 2014), although *Taraxacum officinale* was documented at the nearby (and upstream) Walker Lake (McKee 2002). *Short-term effects:* human activities are anticipated to impact the riparian zone during construction, during placement of road fill, bridge abutments, and riprap within the road footprint. *Long-term effects:* see indirect effects to wetlands for anticipated changes to riparian vegetation in the vicinity of the road. Within both the northern and southern alignments, the riparian zone will extend >100 feet. We assume that the project will develop an Invasive Species Management Plan, which will include best management practices to prevent the introduction and spread of invasive species during construction (e.g., equipment will be washed prior to entering the construction zone) and operations (e.g., vehicles will be washed prior to entering the Ambler Road from the Dalton Highway). However, if this road becomes public (as has been the case with other industrial development roads in Alaska), It is unlikely that stringent invasive species protocols will be maintained and the likelihood of invasive species altering the community is much greater. Also, minor culverts have a higher liklelihood of plugging, with upstream flooding affecting riparian vegetation.
	Left Bank Existing Conditions	3			
	Left Bank Predicted--Short-term Effects		2		
	Left Bank Predicted--Long-term Effects		2		
	Right Bank Existing Conditions	3			
	Right Bank Predicted--Short-term Effects		2		
	Right Bank Predicted--Long-term Effects		2		
Lateral Stability	2. Lateral Stability Extent	Stable	Localized Instability	Widespread Instability	Small Streams are not readily discernable in contemporary or historical imagery, thus no assessment of lateral stability could be made.
	Existing Conditions				
	Predicted--Short-term Effects				
	Predicted--Long-term Effects				
Bedform Diversity (Do not complete if stream is ephemeral)	3. Shelter for Fish and Macroinvertebrates (EPA 1999)	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, rubble, gravel, cobble and large rocks, or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	20-70% mix of stable habitat; suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale)	Less than 20% mix of stable habitat; lack of habitat availability less than desirables obvious; substrate unstable or lacking	*Existing conditions:* no data on fish and macroinvertebrate shelter is available, but review of site photographs suggests ample cover and habitat features within small streams. *Short-term effects:* temporary reduction of macroinvertebrate and fish habitat during culvert installation. *Long-term effects:* minor culvert typicals show no streambed material within the culvert, and riprap extending beyond culvert inlets and outlets.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		
	4. Habitat Heterogeneity	Reach contains a mix of 3 or more habitats (riffles, runs, pools, and glides).		Reach contains a mix of 2 or fewer habitats (riffles, runs, pools, and glides).	Insufficient data are available to assess habitat heterogeneity for this stream type.
	Existing Conditions				
	Predicted--Short-term Effects				
	Predicted--Long-term Effects				

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	9	9	**1.00**
Proposed Short-Term Effects	6	9	**0.67**
Proposed Long-term Effects	6	9	**0.67**

Function-based Rapid Reach Level Stream Assessment (modified from Starr et al. 2015)

Riverine Functional Class: **High-gradient Small Streams** Named Rivers and Streams: ____________

Available Data: N/A

Stream Function Pyramid Level 4 Physicochemical

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Water Quality and Nutrients (Do not complete if stream is ephemeral)	1. Water Quality	Meets state surface water quality standards, including no oil sheen on surface.	May not meet state surface water quality standards at least seasonally. For example, high turbidity following storm events, or high temperature during the summer).	Does not meet state surface water quality standards. Year-long changes in ambient water conditions (increased turbidity, low DO, etc.) Obvious pollutants may be present, including a petroleum sheen.	*Existing conditions:* water quality data are not available for High-gradient Small Streams. DOWL (2014) field data do not indicate sheens, films, or turbid water. *Short-term effects:* changes in turbidity, total suspended solids, and total dissolved solids may occur with runoff during road construction and culvert installation. Pollutants may enter Low-gradient Small Streams from the roadway, or from spills during culvert installation. *Long-term effects:* summer operations will have dust deposition in nearby waters, and pollutants may enter Low-gradient Small Streams from the roadway, but these are anticipated to be relatively minor inputs without substantial effects to streams.
	Existing Conditions	3			
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects	3			
	2. Detritus (Petersen, 1992)	Mainly consisting of leaves and wood without sediment covering it	Leaves and wood scarce; fine organic debris without sediment	Fine organic sediment - black in color and foul odor (anaerobic) or detritus absent	*Existing conditions:* no data are available on detritus within High-gradient Small Streams in the study area, but site photographs suggest they are likely to have wood and leaves without sediment. *Short-term and long-term effects:* sediment loads are likely to increase with road construction, but are unlikely to bury detritus in these high-gradient, higher velocity small streams.
	Existing Conditions	3			
	Predicted--Short-term Effects	3			
	Predicted--Long-term Effects	3			

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	6	6	**1.00**
Proposed Short-Term Effects	5	6	**0.83**
Proposed Long-term Effects	6	6	**1.00**

Stream Function Pyramid Level 5 Biology

Parameter	Indicator	Score 3	Score 2	Score 1	Rationale
Biology (Do not complete if stream is ephemeral)	1. Macroinvertebrate Presence	Abundant	Sparse	Not present	*Existing Conditions:* while no data are available for macroinvertebrates in small streams, we assume macroinvertebrates are sparse due to high gradient. *Short-term effects:* The installation of minor culverts and disturbance related to instream work will likely result in a decrease in macroinvertebrates within the construction zone and immediate downstream waters. Impacts are anticipated, but not substantial enough to move to "not present" category. *Long-term effects:* while localized instability is possible with minor culverts, it is not anticipated to be widespread enough to substantially affect macroinvertebrate communities.
	Existing Conditions		2		
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		
	2. Fish Presence	Abundant	Sparse	Not present	*Existing conditions:* no fish surveys have been conducted in High-gradient Small Streams. We assume that they provide habitat for resident and anadromous fish based on their downstream connections to waters supporting anadromy and the lack of obvious barriers to fish, but the relatively high gradient likely precludes extensive use by resident and anadromous fish *Short-term effects:* instream construction activities could have short-term impacts by causing mortality of small, larval, or juvenile fish from equipment used in the stream, particularly any driving on the streambed (Surface Transportation Board 2009). Impacts are anticipated, but not substantial enough to move to "not present" category. *Long-term effects:* typicals for minor culverts show that they will not be embedded, that there will be riprap at culvert inlets and outlets, and that there will be no bed material within culverts. While sufficient for maintaining hydrologic connectivity across the road, these culverts have the potential to negatively effect fish passage (e.g., smaller fish at high flows) even with proper maintenance. Impacts are anticipated, but not substantial enough to move to "not present" category.
	Existing Conditions		2		
	Predicted--Short-term Effects		2		
	Predicted--Long-term Effects		2		

	Sum of Scores	Max Possible Score	Score (Sum / Max Possible)
Existing	4	6	**0.67**
Proposed Short-Term Effects	4	6	**0.67**
Proposed Long-term Effects	4	6	**0.67**