AMARUQ EXPLORATION ACCESS ROAD AQUATICS BASELINE REPORT
2014 AGNICO EAGLE MINES LTD. - MEADOWBANK DIVISION

Submitted to:

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EXECUTIVE SUMMARY

The Meadowbank Mine is one of Canada's most northerly operating mines, located approximately 75 km north of the Hamlet of Baker Lake, Kivalliq District, Nunavut. It has been in operation since 2009, with open pit mining activities underway since March 2010. The Amaruq project is a 408-square-kilometre exploration property located approximately 50 kilometres northwest of the Meadowbank Mine, where a drilling program started in July 2013 has revealed promising gold mineralization.

In the event that an advanced exploration all-weather access road is deemed necessary to facilitate year-round exploration activities, an evaluation was initiated to examine locations where aquatic habitat might be affected along the approximate route of the proposed all-weather road between the Meadowbank mine and the Amaruq exploration site. This includes water-crossing assessments and fish community and habitat surveys in support of preliminary engineering for road feasibility and design. This report details the results of the assessment of the aquatic resources along the 61.3 km route of the proposed road that was conducted from August 29 to September 2, 2014, which will contribute to the baseline environmental information.

Field investigations, conducted from August 30 to September 2, 2014, included reconnaissance and photographing all locations where the approximate corridor intersected water bodies or watercourses from a helicopter and on-the-ground investigations, that included electrofishing, at 8 watercourses that were considered to be the most likely to support fish. An assessment of fish habitat potential was based on the field investigations and aerial photography. Factors considered included the presence or absence of late summer flow, the presence or absence of reaches where only interstitial flow was occurring in late summer, and the potential that the watercourse provides a migration corridor to upstream habitats.

A total of 52 locations were identified where a lake, pond or watercourse was intersected by the proposed road corridor. Of these, 13 were either the shorelines of larger lakes or small lakes or ponds. It is expected that the final road alignment will avoid these.

Fish were captured at six of the seven locations that were electrofished. Adult Slimy Sculpin were present at all six locations where fish were captured and adult Ninespine Stickleback were captured at one location. Juvenile Arctic char were captured at two locations and a juvenile Arctic Grayling and a juvenile Burbot were each captured at one location. Based on their habitat characteristics and upstream drainage areas, it is likely that many of the watercourses crossed by the proposed route are only inhabited seasonally by small, non-game, non-commercial species. The fact that many of the smaller watercourses are frozen to the permafrost every winter reduces their potential utilization by aquatic organisms.

Three of the 39 watercourses crossed are large (i.e. rivers) that could provide habitat and a migratory route for both large-bodied and small-bodied fish. Bridges are the recommended for those crossings. The other 36 watercourses are smaller and range from open, flowing channels to boulder fields where no water was visible.

Eleven watercourses are considered to be potential migration routes and/or to potentially provide spawning or nursery habitat for large-bodied fish. At seven of these it is recommended that the crossing employ an open-bottomed structure that spans the bankfull channel. At the other four the open channel is bordered by interstitial flow, and it is recommended that the interstitial flow be maintained and the open channel spanned by an open-bottomed structure.

Seventeen watercourses were identified as having the potential to support only small-bodied fish that may move into them during the open-water season. For these watercourses the crossing recommendation depends on the type of habitat at the crossing location. If the habitat is boulder and normally there is only interstitial flow, the recommendation is to maintain the interstitial flow at the crossing and use corrugated steel pipes to provide additional conveyance for occasional high flows, if necessary. If the habitat is graminoid at the crossing then the recommendation is to use appropriately sized corrugated steel pipes that are inset at least 0.3 m below the stream invert. Use of an open-bottomed structure instead of inset corrugated steel pipes is acceptable. Eleven watercourses are not thought to provide fish habitat and no crossing recommendations are provided. It should be noted that, with the exception of the three river crossings where bridges are clearly required, the crossing recommendations are based solely on fish habitat and do not take into account conveyance needs or other hydrologic or engineering considerations.

Additional field work, conducted in the spring, will be necessary to confirm the appropriateness of the final crossing locations and crossing type recommendations to mitigate impacts to valued fishery functions. The results of this initial assessment indicate that, with appropriate mitigation, it will be possible to construct the proposed road in a manner that will not result in serious harm to fish or fish habitat.

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1.0 INTRODUCTION

The Amaruq project (formerly the "IVR project"), is an exploration property located approximately 50 kilometres northwest of the Meadowbank mine in Nunavut as shown in **Figure 1-1**. The 408-square-kilometre Amaruq property is located on Inuit Owned Land, and was acquired by Agnico Eagle in April 2013 subject to a mineral exploration agreement with Nunavut Tunngavik Incorporated.

A drilling program started in July 2013 has revealed promising gold mineralization. Given the size and scope of the discovery, studies are currently underway to evaluate how Amaruq could be incorporated into the Meadowbank mine operational plan.

If advanced exploration proceeds, an all-weather access road is deemed necessary to facilitate year-round exploration activities. Therefore, an evaluation was initiated to look at possible locations of an all-weather exploration access road between the Meadowbank mine and the Amaruq exploration site. This includes water-crossing assessments and fish surveys in support of preliminary engineering for a possible all-weather exploration access road feasibility and design. The intention is to prepare to permit and build an access road linking the Amaruq exploration project site to the Meadowbank mine for the transport of fuel, equipment and personnel. This report details the results of the assessment of the aquatic resources along the 61.3 km route of the proposed access road, which will contribute to the baseline environmental information.

1.1 Background

The Meadowbank Mine (65°N, 96°W) is one of Canada’s most northerly operating mines, located approximately 75-km north of the Hamlet of Baker Lake, Kivalliq District, Nunavut (Figure 1-2). Mine construction began in 2008 under Nunavut Water Board Type A License 2AM-MEA0815 and Fisheries and Oceans Canada Authorization for Works or Undertaking Affecting Fish Habitat NU-03-0191.3 and NU-03-0191.4. Meadowbank has been in operation since 2009, with mining activities formally underway since March 2010, and projected to occur until February 2018. Meadowbank is an open pit operation, with most of the pit development located in close proximity to the mill, office and lodging infrastructure, with the exception of the Vault Pit which is approximately 10 km northeast of the main mine site. The southern terminus of the proposed Amaruq exploration access road is at the Vault Pit and the northern terminus is at the Amaruq exploration site.

Figure 1-1. Location of proposed Amaruq Exploration Access Road corridor.

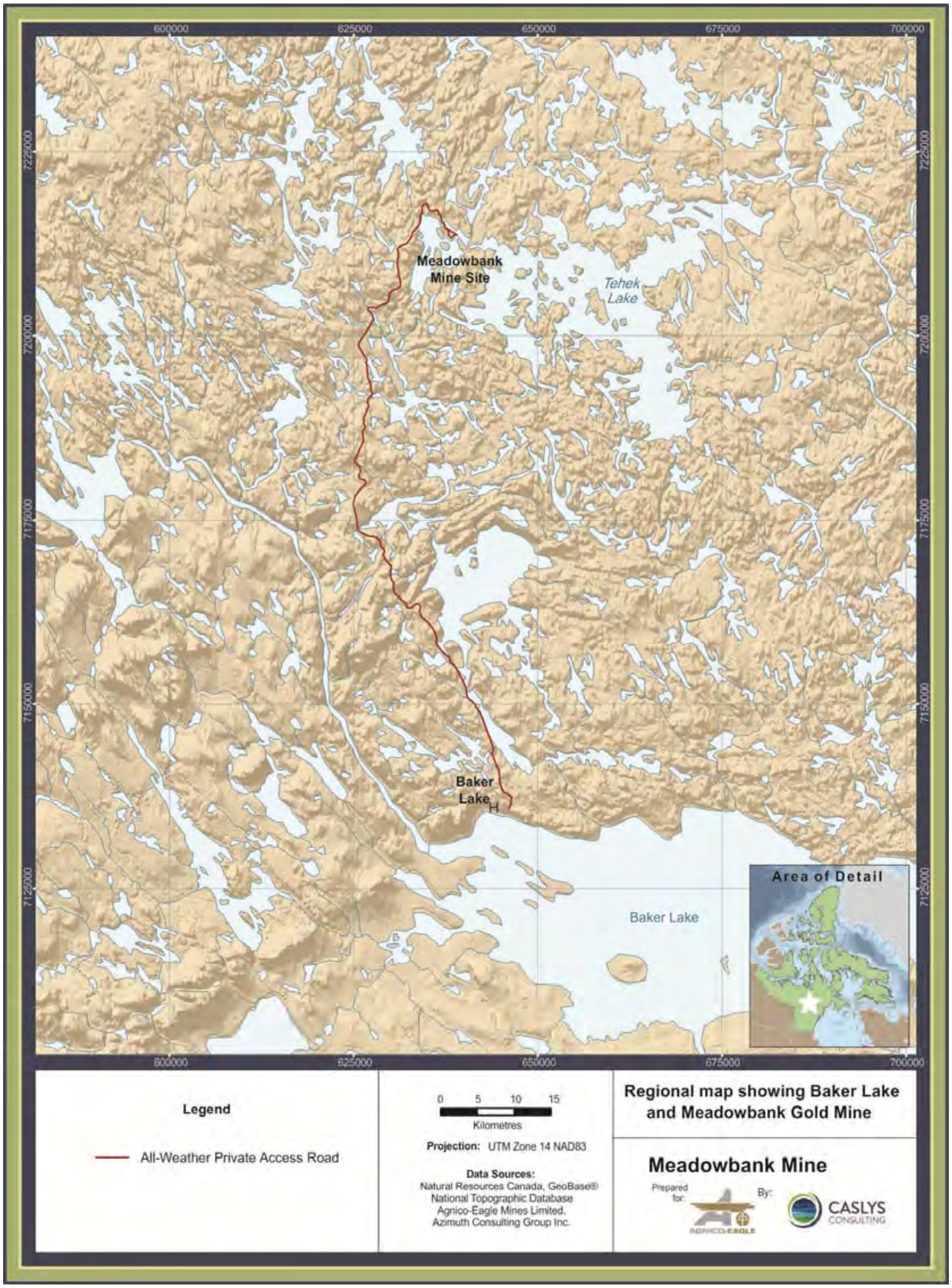

Figure 1-2. Map showing the location of the permitted and licensed Meadowbank Mine that includes an operational all-weather access road to Baker Lake.

1.2 Scope

This report presents an assessment of the watercourses along the proposed Amaruq Access Road corridor, based on field work conducted from August 29 to September 2, 2014.

1.3 Objectives

- Characterize the existing conditions
- Identify potential impacts
- Recommend mitigation

1.4 Physical Setting

The Meadowbank Mine is located on the Canadian Shield within a Low Arctic ecoclimate of continuous permafrost, which is one of the coldest and driest regions of Canada (Azimuth, 2010). The lakes within the Meadowbank project area are ultra-oligotrophic/oligotrophic (nutrient poor, unproductive) headwater lakes that are typical of the Arctic. The ice-free season on the lakes is very short. Ice break-up usually occurs during mid- to late-June, and ice begins to form again on the lakes in late September or early October. Complete ice cover is attained by late October, with maximum ice thickness of about 2 m occurring in March/April (Azimuth, 2013). Many small watercourses become dry once the land begins to freeze in the fall and, where water is present, most freeze to the bottom during the winter (BAER, 2005; Jones *et al*, 2010). Flows during the spring melt and the summer vary with drainage area.

The southern terminus of the proposed Amaruq access road is at the Vault Pit and the northern terminus is at the Amaruq exploration site. The most southern watercourse crossing along the proposed road is within the headwater area of the Chesterfield Inlet watershed that flows to Hudson Bay (referred to as fisheries assessment - Location 1). All of the other locations examined along the proposed road alignment are within the Meadowbank River watershed which flows to the Back River and then to the Arctic Ocean.

There are no known anthropogenic influences between the Vault Pit and the Amaruq exploration site. The nearest community is Baker Lake, 75 km south of the Meadowbank Mine. At the present time, the only practical way of accessing the proposed road alignment is by helicopter.

2.0 METHODS

2.1 Preparation for Field Work

Due to the remote nature of the field work, in an area with few landmarks, it was essential to have proper maps and navigational equipment to locate the proposed road alignment and to assess the connectivity of aquatic habitats. This road route, presented as a red line in Appendix A, is an approximate alignment provided as a shapefile to field staff by Agnico Eagle Mines Ltd. while the final road route was being surveyed. For field orientation this road alignment was overlain on digital topographic mapping of the area (Garmin Topo Canada) and uploaded to a Garmin GPSmap76CSx hand-held GPS receiver. Potential watercourse crossings and waterbodies in close proximity to the road were identified on the topographic maps supplemented with examination of satellite images. These were located on printed copies of the same topographic mapping, which were also taken into the field.

2.2 Aerial Reconnaissance

The proposed access road alignment was examined from the air by helicopter on August 29 and 30, 2014. Each of the previously identified watercourse crossings and waterbodies was located and oblique aerial photographs were taken of each as well as upstream and downstream of watercourse crossings, to include the entire length of watercourse between lakes or to the watercourse's upstream limit. At some locations additional potential crossings were identified and documented in the same manner. The photographs taken during this reconnaissance and during the on-the-ground investigations (see below) were reviewed and supplemental aerial photographs were taken on September 2, 2014, when the entire corridor was flown once more to ensure no important features were overlooked.

2.3 Habitat Characterization

Watercourses which were considered to have the greatest potential to support fish were examined on the ground from August 30 to September 2, 2014. These locations were selected based upon apparent flow and channel morphology and proximity to lakes that are deep enough to not freeze completely during the winter, as observed during the aerial reconnaissance. Each of these watercourses was examined visually in the immediate location of the proposed road crossing and, typically, for several hundred metres upstream and downstream. In most cases where watercourses joined lakes, the entire watercourse between the upstream and downstream lakes was examined. Observations of habitat characteristics including channel dimensions, channel form, and substrate, were recorded and photographs were taken. A Garmin GPSmap76CSx hand-held GPS unit was used to record the location of all observations and photographs, and aid in the stream width and distance measurements. The final habitat characterization for all watercourses was a desktop process that combined field observations with GIS analysis utilizing an orthorectified aerial photograph mosaic. The mosaic components covering

Locations 47 to 52 were taken on July 21, 2011, while those covering Locations 1 to 46 were taken at approximately the time of the field investigations in 2014.

Lakes or ponds were identified as such and relative waterbody size and shoreline substrate were noted. It was assumed that these waterbodies would be avoided by adjusting the road alignment. The watercourses were characterized in terms of their flow condition, channel configuration, dominant habitat type in the vicinity of the proposed crossing location (which is approximate), active channel width and connection to potentially fish-bearing lakes upstream. Potential fish utilization was subsequently inferred based on the habitat characteristics.

Flow condition indicates the state of flow at the time of the field investigations. "Surface flow" indicates that surface water was seen in the watercourse from the helicopter and/or can be seen in the aerial photographs. "Interstitial flow" refers to flow through the interstitial spaces of the boulders and cobble that make up many of the streambeds along the proposed route, which was often not visible. Interstitial flow through boulder or cobble sections was assumed if surface water was visible elsewhere along the watercourse. Interstitial flow was deemed to be ”possible” if no surface water was detected anywhere along a boulder watercourse. Those watercourses may be dry, but this was not confirmed on the ground. Occasionally, if there did not appear to be a defined channel but at least seasonal flow was suspected, the flow was characterized as "potential diffuse".

Channel configuration was characterized as single channel (one flow path), multiple channels (more than one flow path, or what is often termed a "braided" channel), or a diffuse channel (insufficient flow to form an obvious, defined flow path). For a few watercourses the additional descriptor "poorly defined" is used, which indicates that the edge or path of the active channel is unclear, suggesting that surface flow rarely occurs.

The watercourse habitats were divided into three categories, river, boulder, and graminoid. Examples of each are shown in **Figure 2-1.** River habitats were large, flowing, open channels, which occurred at only three locations. Boulder habitats typically appear in the aerial photographs as well-defined, linear, boulder fields associated with depressions on the landscape. Often there is no water visible along some or most of their length, but there may be interstitial flow that is obscured by the upper boulder layers. The size of most of these boulder features appears disproportionately large relative to the magnitude of the flows observed in late summer, which were small. It is not known if the boulder field widths are the result of higher flows during spring freshet or if these features were formed by post-glacial meltwater or periglacial processes. Graminoid habitats are reaches of small watercourses whose banks are vegetated primarily by graminoids growing on peat. Often there are multiple smaller channels that branch and coalesce. Some of these habitats that were examined on the ground have a significant sand/gravel fraction in the substrate.

Figure 2-1. Examples of habitat types encountered. From top left, moving clockwise: river, river, boulder, graminoid with coarse substrate, graminoid with organic substrate, boulder.

Approximate active channel width was measured using GIS with the orthorectified aerial photograph mosaic. Channels that were reasonably uniform in width have been assigned a single number, while those channels of widely varying width have been assigned a range. The width of boulder channels was discerned in the aerial photography by the colouration of the boulders or the absence of vegetation. Rivers and graminoid single channels were measured directly in GIS. Multiple channel watercourses were measured from the outer edge of the first channel on one side, to the outer edge of the last channel on the opposite side. Width could not be accurately determined from the aerial photographs for diffuse channels.

2.4 Fish Community Assessment

Each of the locations examined on the ground was electrofished using a Halltech Model HT 2000 backpack electrofisher and a dipnet. Electrofishing was conducted with the two-person crew moving in an upstream direction, sampling as many habitat types as possible. After investigating a number of electrofisher settings in the low conductivity waters of the study area, it was found that settings of 950 volts and 250 hertz, resulting in approximately 3-4 amperes of current, were most effective at immobilizing or drawing fish out of their hiding locations. These settings were used at all locations. The number of electroseconds (amount of time power was applied to the water) and the length of watercourse electrofished were recorded for each location electrofished. Most fish were identified to species in-situ and released, but some were photographed and the photographs were used to confirm identity at a later time using keys in Scott and Crossman (1973) and McPhail and Lindsey (1970). The number of adults and juveniles captured, distinguished on the basis of size, was recorded for each species.

2.5 Assessment of Fish Habitat Significance and Crossing Recommendation

The significance of fish habitat in each watercourse was evaluated based upon the habitat in the vicinity of the proposed road crossing, the potential for the watercourse being a migratory route for large-bodied or small-bodied fish between habitats upstream and downstream of the crossing, the life histories and habitat requirements of the fish species present in the study area, and the ecology of Arctic streams. The type of crossing structure recommended was selected to protect the habitat attributes and functions for the maintenance of existing fish populations. The recommended crossing structures are discussed in Section 4.0 (Mitigation and Impact Assessment) and listed for each watercourse crossing in Table 3-2.

3.0 RESULTS

3.1 Overview of Waterbodies and Watercourses Intersected by the Proposed Access Road Corridor

A total of 52 locations were examined along the proposed road alignment (Figure 3-1). Of these, 7 are along shorelines of larger lakes, 6 are portions of small lakes or ponds less than 150 m wide, and 39 are

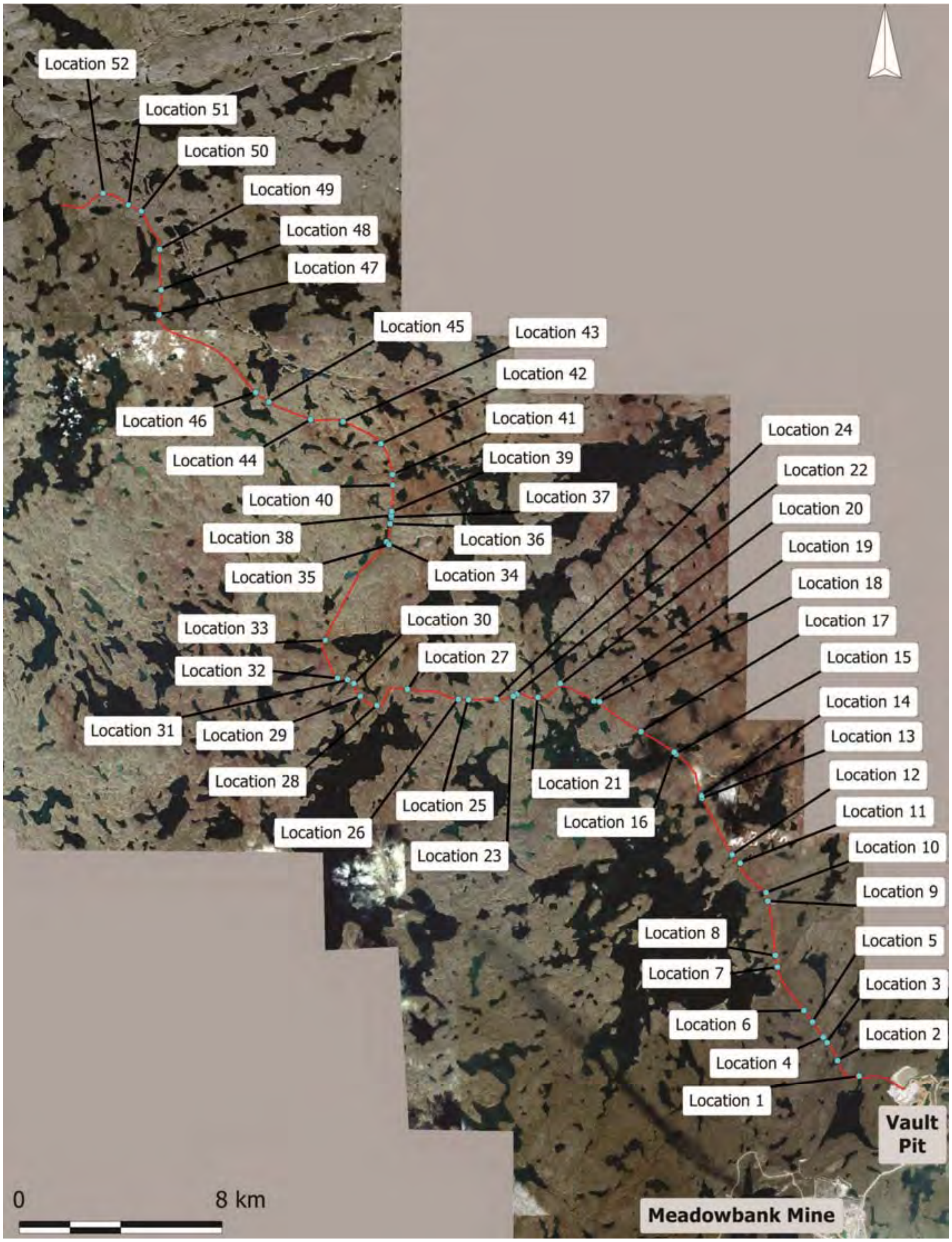

Figure 3-1. Route of the proposed Amaruq Exploration Access Road (red line) and the 52 locations examined (blue dots).

watercourses. The watercourses range from poorly defined features that may only experience seasonal diffuse flow to river channels with substantial late summer flow. Based on their potential to be fish habitat, a total of seven watercourses were sampled on the ground during this study.

3.2 Fish Communities

The relatively recent glaciation and the harsh winters of northern Canada have resulted in a fairly short list of fishes that occur in the vicinity of the Meadowbank mine (McPhail and Lindsey, 1970; Scott and Crossman, 1973). The effect of long cold winters upon fish communities is further amplified in small streams and shallow lakes which freeze completely each winter (Haynes *et al*, 2014; Jones *et al*, 2010). In total, five fish species were captured in one or more of the seven watercourses sampled during the field investigations.

3.2.1 Species

The number of individuals of each fish species collected in each watercourse sampled are provided in Table 3-1. The sampling effort, expressed as electroseconds, and the length of channel sampled, are also provided. Based on their size, all of the Slimy Sculpin and Ninespine stickleback were adults and the Burbot, Arctic Char and Arctic Grayling were juveniles. Fish were captured in all but one of the locations that were electrofished. The most species captured at a site was three at location 14, which is a short watercourse connecting two lakes. Slimy sculpin was the most commonly captured species; individuals were captured at six of the seven sites sampled.

Table 3-1. Electrofishing catch and effort. Fisheries Assessment Locations are shown in **Figure 3-1**.

Location	Electro-seconds (s)	Channel length sampled (m)	Slimy Sculpin (*Cottus cognatus*)	Ninespine Stickleback (*Pungitius pungitius*)	Burbot (*Lota lota*)	Arctic Char (*Salvelinus alpinus*)	Arctic Grayling (*Thymallus arcticus*)
2	416	66	2	0	0	0	0
14	438	88	4	0	1	1	0
17	353	20	13	0	0	1	0
18	368	70	0	0	0	0	0
20	590	95	5	1	0	0	0
28	626	135	2	0	0	0	0
41	249	47	7	0	0	0	1

3.2.2 Biological Characteristics

The following presents an overview of the fish species that were captured in this study. The natural history of these fishes was considered during the habitat assessment and in determining mitigation recommendations. In addition to these 5 species, lakes in the vicinity of the Meadowbank Mine that have been sampled also contain Lake Trout (*Salvelinus namaycush*) and Round Whitefish (*Prosopium cylindraceum*).

Slimy Sculpin

This species is widespread in rivers and streams of the north, and prefers running water with rocky, gravelly or sandy substrate (McPhail and Lindsey, 1970; Scott and Crossman, 1973). It spawns in the early spring under rocks in shallow shore areas of lakes or in streams (McPhail and Lindsey, 1970; Scott and Crossman, 1973). Slimy Sculpin may be less tolerant of winter conditions than Ninespine Stickleback (Haynes *et al*. 2014), and may be restricted to areas with large amounts of overwintering habitat (Haynes *et al*. 2014; Hershey *et al*. 2006). Based upon the ecology of Slimy Sculpin in the Arctic, as presented in Haynes *et al*. (2014) and Hershey *et al*. (2006), it is speculated that they were captured at almost all electrofished locations because of those locations' close proximity to winter refugia in upstream and/or downstream lakes.

Ninespine Stickleback

The Ninespine Stickleback is found in the shallow bays of lakes, slow flowing streams, and tundra ponds. It apparently is most associated with aquatic vegetation, but is also found in lower numbers over sand and gravel. It spawns during the spring and summer, usually in dense vegetation (McPhail and Lindsey, 1970). Haynes *et al*. (2014) suggest that Ninespine Stickleback is widely distributed in the Arctic because it can tolerate low oxygen concentrations and high salinity which allows the species to overwinter in lakes where others cannot, as well as its ability to rapidly recolonize de-populated waterbodies via shallow and ephemeral connections during the spring, and then build populations rapidly due to short generation time and rapid growth.

Burbot

Adult Burbot tend to inhabit lakes and large rivers (McPhail and Lindsey, 1970; Scott and Crossman, 1973), but are also known to occur in small streams in the north (McPhail and Lindsey, 1970). Burbot spawn under the ice in late winter, in streams or lake shallows (McPhail and Lindsey, 1970). In the study area spawning is probably limited to deeper lake habitats that do not freeze.

Arctic Char

Freshwater Arctic Char are most commonly lake-dwellers, but they will also live in rivers (Stewart and Watkinson, 2004). They must overwinter in water deep enough to not freeze to the bottom (Stewart and Watkinson, 2004). Spawning occurs in the fall, over gravel beds or rocky shoals in lakes and in quiet pools below rapids in rivers, where water depth is sufficient to prevent the embryos from freezing over the winter (McPhail and Lindsey, 1970; Scott and Crossman, 1973).

Arctic Grayling

Arctic Grayling are typically found in schools in clear-water lakes, large rivers and streams (McPhail and Lindsey, 1970; Scott and Crossman, 1973). They spawn during the spring at about the time that the lake ice is breaking-up, usually in small streams over a gravel or rocky bottom (McPhail and Lindsey, 1970), but will spawn in larger rivers if smaller streams are not available (Scott and Crossman, 1973). Arctic Grayling is the only species captured that spawns exclusively in streams.

3.2.3 Abundance

Fish abundance was low at all of the locations sampled. Slimy Sculpin was the most abundant of the fish species captured, and adults were collected in every watercourse where fish were captured (Table 3-1). Adult Ninespine Stickleback were collected at one location. One juvenile Arctic Char was captured at each of two locations, and a juvenile Arctic Grayling and a juvenile Burbot were captured at one location each.

3.2.4 Fish Movement

No attempt was made to investigate fish movement. Because most small arctic streams freeze down to the permafrost every winter (Jones *et al*, 2010), the fish in those streams are thought to be present as a consequence of either directed seasonal movement (i.e. spawning or feeding migrations) or non-directed seasonal dispersal which, in the case of Ninespine Stickleback, may include dispersal to sink habitats where individuals perish during the winter (Haynes *et al*, 2014). The movement of large-bodied fish may be precluded in the smaller streams by the shallow depth. Also, in many of the smaller streams examined in this study there are reaches where there is no surface flow, only interstitial flow among boulders and cobbles. The extent of movement by small-bodied fish through the interstitial spaces is not known but it is unlikely that there is movement through those spaces by large-bodied fish. Large fish passage might occur if there is flow on top of the boulders or around the boulders during the spring freshet. As part of the habitat assessment provided below in **Table 3-2**, the potential importance of a watercourse as a migration route is assessed based upon the continuity of surface flow and the presence of suitable upstream lakes or potential instream spawning habitat.

3.3 Habitat Characterization

The habitat characterization for each of the locations examined along the route of the proposed Amaruq Exploration Access Road are provided in Table 3-2. A close-up of the orthophoto at each location, as well as oblique aerial photographs taken from the helicopter and on-the-ground photographs, where available, are presented in Appendix A.

As stated above, 7 locations are shorelines of lakes, 6 are portions of small lakes or ponds, and 39 are watercourses. The watercourses at three of the crossing locations were characterized as rivers. These provide habitat for small-bodied fish, and potentially also for large-bodied fish, throughout the open-water period. Due to their depth and flow, these watercourses are also potential migration routes for large-bodied fish throughout the open water period.

The remaining 36 watercourses are smaller and provide more local drainage. Eight of these were identified as potentially having functions that extend beyond the immediate area of the proposed crossing because they are potential spawning areas for Arctic Grayling and/or potentially important migration routes within a river system, or to upstream lakes capable of supporting fish, when water levels or flows are high. For these smaller watercourses, the dominant habitat types at the crossing were approximately equally divided between boulder (n=20) and graminoid (n=16). Surface flow was evident in the vicinity of the proposed crossing in 6 of the boulder locations. All but one of the boulder watercourses is thought to have had interstitial flow during the field investigations; one was suspected to be dry. All of the watercourses with boulder habitat dominant in the vicinity of the proposed crossing had at least one section with only interstitial flow. Surface flow was present at all but one of the watercourses where the graminoid habitat type was dominant at the proposed crossing location, although in a few cases there was no defined channel evident.

3.4 Assessment of Fish Habitat Significance

The significance of fish habitat in each watercourse was assessed based upon the habitat in the vicinity of the proposed road crossing, the potential for the watercourse being a migratory route between habitats upstream and downstream of the crossing, the life histories and habitat requirements of the fish species present in the study area, and the ecology of Arctic streams. Most Arctic streams freeze down to the permafrost every winter (Jones *et al*, 2010). Consequently, fish that are present in those streams during the open water period must move into the stream after the ice melts in the spring and either move to deeper lake habitats to overwinter in the autumn or perish.

Lake fish communities are determined by factors affecting connectivity and extinction (Hershey *et al*, 2006). Harsh winter conditions are a primary cause of extinction in Arctic lakes and depth is a major determinant. Shallow lakes freeze to the bottom and therefore do not provide overwintering habitat. Consequently they are usually either fishless or contain fish seasonally as a result of recolonization. Overwinter survival requires the presence of deeper areas that remain unfrozen, with sufficiently high dissolved oxygen concentrations.

Connectivity between lakes is influenced by the depth and duration of the surface connections and, potentially, by velocity barriers in reaches with high gradients or falls. The movement of large-bodied fish may also be restricted by the size of spaces between boulder and cobble substrates in reaches where only interstitial flow occurs.

The three watercourses classified as rivers are probably passable by large-bodied fish throughout the ice-free period and therefore have the potential to be seasonal migration routes between spawning, feeding and over-wintering areas. They also provide habitat for small-bodied fish and, potentially, for large-bodied fish during the ice-free period.

The extent to which small-bodied fish (Slimy Sculpin and Ninespine Stickleback) utilize the boulder habitats where only interstitial flow occurs is not known; it is not possible to sample these reaches using any conventional means. Likewise the extent of movement through these reaches by small-bodied fish is unknown. For this assessment, it is conservatively assumed that the boulder reaches with only interstitial spaces may provide habitat for small-bodied species, particularly Slimy Sculpin, during the open water period. Ninespine Stickleback is unlikely to reside in these reaches due to its preference for vegetated habitats. Occupancy by large-bodied fish is not feasible, as is movement by large-bodied fish through the interstitial spaces. Migration of large-bodied fish might occur in the spring if water levels and/or flows are high enough.

It is postulated, based on their bank vegetation, that most of the graminoid watercourses exhibit relatively stable flows during the open-water months. Based on our sampling results, most of these watercourses probably support low numbers of Slimy Sculpin and/or Ninespine Stickleback if they are accessible from over-wintering habitats in lakes. Where accessible, and where water levels are high enough and suitable substrate is present, these watercourses may also provide spawning habitat for Arctic Grayling. If flow and depth are adequate they may also function as migration routes if suitable habitats are available upstream and downstream.

Table 3-2. Habitat characterization and assessment and crossing recommendations. Maps and photographs for each location are presented in Appendix A.

Crossing	Latitude	Longitude	Feature type	Flow characteristics	Channel configuration	Dominant habitat	Approximate active channel width (m)	Potential fish-bearing lake upstream	Examined on ground	Fish captured	Comment	Habitat assessment. Functional considerations that extend beyond the crossing footprint are in bold.	Minimum crossing type recommended to mitigate potential impacts to fish.
1	65.08255	-96.04183	Watercourse	No surface flow. May be interstitial flow	Single	Boulder	25	Yes	No		Surface flow is infrequent	May not provide fish habitat most of the time due to lack of flow. Fish passage also unlikely.	Maintain interstitial flow. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.
2	65.08841	-96.05928	Watercourse	Mainly surface flow, but short sections of interstitial flow near proposed crossing.	Single	Boulder	20-50	Yes	Yes	2 Slimy Sculpin	Upstream of crossing is open with boulder and cobble, with some patches of graminoid. In boulder section, lichen suggest flow rarely covers boulders. Higher gradient.	Provides seasonal small-bodied fish habitat and a **potential migration route for fish**, but upstream lakes not extensive or deep and so may have limited fish habitat.	Maintain interstitial flow, and use an open-bottom structure to span open channel.
3	65.09496	-96.06739	Watercourse	Surface flow at crossing, but short sections of interstitial flow where boulders dominate upstream and downstream	Single	Graminoid	10-20	No	No		Graminoid at crossing. Boulder sections upstream and downstream, therefore the final crossing location may be in boulder or graminoid habitat.	May provide seasonal small-bodied fish habitat only. Upstream migration by large-bodied fish unlikely. Only small, shallow lake upstream.	If crossed in graminoid reach, corrugated steel pipes inset 0.3 m below the channel invert. If crossed in boulder reach maintain interstitial flow and use corrugated pipe on top of boulders if required to convey flows in excess of what is conveyed through boulders.
4	65.09695	-96.07033	Lake	na	na	na	na	No	No		Small, shallow lake. Bedrock/ boulder substrate	May provide seasonal small-bodied fish habitat only.	Avoid road footprint in lake if feasible.
5	65.10256	-96.07876	Watercourse	No surface flow. May be interstitial flow	Single	Boulder	11-19	Yes	No		Small gorge with boulder substrate rarely has surface flow, based upon presence of tundra vegetation.	Not fish habitat. Fish passage is unlikely.	No fish habitat considerations.
6	65.10667	-96.08533	Watercourse	Some surface water at crossing. May be interstitial flow.	Single/Diffuse	Graminoid	Not determinable	No	No		Poorly defined watercourse. Likely little or no flow most of the time	Not fish habitat.	No fish habitat considerations.
7	65.12255	-96.10623	Lake	na	na	na	na	No	No		Small lake approximately 150 m wide	May provide seasonal small fish habitat.	Road footprint to avoid lake.
8	65.12674	-96.10721	Watercourse	Surface flow at crossing. Interstitial flow where boulders dominate downstream	Multiple	Graminoid	Not determinable	Yes	No		Watercourse poorly defined, and upstream lake is small	May provide seasonal small-bodied fish habitat only. Upstream migration by large-bodied fish unlikely. Only small lake upstream.	Corrugated steel pipes inset 0.3 m below channel invert
9	65.14604	-96.11164	Watercourse	Interstitial flow at crossing. Surface flow in upstream bedrock sections	Single	Boulder	25-90	Yes	No		Flow may rarely cover boulders. Bedrock sections upstream of crossing.	May provide seasonal small fish habitat. **Possible upstream migration route for fish during spring freshet or during other periods of high flow.**	Span bankfull channel with bridge or open-bottom culvert.
10	65.14912	-96.1126	Watercourse	Surface flow	Single	Graminoid	1-8	No	No			May provide seasonal small-bodied fish habitat only.	Corrugated steel pipes inset 0.3 m below channel invert. Avoid fill in adjacent lake.
11	65.15995	-96.13325	Watercourse	Surface flow, but diffuse in places.	Multiple/ Diffuse	Graminoid	30	No	No		Poorly defined channel resembles wetland	May provide seasonal small-bodied fish habitat only. No upstream migration of large fish due to unsuitable stream and upstream lake habitats.	Corrugated steel pipes inset 0.3 m below channel invert. Avoid lake.
12	65.16303	-96.13991	Watercourse	No surface flow. May be interstitial flow	Diffuse	Graminoid	Not determinable	No	No		No defined watercourse. Graminoid and tundra vegetation.	Not fish habitat.	No fish habitat considerations.

Crossing	Latitude	Longitude	Feature type	Flow characteristics	Channel configuration	Dominant habitat	Approximate active channel width (m)	Potential fish-bearing lake upstream	Examined on ground	Fish captured	Comment	Habitat assessment. Functional considerations that extend beyond the crossing footprint are in bold.	Minimum crossing type recommended to mitigate potential impacts to fish.
13	65.18345	-96.16312	Lake	na	na	na	na	Yes	No		Shallow boulder shoreline of small lake	Fish habitat. Probably not spawning habitat for Lake Trout or Whitefish due to shallow nature of nearshore area.	Road footprint to avoid lake.
14	65.18445	-96.16333	Watercourse	Surface flow	Single	River	71	Yes	Yes	4 Slimy Sculpin, 1 Burbot, 1 Arctic Char	Wide, shallow, flowing watercourse with cobble/gravel/boulder substrate and graminoid patches	**Watercourse provides seasonal small fish habitat and contains gravel substrate that may be suitable for Arctic Grayling spawning. Potential migration route between lakes.**	Span bankfull channel with bridge
15	65.19967	-96.18315	Lake	na	na	na	na	Yes	No		Steep bedrock shoreline of large lake	Fish habitat. Probably not spawning habitat for Lake Trout or Whitefish due to bedrock substate.	Road footprint to avoid lake.
16	65.20026	-96.18477	Watercourse	Mainly interstitial flow.	Single	Boulder	40	Yes	No		Boulder/cobble substrate. Tundra vegetation in parts of wide channel suggest surface flow is infrequent. Some sections may have high gradient.	Small wetted channel within the larger feature may provide seasonal habitat for small-bodied fishes only. High flows may be infrequent. **Potential upstream migration route for fish during spring freshet or other periods of high flow.**	Span bankfull channel with bridge or open-bottom culvert.
17	65.20813	-96.21188	Watercourse	Mainly surface flow, but section of interstitial flow where boulders dominate on slope near proposed crossing	Multiple	Boulder	18-50	Yes	Yes	13 Slimy Sculpin, 1 juvenile Arctic Char	Steeper sections have shrubs and other tundra vegetation perched on top of boulders, with water flowing beneath. Upstream of crossing is open with boulder and cobble, with some areas of graminoid.	Provides seasonal small fish habitat, as well as **potential spawning habitat with cobble/gravel substrate in places for Arctic Grayling. Potential migration route for large-bodied fishes.**	Maintain interstitial flow, and use an open-bottom structure to span open channel. Significant gradient at proposed crossing location.
18	65.21944	-96.24559	Watercourse	Surface flow, but diffuse in some locations	Multiple/ Diffuse	Graminoid	Not determinable	No	Yes	no fish captured	Invertebrates observed	May provide seasonal small-bodied fish habitat only. Upstream migration likely not possible or important due to channel configuration and flow volume. Upstream lake is small.	Corrugated steel pipes inset 0.3 m below channel invert
19	65.21969	-96.25025	Lake	na	na	na	na	No	No		Shallow boulder shoreline of large lake	Fish habitat. Probably not spawning habitat for Lake Trout or Whitefish due to shallow nature of nearshore area.	Road footprint will be located outside of lake. Fish access to watercourse must be maintained.
20	65.22636	-96.27828	Watercourse	Surface flow	Single	River	100-120	Yes	Yes	5 Slimy Sculpin, 1 Ninespine Stickle-back	Short watercourse between lakes. Flow from south to north. Some algae on rocks. Boulder/cobble substrate	Fish habitat. Broad, short section of river between two large lake systems. Therefore **fish passage is an important function.**	Span bankfull channel with bridge
21	65.22177	-96.29755	Watercourse	Diffuse minor surface flow	Diffuse	Graminoid	Not determinable	Yes	No		Poorly defined watercourse.	Not fish habitat at crossing location. No upstream migration potential.	No fish habitat considerations.
22	65.2233	-96.31499	Lake	na	na	na	na	No	No		Small isolated pond	Small isolated pond (max 100 m wide). May provide small-bodied fish habitat only.	Road footprint to avoid pond.
23	65.22259	-96.31832	Watercourse	No surface water except at crossing. May be interstitial flow.	Single	Boulder	17-72	Yes	No			May not provide fish habitat most of the time, however, **it appears as if flows may occasionally be substantial and fish passage may occur at that time, as this is a connection between two potentially fish-bearing lakes.**	Maintain interstitial flow, and use an open-bottom structure to span open channel.
24	65.22189	-96.33241	Watercourse	Surface flow	Multiple/ Diffuse	Graminoid	Not determinable	No	No		Seepage area with a small watercourse.	Not fish habitat at crossing location	No fish habitat considerations.
25	65.22204	-96.35627	Lake	na	na	na	na	No	No		Shallow boulder shoreline of large lake	Fish habitat.	Road footprint will be located outside of lake.

Crossing	Latitude	Longitude	Feature type	Flow characteristics	Channel configuration	Dominant habitat	Approximate active channel width (m)	Potential fish-bearing lake upstream	Examined on ground	Fish captured	Comment	Habitat assessment. Functional considerations that extend beyond the crossing footprint are in bold.	Minimum crossing type recommended to mitigate potential impacts to fish.
26	65.22235	-96.3647	Watercourse	No surface flow. May be interstitial flow	Single	Boulder	20-60	Yes	No			May not provide fish habitat most of the time, however, **it appears as if flows may occasionally be substantial and fish passage may occur at that time, as this is a connection between two potentially fish-bearing lakes.**	Maintain interstitial flow, and use an open-bottom structure to span open channel.
27	65.22661	-96.4071	Watercourse	No surface flow. May be interstitial flow	Single	Boulder	50	No	No			May not provide fish habitat most of the time due to lack of flow. Fish passage also unlikely.	Maintain interstitial flow. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.
28	65.22133	-96.43345	Watercourse	Surface flow	Single	River	13-25	Yes	Yes	2 Slimy Sculpins	Meadowbank River. Flowing south to north. Boulder/cobble/bedrock substrate	**Large flowing river, with large lakes upstream and downstream. Important fish habitat. May provide spawning habitat for large-bodied fishes and likely is an important migration route for fishes.**	Span bankfull channel with bridge
29	65.22481	-96.44724	Watercourse	No surface flow. May be interstitial flow	Single. Poorly defined	Boulder	30	Yes	No		Tundra vegetation over boulders at crossing location indicates that substantial flow is rare. 150 m downstream of crossing is a section of open multi-channel graminoid habitat.	Not fish habitat at the crossing location. Surface flow possibly during an extreme flow-generating event. Fish passage is likely not an issue due to shallowness of the small upstream lake and the lack of flow in the watercourse.	No fish habitat considerations except keep to south to avoid potential habitat in the graminoid channel section.
30	65.22941	-96.45226	Watercourse	No surface flow. May be interstitial flow	Single	Boulder	20-55	No	No		1 of 2 flow paths from lake.	Not fish habitat at the crossing location. Surface flow at crossing is unlikely except possibly during an extreme flow-generating event. Fish passage is likely not an issue due to shallowness of small upstream lake and the lack of flow in the watercourse.	No fish habitat considerations.
31	65.23097	-96.45748	Watercourse	No surface flow. May be interstitial flow	Single	Boulder	27-62	No	No		2 of 2 flow paths from lake	Not fish habitat at the crossing location. Surface flow at crossing is unlikely except possibly during an extreme flow-generating event. Fish passage is likely not an issue due to shallowness of small upstream lake and the lack of flow in the watercourse.	No fish habitat considerations.
32	65.23161	-96.46593	Watercourse	No surface flow. May be interstitial flow	Single	Boulder	11-35	Yes	No		May not flow often, as it appears to be a secondary outlet for lake to south	Likely does not provide fish habitat. Surface flow is unlikely except possibly during an extreme flow-generating event, as this watercourse appears to be the secondary outlet of the small upstream lake. Fish passage is likely not an issue due the lack of flow in the watercourse.	No fish habitat considerations.
33	65.24516	-96.47481	Watercourse	Surface water at crossing. May have interstitial flow upstream and downstream	Single	Boulder	31-71	Yes	No		Seepage area with a small watercourse just west of crossing on south side of the channel appears to provide water to shallow pool at crossing.	Shallow pools may be seasonal habitat for small-bodied fishes only. Remainder of watercourse is likely not fish habitat most of the year, though the channel size suggests that flows are substantial periodically. Based upon the small size of the upstream watershed, flows may be insufficient most years to provide for fish passage.	Maintain interstitial flow. If additional capacity required can use corrugated steel pipe(s) placed on top of channel boulders. Road should be moved 50-100 m east of alignment shown to allow only one crossing and avoid pool areas.
34	65.27907	-96.41976	Lake	na	na	na	na	No	No		Boulder/cobble shoreline of large lake	Fish habitat.	Road footprint to avoid lake.
35	65.27809	-96.41784	Watercourse	Surface flow, but diffuse in some locations	Multiple/ Diffuse	Graminoid	Not determinable	No	No		Broad seepage area	May provide seasonal small-bodied fish habitat only. Migration of large-bodied fish unlikely due to channel configuration, low flow volume, and the fact that there is no significant upstream habitats.	Corrugated steel pipe inset 0.3 m below channel invert

Crossing	Latitude	Longitude	Feature type	Flow characteristics	Channel configuration	Dominant habitat	Approximate active channel width (m)	Potential fish-bearing lake upstream	Examined on ground	Fish captured	Comment	Habitat assessment. Functional considerations that extend beyond the crossing footprint are in bold.	Minimum crossing type recommended to mitigate potential impacts to fish.
36	65.28555	-96.41613	Watercourse	Surface flow, but diffuse in some locations	Multiple/ Diffuse	Graminoid	Not determinable	No	No		Two broad seepage areas	May provide seasonal small-bodied fish habitat only. Migration of large-bodied fish unlikely due to channel configuration, low flow volume, and the fact that there is no significant upstream habitats.	Corrugated steel pipe inset 0.3 m below channel invert
37	65.2878	-96.41476	Watercourse	Surface flow, but diffuse in some locations	Multiple/ Diffuse	Graminoid	Not determinable	No	No		Three broad seepage areas	May provide seasonal small-bodied fish habitat only. Migration of large-bodied fish unlikely due to channel configuration, low flow volume, and the fact that there is no significant upstream habitats.	Corrugated steel pipe inset 0.3 m below channel invert
38	65.2885	-96.41504	Lake	na	na	na	na	No	No		Boulder/cobble shoreline of small lake.	Fish habitat.	Road footprint to avoid lake.
39	65.28983	-96.41449	Watercourse	Surface flow at crossing and other discrete locations, but interstitial flow through much of watercourse	Single	Boulder	50-90	Yes	No			May provide seasonal fish habitat. **Fish passage may be possible during the spring freshet, and may be important for the chain of upstream lakes.**	Span bankfull channel with bridge or open-bottom culvert.
40	65.29906	-96.41242	Watercourse	Surface flow, but diffuse in some locations	Multiple/ Diffuse	Graminoid	14-50	No	Yes	Not electro-fished	One channel examined had rock substrate, but others had organic (peat) substrate.	May provide seasonal small-bodied fish habitat only. Upstream migration probably not important due shallowness of small upstream lake. No spawning habitat for large-bodied fish downstream of crossing due to lack of suitable substrate.	Corrugated steel pipes inset 0.3 m below channel invert
41	65.30285	-96.41258	Watercourse	Surface flow	Multiple	Graminoid	30	Yes	Yes	7 Slimy Sculpin, 1 juvenile Arctic Grayling	Variety of substrate sizes (gravel/cobble). Caddisflies on rocks.	**Seasonal small-bodied fish habitat and potential spawning habitat for Arctic Grayling. Likely provides fish passage upstream to a number of small lakes**	Span bankfull channel with bridge or open-bottom culvert.
42	65.31409	-96.42112	Watercourse	Surface flow, but diffuse.	Single	Graminoid	Not determinable	No	No		Poorly defined channel resembles wetland.	May provide seasonal small-bodied fish habitat only, Upstream migration for large-bodied fishes unlikely due to absence of instream spawning habitat, small shallow upstream lake, and the fact that watercourse appears to be a secondary drainage connection to upstream lakes.	Corrugated steel pipes inset 0.3 m below channel invert
43	65.32243	-96.4526	Lake	na	na	na	na	No	No		Shallow boulder shoreline of small lake.	May be fish habitat. Probably not spawning habitat for Lake Trout or Whitefish due to shallow nearshore area and the shallowness of the small lake.	Road footprint to avoid lake.
44	65.32362	-96.47974	Watercourse	Surface flow, but diffuse or interstitial in many locations	Multiple/ Diffuse	Graminoid	Not determinable	Yes	No		Poorly defined channel resembles wetland	May provide seasonal habitat for small-bodied fish. Migration of large-bodied fish unlikely due to nature of channel, which resembles a wetland.	Corrugated steel pipes inset 0.3 m below channel invert
45	65.33033	-96.51472	Watercourse	No surface flow. May be interstitial flow	Single	Boulder	65-100	Yes	No		May be connection when lake levels high	May not provide fish habitat most of the time, though the channel size suggests that flows or flooding are substantial periodically. May contain insufficient water most years to provide for fish passage.	Maintain interstitial flow. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.
46	65.33403	-96.52536	Watercourse	No surface flow. May be interstitial flow	Single	Boulder	20	Yes	No		Connection between upstream and downstream lakes may only occur during extreme flow generating events.	Flows may be insufficient most years to provide fish habitat or fish passage, although the channel size suggests that flows or flooding are substantial periodically.	Maintain interstitial flow. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.

Crossing	Latitude	Longitude	Feature type	Flow characteristics	Channel configuration	Dominant habitat	Approximate active channel width (m)	Potential fish-bearing lake upstream	Examined on ground	Fish captured	Comment	Habitat assessment. Functional considerations that extend beyond the crossing footprint are in bold.	Minimum crossing type recommended to mitigate potential impacts to fish.
47	65.36276	-96.605	Watercourse	Some surface flow at crossing and other discrete locations, but interstitial flow through much of watercourse	Single	Boulder	60-85	Yes	No		Maybe connection between lakes when lake levels high	May not provide fish habitat, though the channel size suggests that flows or flooding are substantial periodically. May contain insufficient water most years to provide for fish passage.	Maintain interstitial flow. If additional capacity required, can use corrugated steel pipe(s) on top of channel boulders.
48	65.37164	-96.60231	Watercourse	No surface flow, and likely no interstitial flow	Single. Poorly defined	Boulder	40	No	No		Poorly defined watercourse with some tundra vegetation	Not fish habitat at crossing location. Surface flow at crossing is unlikely except possibly during an extreme flow-generating event. Fish passage is not an issue due to the very small and shallow upstream lake and the lack of flow in the watercourse.	No fish habitat considerations.
49	65.38595	-96.60224	Lake	na	na	na	na	No	No		Very small (approx 100 m across) isolated pond. Boulder substrate.	May provide seasonal habitat for small-bodied fishes.	Road footprint will be located outside of pond.
50	65.39969	-96.61648	Watercourse	No surface flow. May be interstitial flow	Single. Poorly defined	Boulder	30	No	No		Poorly defined feature with some tundra vegetation. Very small drainage area	Does not provide fish habitat at the crossing location. Surface flow at crossing is unlikely except possibly during an extreme flow-generating event. Fish passage is not an issue due to the very small and shallow upstream lake and the lack of flow in the watercourse.	No fish habitat considerations.
51	65.40204	-96.62716	Lake	na	na	na	na	No	No		Very small (approx 100 m across) isolated pond. Boulder substrate.	Unlikely to provide any fish habitat because this small shallow pond is isolated and probably freezes to bottom every winter.	No fish habitat considerations.
52	65.40652	-96.64856	Lake	na	na	na	na	No	No		Very small (approx 100 m across) isolated pond. Boulder substrate.	Unlikely to provide any fish habitat because this small shallow pond is isolated and probably freezes to bottom every winter.	No fish habitat considerations.

4.0 MITIGATION AND IMPACT ASSESSMENT

There are three principal mechanisms by which road crossings can impact fish productivity. These are:

- by altering the habitat and its use in the portion of the watercourse directly altered at the crossing,
- by interfering with or preventing fish passage and
- by causing sediment or other deleterious substances to enter the watercourse and affect downstream habitat.

Minimum crossing type recommendations for the mitigation of the potential negative effects of the watercourse/waterbody crossings along the proposed Amaruq Exploration Access Road have been developed and are presented in Table 3-2 above.

Fisheries and Oceans Canada provides advice to avoid serious harm to fish and comply with the *Fisheries Act.* A Fisheries and Oceans Canada review is not required for a clear-span bridge where there will be no earth fill below the high water mark, no complete obstruction to fish passage during the appropriate timing window, and, all "measures to avoid harm" are implemented. Measures to avoid harm are detailed on the Projects Near Water webpage (http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html), and include measures related to Project Planning (timing, site selection, contaminant and spill management), Erosion and Sediment Control, Shoreline Re-vegetation and Stabilization, Fish protection, and Operation of Machinery.

Based on the field investigations undertaken from August 29 to September 2, 2014, eleven of the 39 watercourses were assessed to potentially have valued fisheries functions that extend beyond the immediate area of the proposed crossing, due to the possibility that they provide spawning, rearing or nursery habitat and/or a migration corridor for large bodied fish. For seven of these an open-bottomed structure (i.e. a bridge or open-bottomed culvert) spanning the bankfull channel is recommended to avoid impacts. For the other four of these crossings, where interstitial flow through boulders occurs adjacent to an open channel, spanning the open channel with an open-bottomed structure and maintaining interstitial flows where they now occur is recommended, provided that this approach is adequate to pass the spring freshet without high velocities through the structure obstructing upstream fish movement. If a critical habitat that is in limited supply is present within the crossing footprint, the potential impact is obviously much greater, and if such habitats are identified the road alignment should be adjusted to avoid them.

For the remaining 28 smaller watercourse crossings, unless a critical habitat (for example spawning habitat) that is in limited supply is located at the crossing, the footprint of the road can be expected to have little effect upon overall aquatic productivity. This is because the footprint area will be small relative to the entire area of similar aquatic habitat available, and also because of the low diversity and density of the fish community in these seasonal habitats that are frozen solid for more than half of the year.

The potential for impact from the road crossings of watercourses on upstream migration is a significant concern because the impact can extend well beyond the footprint of the road. This is particularly critical where spawning migrations or other directed seasonal migrations occur. Barriers can also prevent non-directed dispersal to seasonal habitats. This assessment has taken the position that a crossing should not create an additional impediment to fish migration. For boulder watercourses, if flow is only through interstitial spaces then, at a minimum, the interstitial spaces should be maintained through the crossing. If surface flow occurs seasonally and there is suitable habitat upstream for large-bodied fish then a structure or structures should convey this seasonal flow without impeding their upstream movement. If there is not suitable habitat upstream for large-bodied fish, then maintaining the interstitial spaces should be adequate and higher flows can be conveyed using one or more corrugated steel pipes or open-bottomed structures above the boulders. Graminoid streams where only small-bodied fish occur should, at a minimum, employ corrugated steel pipes sized to match or slightly exceed the wetted channel widths of the existing channels and embedded at least 0.3 m below the existing stream invert to maintain habitat and fish passage through the culvert.

The field work for this assessment was undertaken during the late summer low-flow period. While it was possible to infer some aspects of flow history at some crossing locations, it was generally not possible to determine the range of flows that may occur. Hydrological investigations by others will determine the necessary conveyance capacity. Where upstream fish movement during spring freshet is a concern, structures should be sized so as not to cause higher flow velocities than in the existing channel.

The hierarchy of crossing structures, in order of decreasing potential to negatively affect fish and fish habitat is:

- clear-span bridge,
- open-bottom culvert, and
- embedded corrugated steel pipe.

Switching to a structure with less potential to affect fish and fish habitat for hydrological or engineering reasons will generally be acceptable. Switching to a structure with more potential to affect fish habitat will not be acceptable unless supported by additional field investigations.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on their habitat characteristics and upstream drainage areas, it is likely that many of the watercourses crossed by the proposed route are only inhabited seasonally by small, non-game, non-commercial species. Some of the watercourses, based on their flow characteristics and habitats, and/or connections to upstream waterbodies, are potential spawning habitat and/or potential migration routes for larger fish species.

The proposed Amaruq Exploration Access Road route is 62.3 km long, and runs from the Vault Pit of the Meadowbank Mine to the Amaruq project exploration property, which is located approximately 50 kilometres northwest of the Meadowbank mine.

A total of 52 locations have been identified along the proposed Amaruq Exploration Access Road route during the course of this investigation where watercourses are crossed or lakeshores or ponds are directly on the proposed route. The road alignment used for this assessment is approximate, and the findings of this study will be integrated into the selection of the final proposed road alignment during the final design to minimize the potential to harm fish and fish habitat. It is expected that the lakes and ponds will be avoided by adjusting the road alignment away from the high water mark. Of the 39 watercourses that are crossed by the approximate route, 11 were assessed to have significant fisheries value due to the possibility that they provide spawning, rearing or nursery habitat and/or may provide a migration corridor for large-bodied fish. The remaining 28 watercourses are not thought to provide fish habitat, or are thought to provide habitat for only small-bodied species, which are Slimy Sculpin and Ninespine Stickleback.

Recommendations have been provided regarding the types of crossing structure to be used in order to mitigate the access road's potential impact upon aquatic resources.

There are limitations and uncertainties in this assessment which is based upon the results of a single field investigation undertaken at the transition between summer and autumn, 2014. It is recommended that an additional field assessment be undertaken during the spring freshet to assess the potential for fish movement under high flow conditions. The crossing structure recommendations should be re-evaluated after those investigations. It is also recommended that the route alignment be “field fit” to locate crossings where potential crossing impacts are least, given other constraints.

Based on the knowledge of the habitat conditions and fish communities gathered to date, it is our opinion that it will be possible, with appropriate mitigation, to construct the proposed access road in a manner that will not result in serious harm to fish or fish habitat.

6.0 LITERATURE CITED

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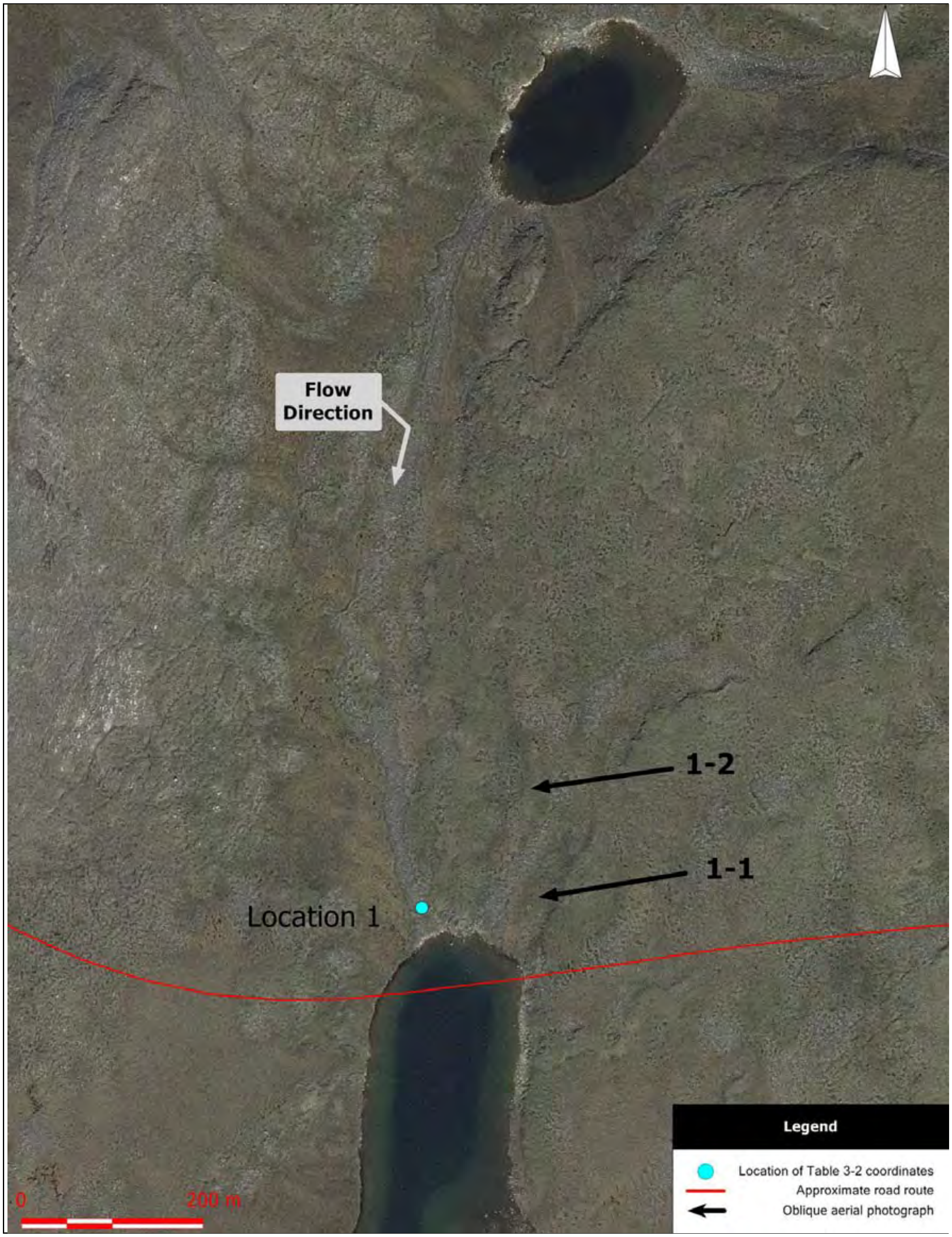
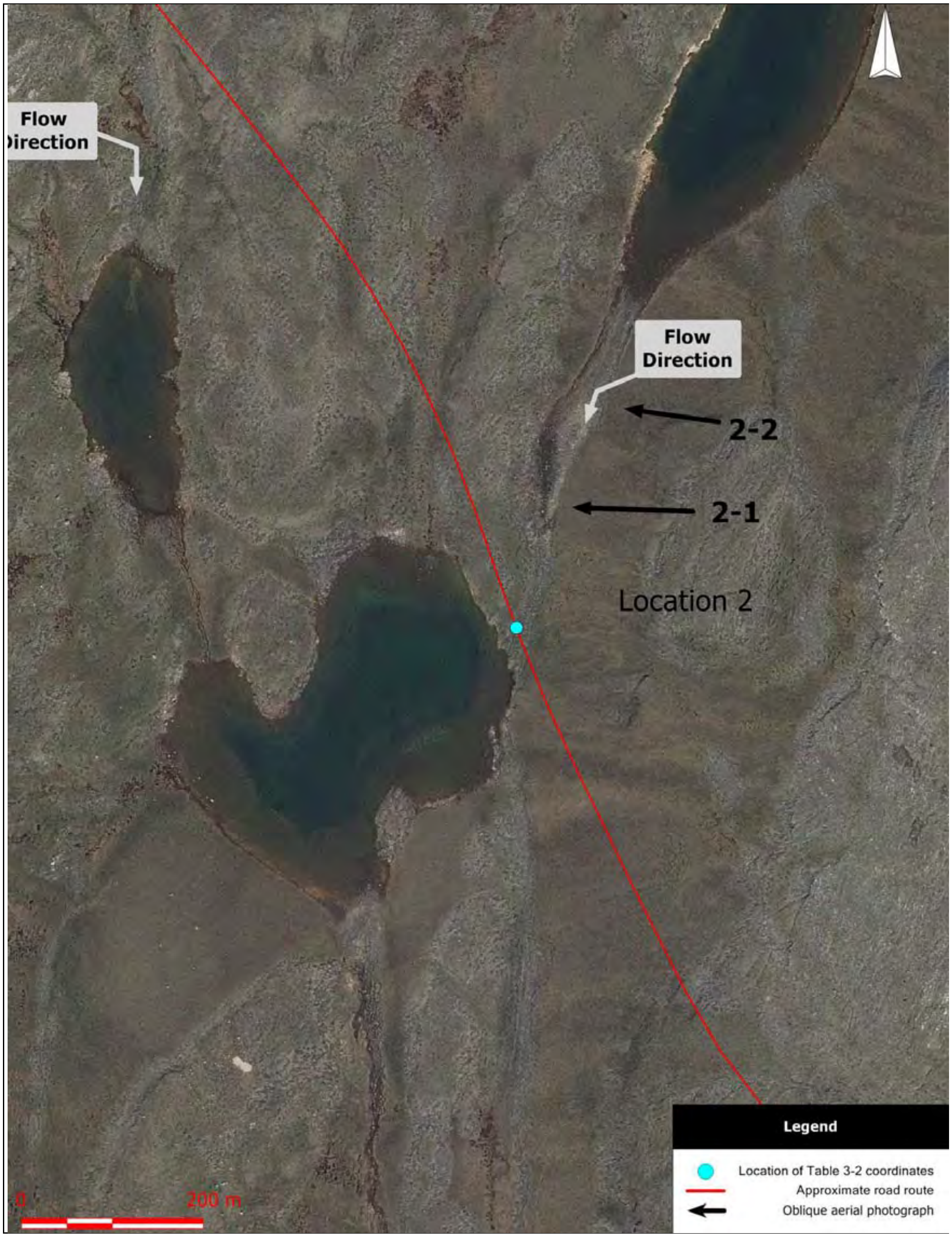
APPENDIX A - PHOTOGRAPHS



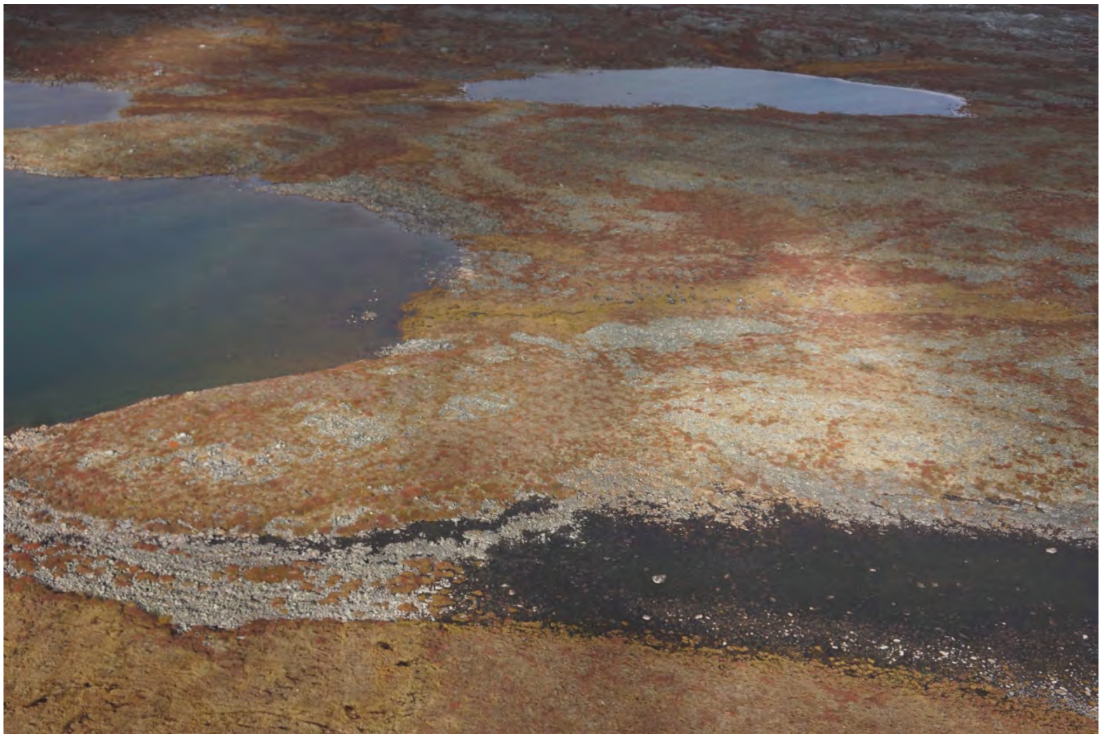
Location 1. Aerial photograph (scale 1:5000) showing the approximate road route, the location of coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs. Lake near Location 1 will be avoided.


Location 1. Oblique aerial photograph 1-1.

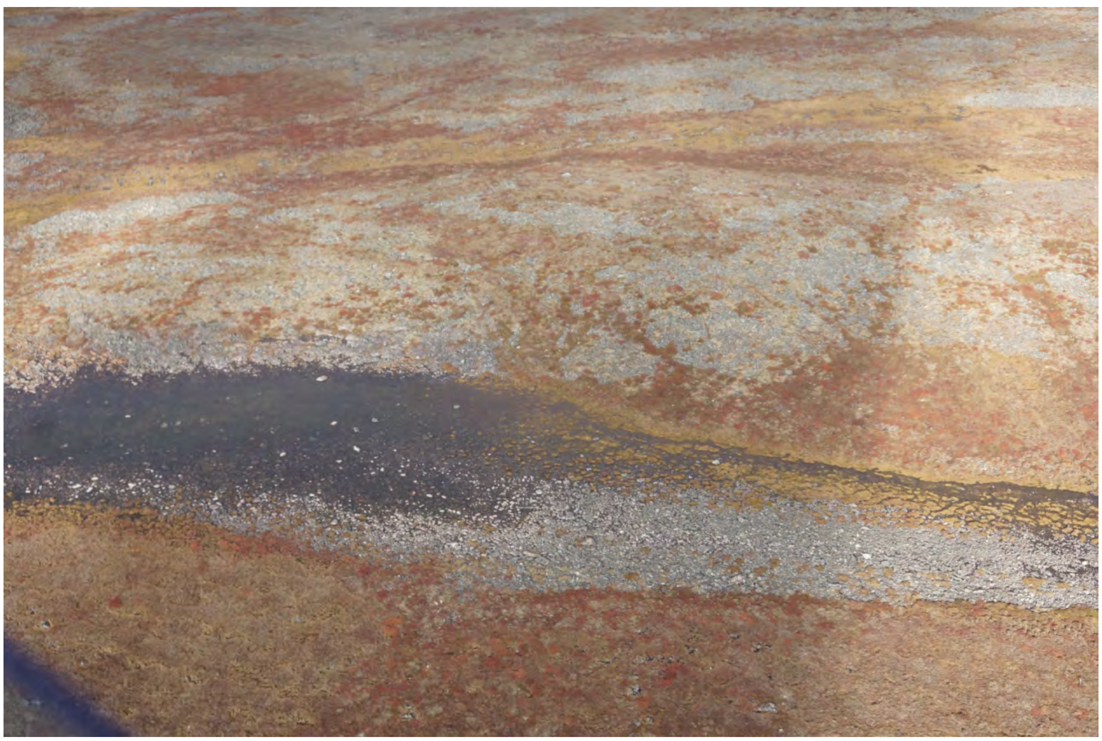

Location 1. Oblique aerial photograph 1-2.



Location 2. Aerial photograph (scale 1:5000) showing the approximate road route, the location of coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.



Location 2. Oblique aerial photograph 2-1.

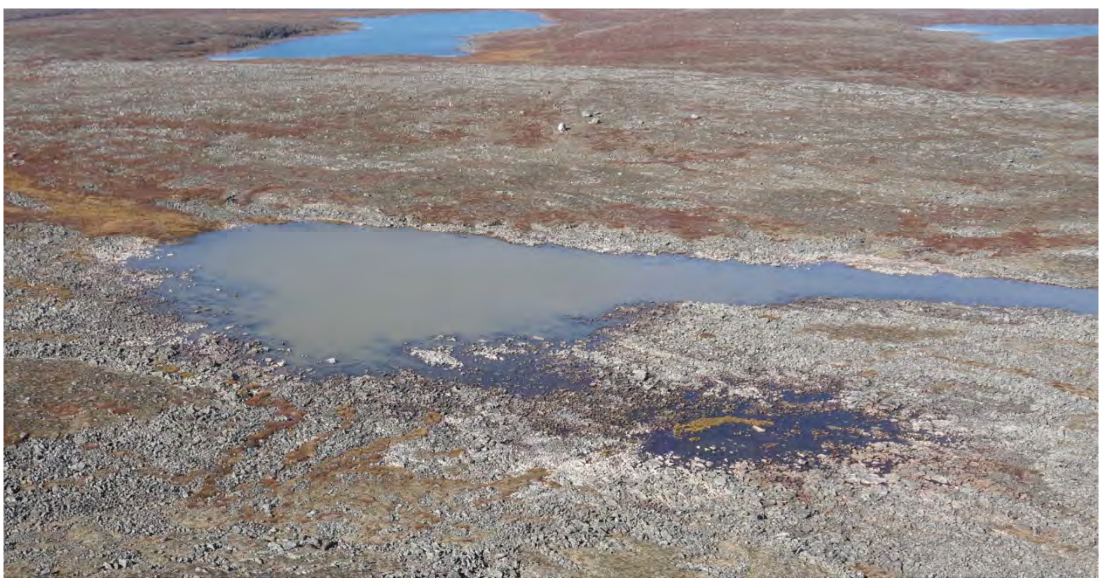


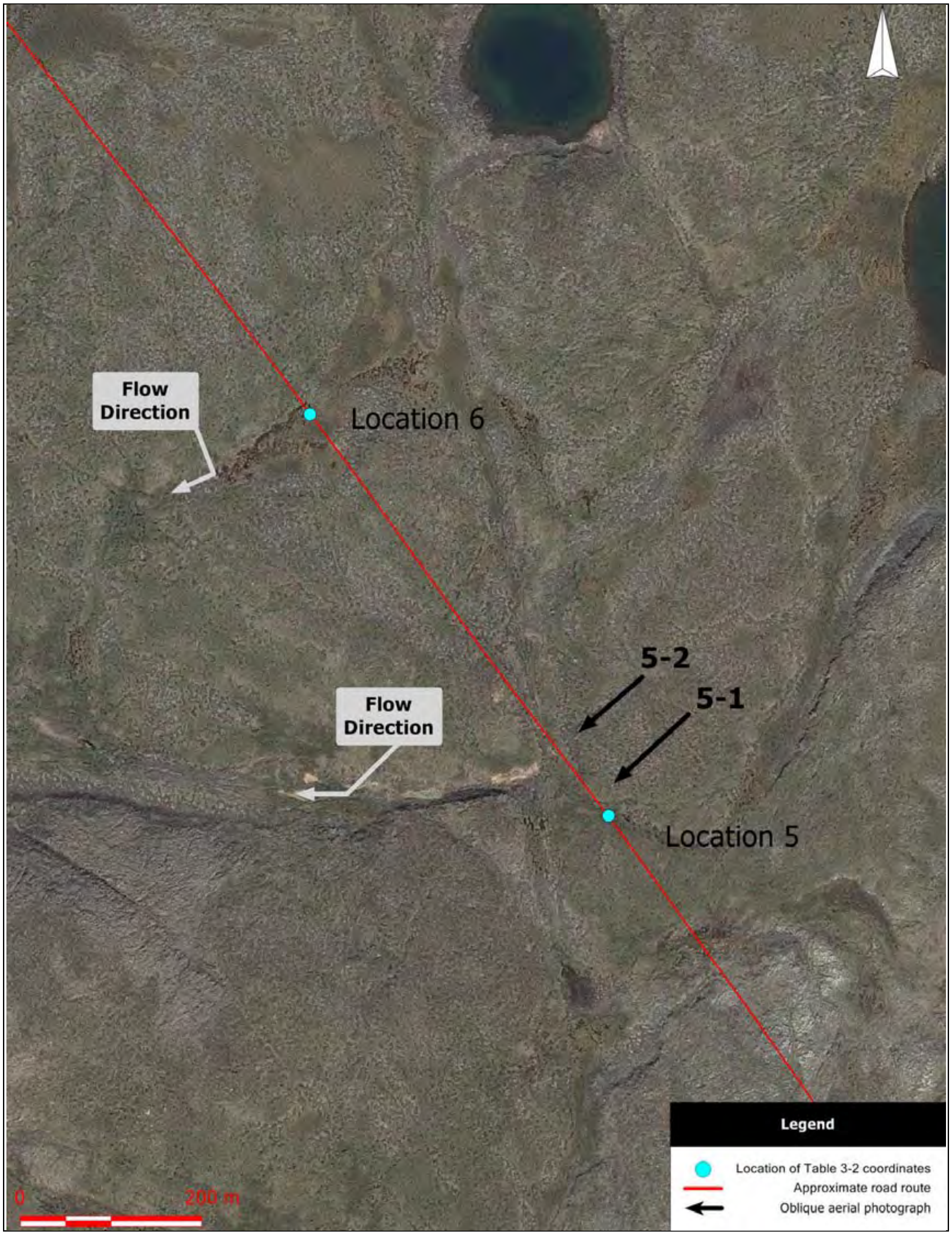
Location 2. Oblique aerial photograph 2-2.

Location 2. Photograph from the ground. Upstream view approximately 100 m upstream from the proposed road crossing.

Locations 3 and 4. Aerial photograph (scale 1:5000) showing the approximate road route, the location of coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs. Lake at Location 4 will be avoided if feasible.


Location 3. Oblique aerial photograph 3-1.

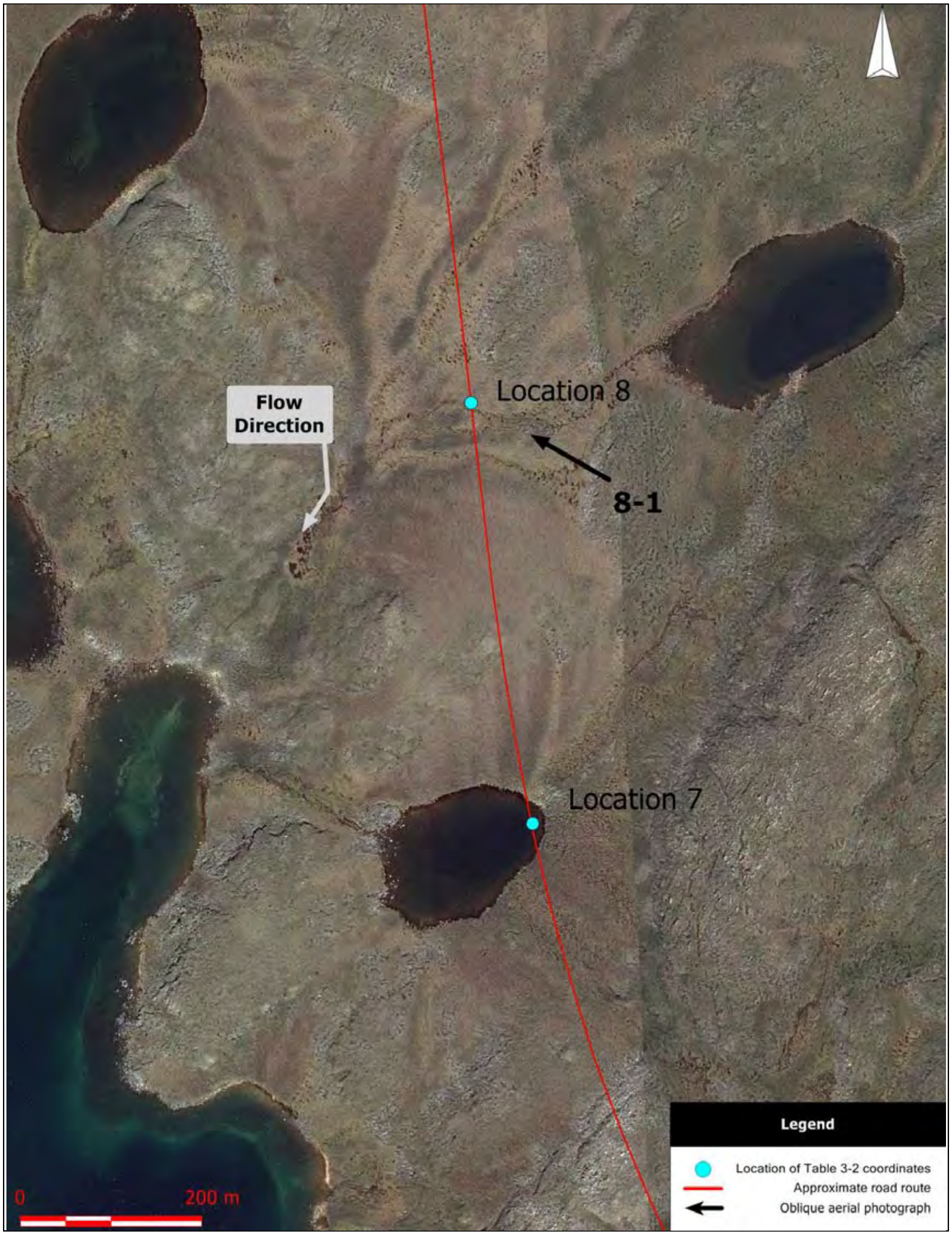

Location 4. Oblique aerial photograph 4-1.



Locations 5 and 6. Aerial photograph (scale 1:5000) showing the approximate road route, the location of coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs.

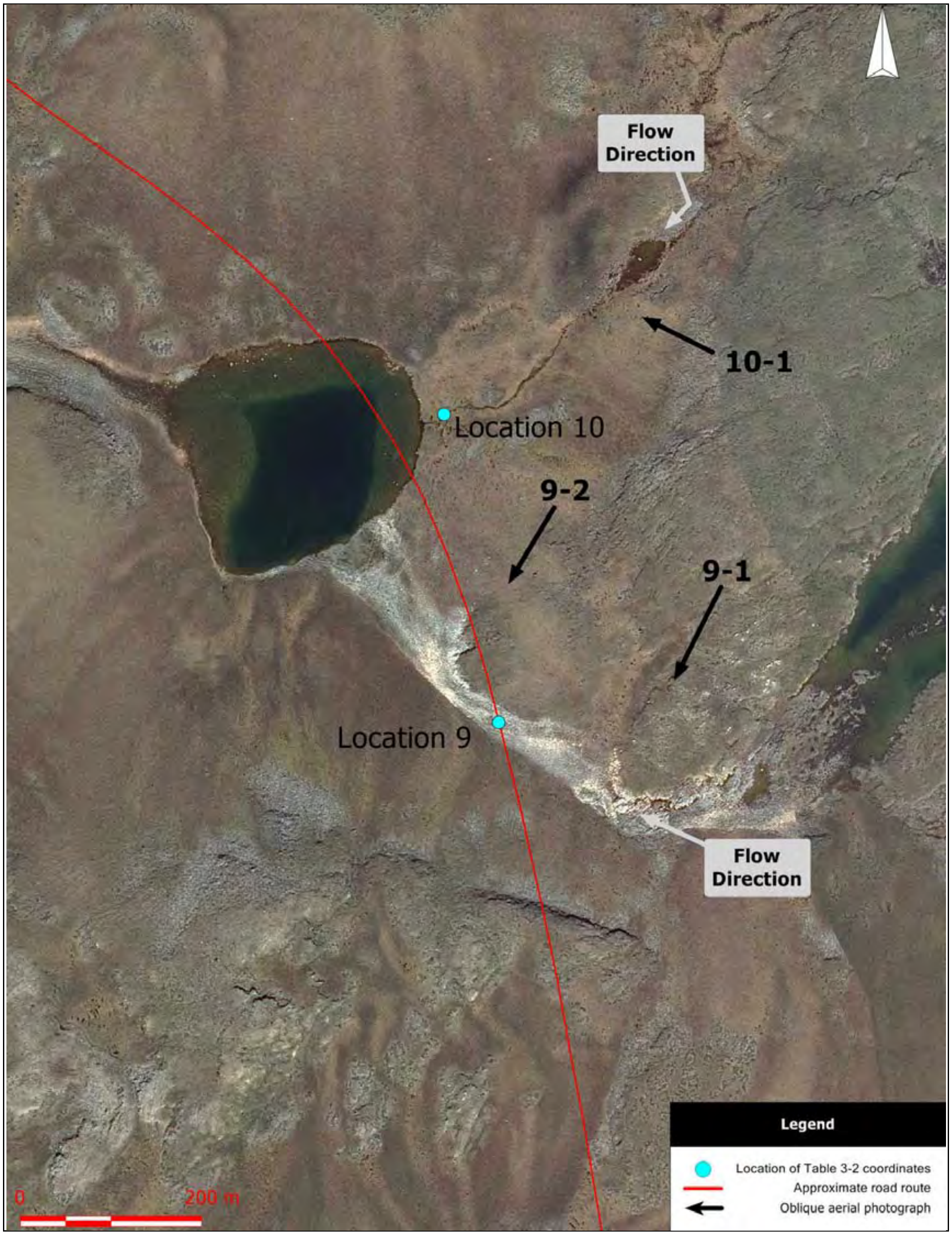
Location 5. Oblique aerial photograph 5-1.

Location 5. Oblique aerial photograph 5-2.



Locations 7 and 8. Aerial photograph (scale 1:5000) showing the approximate road route, the location of coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs. Lake at Location 7 will be avoided.

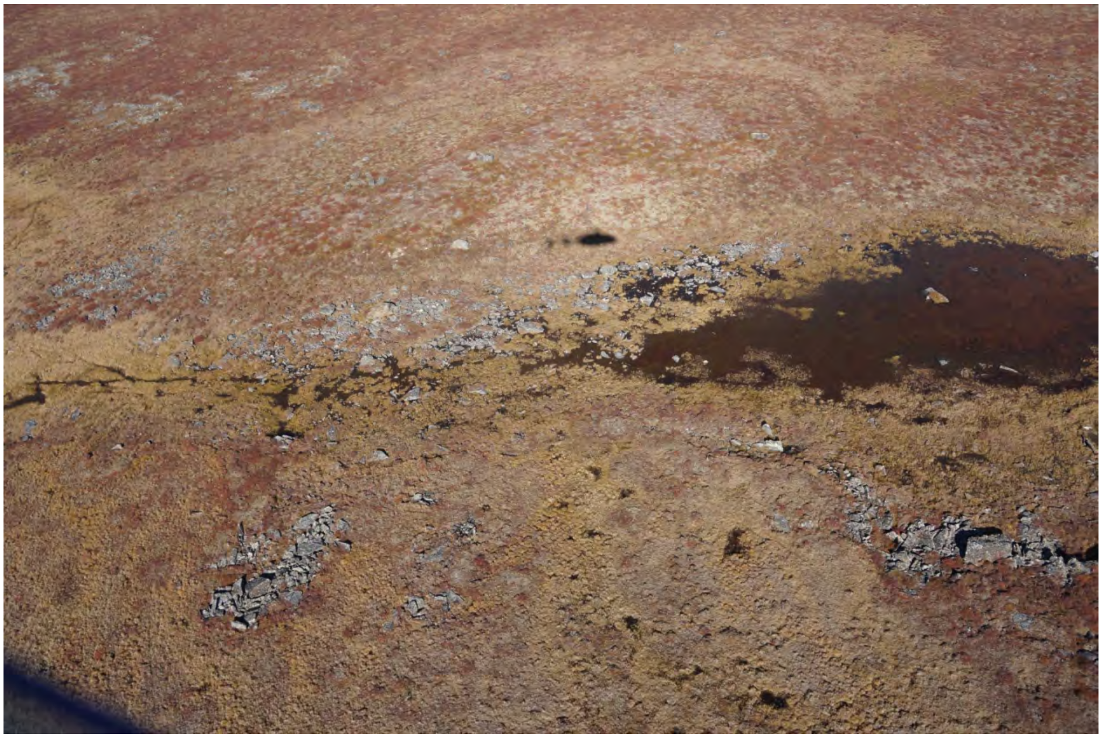
Location 8. Oblique aerial photograph 8-1.



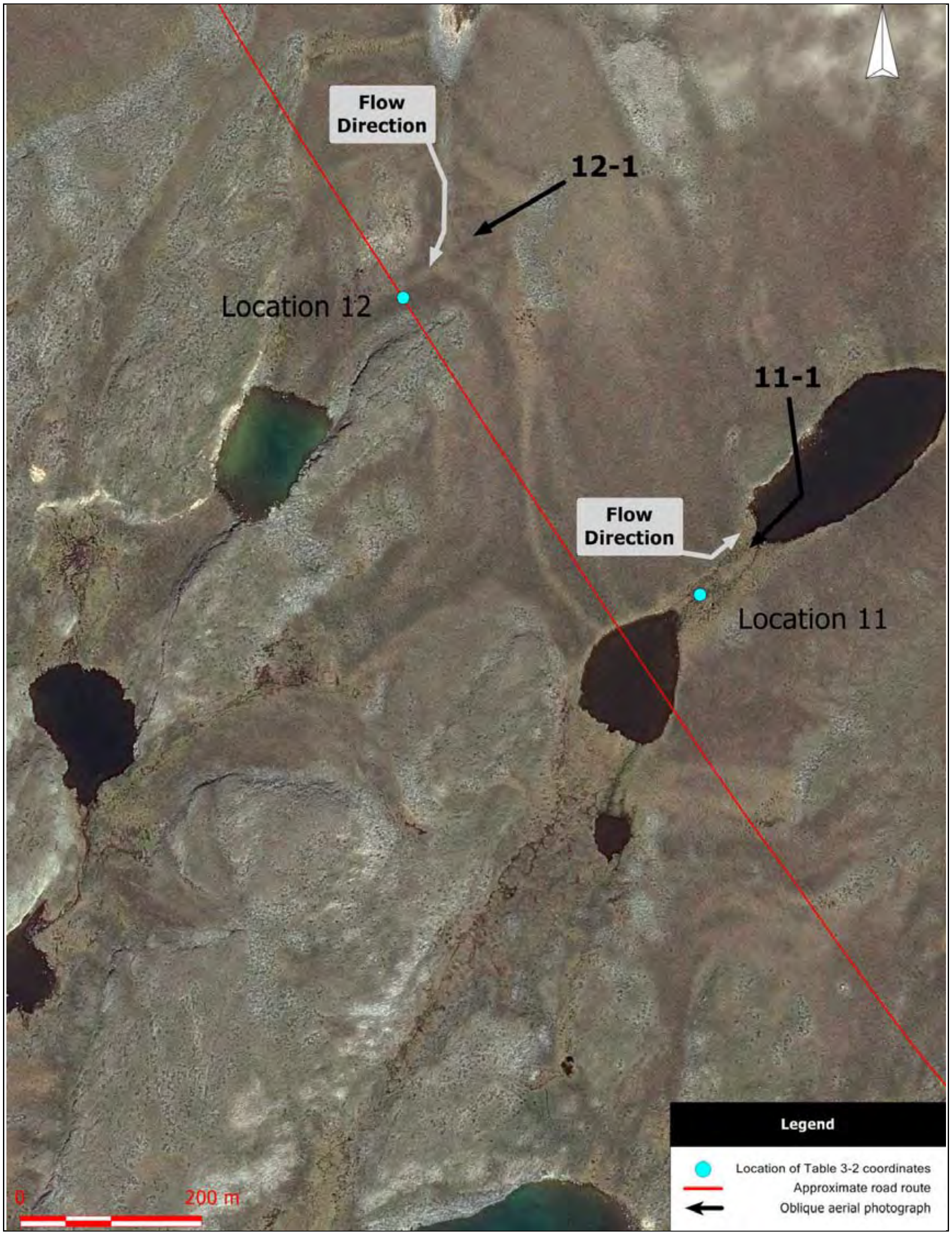
Locations 9 and 10. Aerial photograph (scale 1:5000) showing the approximate road route, the location of coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs. Lake near Location 10 will be avoided.

Location 9. Oblique aerial photograph 9-1.

Location 9. Oblique aerial photograph 9-2.

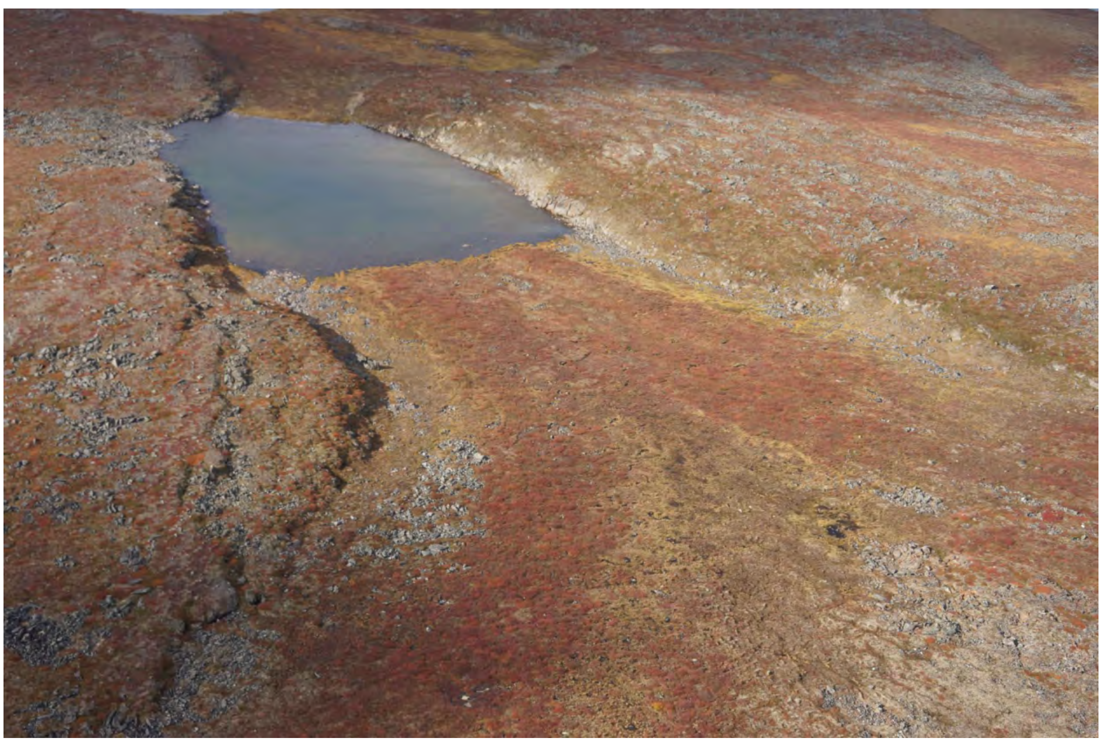


Location 10. Oblique aerial photograph 10-1.



Locations 11 and 12. Aerial photograph (scale 1:5000) showing the approximate road route, the location of coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs. Lake near Location 11 will be avoided.

Location 11. Oblique aerial photograph 11-1.



Location 12. Oblique aerial photograph 12-1.

Locations 13 and 14. Aerial photograph (scale 1:5000) showing the approximate road route, the location of coordinates provided in Table 3-2, the flow direction, and the location of oblique aerial photographs. Lake at Location 13 will be avoided.

Location 13. Photograph from the ground. View south along lakeshore from watercourse.

Location 13. Photograph from the ground. View north along lakeshore from watercourse.