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Knight Piésold CONSULTING

ATTACHMENT 6.1

NORTH RAILWAY TERRAIN ANALYSIS

Baffinland Iron Mines Corporation

Site Assessment of North Railway Alignment

H352034-1000-220-068-0001

			Warren R. Hoyle	Warren R. Hoyle	[signature]	[signature]
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2017-10-03	1	Approved for Use	S. Hinchberger	W. Hoyle	S. Heiner	M. Weaver
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DATE	**REV.**	**STATUS**	**PREPARED BY**	**CHECKED BY**	**APPROVED BY**	**APPROVED BY**
HATCH						**Client**

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This report contains the expression of the professional opinion of Hatch, based upon information available at the time of preparation. Hatch has conducted this investigation in accordance with the methodology outlined herein. It is important to note that the methods of evaluation employed, while aimed at minimizing the risk of unidentified problems, cannot guarantee their absence. The quality of the information, conclusions and estimates contained herein is consistent with the intended level of accuracy as set out in this report, as well as the circumstances and constraints under which this report was prepared.

Waiver, Release and Indemnification

To: Hatch Ltd. together with its affiliates, the “Consultant”

Re: Site Assessment of North Railway Alignment, (and together with any subsequent revisions thereof, the “Report”) dated April 21, 2017 prepared by the Consultant for Baffinland Iron Mines Corporation (the “Client”), in respect of the drilling, soil and rock sampling along a proposed railway alignment and laboratory testing of samples. 2

The undersigned hereby:

(a) acknowledges that it wishes to receive a copy of the Report from the Client and that a condition precedent to the provision of the Report to the undersigned is that it sign and deliver to the Consultant this Waiver, Release and Indemnification; and

(b) irrevocably and unconditionally:

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Dated: [insert current date]

[INSERT NAME OF REPORT RECIPIENT]

By:____

Name:

Title:

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1. Introduction

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Baffinland Iron Mines Corporation (BIM) operates a Direct Shipping Ore (DSO) Iron Ore mine on Baffin Island, Canada. The current operation (the Mary River Expansion Project) comprises a DSO iron ore mine at Mount (Mnt) Nuluujaak, a camp and associated operating infrastructure located just south of Mnt Nuluujaak, and a port with infrastructure and camp at Milne Inlet. Currently, ore is crushed at the Mary River site, loaded onto B-train haul trucks and transported to the Milne Port on a haul road referred to as the Tote Road. Current production target for this year is 5 Mtpa.

Hatch has been retained by BIM to study the option of a pit-to-port railway for the Mary River Expansion Project. The objective of the study is to expand production to 12 Mtpa and reduce the unit operating cost.

Between September 7 and 14, 2016, Dr. Sean Hinchberger, a Senior Geotechnical Consultant at Hatch, visited the Mary River Expansion Project to inspect the proposed rail alignment and alternatives, identify potential quarry sources for the railway earthworks, and inspect the terrain with attention given to the types of permafrost. This report summarizes the work performed during the site visit as well as the main observations.

2. Methodology

2.1 Geological Review

The following bedrock and surficial soil (geological) maps were reviewed prior to undertaking the site visit. The maps were ‘ground truthed’ during the site visit in order to assess if they are appropriate for use as a basis for the Feasibility Study supplemented with boreholes. Modified versions of the reference maps are attached in Appendix A:

- Little, E.C., Holme, P.J., and Kerr, D.E., 2013. Surficial Geology Icebound Lakes (Southwest) Baffin Island, Nunavut, Geological Survey of Canada Map 74 (preliminary), scale 1:100,000
- Dyke, A.S. 2000, Surficial Geology Phillips Creek, Baffin Island, Nunavut, Geological Survey of Canada, Map 1961A, scale 1:250,000
- Jackson, G.D., Morgan, W.C. and Davidson, A., 1975. Geology Icebound Lake District of Franklin, Geological Survey of Canada, Map 1451A, scale 1:250,000
- Blackadar, R.G. and Davison, W.L., 1968, Geology Phillips Creek District of Franklin, Baffin Island, Geological Survey of Canada, Map 1239A, scale 1:253,440

2.2 Helicopter Inspections

The author undertook site induction training on September 7, 2016, and developed a work plan on September 8, 2016, with assistance from Jim Mallard and BIM's Exploration and Environmental Teams. The following helicopter assisted inspections were performed in accordance with the work plan:

- September 9, 2016: The author visited a series of locations between Chainage (CH) 10+000 and CH 100+000 on the Tote Road in order to observe and photograph the terrain. The initial inspections confirmed the general accuracy of the geologic maps and enabled the author to identify potential quarry sites considered to be suitable for the railway construction.
- September 11; 2016: The author resumed helicopter inspections on September 11, accompanied by BIM's archeologist (Claude Pinard, Consultant). Potential quarry sites and ice rich permafrost zones were examined as well as the main archeological sites situated adjacent to the Tote Road and Philips Creek. The author gained an understanding of typical archeological constraints, assessed the quarries and obtained rock samples from the quarries for durability and soundness testing.
- September 12, 2016: The remaining quarry sites were inspected, rock sampling was completed, and the rail deviation from CH 60+000 to CH 80+000 was examined.

3. Observations

3.1 Photographic Record

The site visit photographic record is attached in Appendix B. Sixty-three photographs were selected for the record. The photographs are numbered sequentially starting from the north end of the Tote Road near the Milne Port and working south toward the mine site. The photographs were taken using a digital camera equipped with a GPS (Global Positioning System) and their location and view direction are illustrated on the attached Drawing H352035-GEOSKT-229-292-0002; Sheets 1 to 4 (see Appendix B).

Drawing H352035-GEOSKT-229-292-0002 also shows the rail alignment and the terrain types adjacent to the railway as digitized from the surficial geologic maps listed in Section 2.1. Fifteen potential quarry sites were also identified and are labeled PQ01 to PQ15 and plotted on the above noted drawing. The following sections discuss the terrain and potential quarry locations with reference to the photographic record.

3.2 Terrain Evaluation

3.2.1 CH 0+000 to 10+000

The proposed railway alignment between CH 0+000 and 10+000 is situated mainly on either till (silt, sand and some gravel) or glacial outwash terraces (gravelly sand). Locally, the alignment encroaches on a ridge of granitic bedrock that is oriented parallel to Philips Creek and situated approximately 500 m east of the Tote Road. It was intended to locate the rail at least partially within the granitic ridge in order to provide borrow material for the rail embankment construction. The ridge is ideal for quarry development as described below in Section 4.

Earthwork cuts in this terrain are likely to yield either frozen gravelly sand or good quality rockfill. The frozen gravelly sand will likely be suitable for fill provided that it is passed through a cone crusher after excavation, spread using large dozers (i.e., D8 or larger) and compacted in thin lifts (i.e., 150 mm) to mechanically break down the frozen clumps.

Photograph 1 shows an aerial view of the Tote Road and the granitic ridge between approximately CH 2+500 (foreground) and 10+000 (background). The Tote road is situated on glacial outwash terraces (frozen gravelly sand), which are highly undulating as illustrated by the winding road alignment.

The outwash terraces (gravelly sand) are shown in Photographs 2 and 3 near CH 10+000 (viewing north).

Photographs 4 and 5 show the upstream and downstream reaches of Phillips Creek near the waterfall located at CH 10+800. See also Figure 3-1. These photographs (i.e., 4 and 5) show outcropping granitic bedrock in Phillips Creek and ice rich soils situated immediately east of the creek. Between CH 0+000 and 12+000, similar granitic outcrops occur periodically between Philips Creek and the granitic ridge. Referring to Drawing H352035-GEOSKT-229-292-000, Sheet 1 of 4, there are several pre-existing permitted granitic quarries within this segment of the railway as denoted by the diamond (♦) symbols.

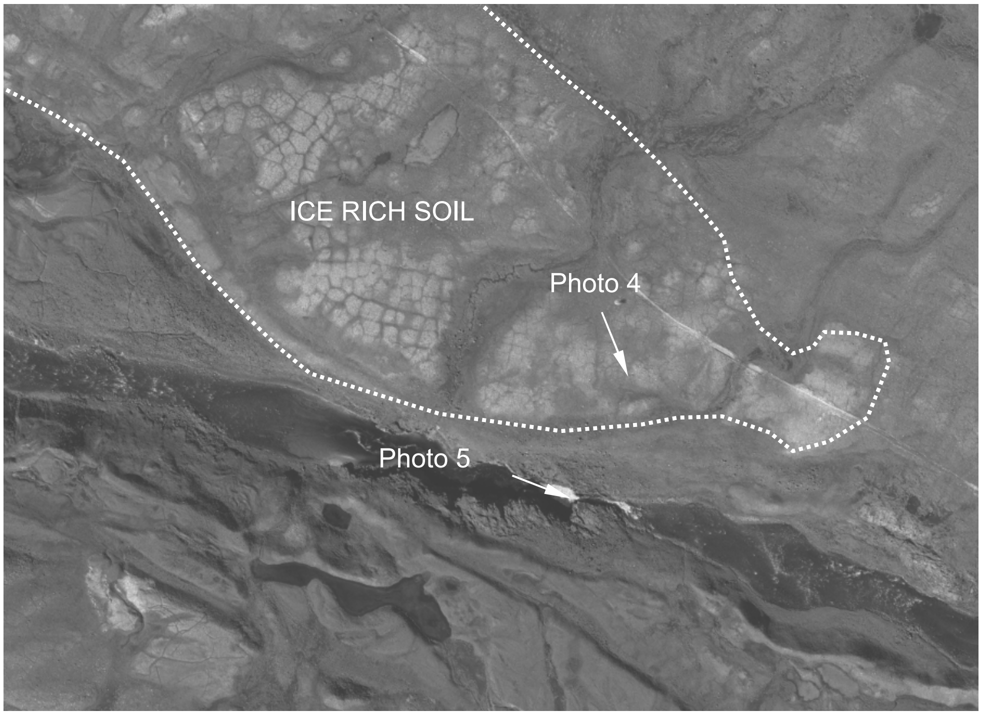


Figure 3-1: Ice Rich Soil Near CH 10+500

3.2.2 CH 10+000 to 46+000

The terrain between CH 10+000 and 46+000 is less undulating compared to CH 0+000 to 10+000. Also, the Phillips Creek valley widens substantially on the east side of the creek as the creek bends southward and diverges from the granitic ridge. Except locally near Philips Creek, the valley comprises a broad till sheet, which slopes gently from east to west. The proposed rail alignment generally follows along the contact between the till sheet (sandy silt with gravel) and glacial outwash deposits (sand and gravelly sand), and as a result, the subgrade conditions alternate between these two domains.

The glacial outwash (mainly sand and gravelly sand) and till can be differentiated by their colour and particle size distributions. The till is damp to wet when thawed, gray and has a silt content that generally ranges between 30 and 50 percent (Note: estimated). The outwash sand is tan coloured and is variable; it generally alternates between relatively clean sand or gravelly sand (0 to 8 percent silt) and silty sand (20 percent silt).

Photographs 6, 7 and 8 show the north approach to Bridge No. 1, Bridge No. 1, and the south approach to Bridge No. 1, respectively. Notably, the terrain is flat with regularly occurring small water bodies, which are usually indicative of ground ice. In this area, the soils comprise mainly sand with trace to some gravel, and variable silt content.

Photographs 9 to 19 illustrate the two contrasting terrain units that effectively dominate the geology between CH 10+000 and 46+000, i.e., the gray till and tan to reddish brown outwash gravelly sand deposits. Referring to Photograph 10, several ridges occur in the till to the east of the existing Tote Road. These ridges typically indicate the presence of shallow sedimentary bedrock (i.e. limestone beds) located just below the ground surface. The noses of the beds are typically exposed in the occasional creek beds that flow east to west during summer toward Phillips Creek. In some areas, these ridges may be indicative of ground ice as highlighted in Photograph 12.

Photograph 13 shows a typical creek bed. The creek gradient is relatively flat and the flows, when present, are typically along the top of underlying limestone or sandstone beds (i.e. bedrock). Photograph 14 shows a general view of the till plain.

Photographs 15, 17, and 18 all show views of the outwash terrain. As noted above, the surface soils comprise sands and gravelly sands with occasional cobbles.

Photograph 16 shows exposed sedimentary bedrock in the Phillips Creek stream bed. At this location, taking into account the relief and flat lying nature of the bedrock, the depth to bedrock under the Tote Road is in the order of 5 to10 m.

Photograph 19 illustrates the contact between the glacial outwash and till terrain units at CH 46+000. As noted above, these two units can be easily differentiated by their colour and fines content; notably, the till is generally gray and comprises 30 to 50 percent silt particles; whereas, the sand and gravelly sand is tan coloured and relatively clean.

3.2.3 CH 46+000 to 59+200

Between CH 46+000 and 59+000, Tote Road and proposed rail alignment continue to follow the contact between the glacial outwash (gravelly sands) adjacent to associated with Phillips Creek and the glacial till units overlying sedimentary rock located east of the outwash deposits. The terrain is moderately undulating and the predominant soil type is either gravelly sand or sandy silt with gravel.

Over this stretch of the alignment, there is an exposed limestone ridge or mesa running parallel to and approximately 500 m east of the Tote Road. The bedrock ridge occurs between approximately el 750 to el 850 ft and is shown in Photographs 21 (CH 54+200), Photo 22 (CH 57+800) and Photo 26 (CH 52+000 to 58+000). The limestone bed associated with this ridge is more prevalent on the west side of Phillips Creek as shown in Photographs 15, 18, 19, 20 and 24. It is noted that there is possible ground ice at CH 45+000 (see Photograph 20), which is not delineated on the public domain geologic maps for this area. The reader is referred to Appendix C for aerial photographs and an estimate of the extent of ice rich soil.

Lastly, between CH 55+200 and 59+200, Tote Road traverses a flat plain consisting of sand and silty sands deposited in a shallow water proglacial lake environment. Photos 23, 24 and 25 are representative of the terrain at this portion of the alignment.

Photograph 26 shows a good perspective of the exposed limestone ridge between CH 52+000 and CH 59+200. The ridge is a prime candidate for quarry development.

Photographs 27 to 30, inclusive, show views of Bridge No. 2 and the lake bed deposits located west of the bridge. The primary soil type is silt and sand or silty sand.

3.2.4 CH 59+200 to 70+000

Between CH 59+200 and 70+000, the rail alignment moves from the east side of the Phillips Creek valley to the west side at the headwaters. An unnamed creek enters the valley from the east at CH 59+500 and bends to flow south as shown on Drawing H352034-GEOSKT-229-292-0002, Sheet 3 of 4.

At CH 59+500, the terrain transitions from a relatively flat glacial lacustrine plain to alternating till and glacial fluvial soils overlying limestone bedrock. At the time of the site visit, the proposed rail alignment was situated on the east side of the unnamed creek whereas it has now been located on the west side. Although the following pictures and discussions relate to the terrain on the east side, it is noted that the terrain is similar on both sides of the creek valley.

Photographs 31 and 34 show the exposed dolomitic limestone ridge at CH 64+200 of the rail alignment (Note: East side of the valley). This is the same bedrock unit that is present between CH 42+000 and CH 59+200 on the east and west sides of Phillips Creek and it is prevalent throughout most of the central portion of the rail route. At this location, the bedrock is fairly blocky due to ice jacking and it is covered by a thin discontinuous veneer of glacial till of approximately 1 m thickness or less.

Photographs 32 and 33 show the glacial till blanket in the unnamed creek valley, as well as the lacustrine terrain to the north near the Tote Road Bridge No. 2.

Photographs 35, 36 and 37 show the limestone ridge at CH 66+000 (i.e. between El. 750 ft and 850 ft). Initially, this was thought to be a quarry location for the rail alignment when the alignment was located east of the unnamed creek; however, it is representative of the expected conditions on the west side at PQ09 (See H352034-GEOSKT-229-292-0002, Sheet 3 of 4).

In summary, the author believes that photographs 31, 33, 34, 35, 36 and 37 should be indicative of the conditions at PQ07, PQ08 and PQ09.

3.2.5 *CH 70+000 to 72+600*

The proposed railway crosses the unnamed creek from the west side to the east side between CH 70+000 and 72+600. The left bridge approach is situated on a gently sloping till blanket; Photographs 40 and 41 illustrate the till blanket (east side). The terrain transitions to a broad and flat alluvial plain approximately 300 m west of the bridge crossing. The alluvium comprises sand and gravel with cobbles and is illustrated on Photograph 40. Between CH 71+300 and 72+600, the alignment transitions to a glacial lacustrine deposit comprising medium fine sand, which is also shown in Photograph 40. This deposit is wet with numerous small surface water bodies, which again is normally associated with thermal karst and ground ice.

3.2.6 *CH 72+000 to 82+000*

Between CH 72+000 and 82+000, the railway traverses an extensive till blanket. The till is gray, wet, fine-grained and consists of predominantly silt and sand with some gravel. Locally, there are areas of ground ice as illustrated on H352034-GEOSKT-229-292-0002, Sheet 3 of 4. It is noted that the composition of the till unit is very consistent to that at the north end of the rail near CH 12+000 to CH 82+000; only the moisture content varies and degree of vegetative cover.

The till slopes gently from the north to the south and it is dissected by numerous north-south flowing creeks (summer only). The creeks have eroded through the till to expose the underlying limestone bedrock. Visual examination of some of the creek beds indicates that the till deposit is generally less than 2 m thick.

Photographs 41 to 44 show the general till terrain. Photograph 45 shows the prominent bedrock ridge that is situated about 1.5 km north of the rail and emerges starting at CH 80+000 (see Photograph 45).

The bedrock is very shallow at numerous locations particularly adjacent to the Tote Road. For example, Photograph 47 shows a road cut made in 2016 to reduce grades on the Tote Road. The bedrock at this location is very shallow and the till cover is less than 0.3 m thick. This has been identified as a potential quarry location, See PQ12, as noted in Section 4 of this report.

3.2.7 *CH 82+000 to 100+000*

Between CH 82+000 and CH 100+000, the terrain alternates between glacial fluvial deposits (gravely sand) and lacustrine deposits (sandy silt and silty sand). The lacustrine is locally ice rich as indicated on drawing H352034-GEOSKT-229-292-0002, Sheet 3 of 4.

Photographs 46, 48, 49, 55, and 56 show the glacial lacustrine terrain, which comprises predominantly flat ice rich sandy silt to silty sand.

There is an excellent quarry site situated just over 1 km north of the rail alignment and labeled PQ13 on Drawing H352034-GEOSKT-229-292-0002. The potential quarry site is a hill of granitic rock and is shown on Photographs 50 and 52. As an alternate to PQ13, there is also an exposed Diabase Dyke situated another 1.5 km north of PQ13. The dyke is shown in Photographs 51a and b.

Generally, the terrain is flat from about CH 82+000 to CH 95+000; and it becomes more undulating from CH 95+000 to CH 100+000 as the route crosses an esker ridge.

Photographs 57 and 58 show the esker terrain, which consists of mainly gravelly sand.

3.2.8 CH 100+000 to Terminus

The remainder of the route traverses undulating terrain consisting of either a thin veneer of sand and gravel (glacial fluvial) overlying granitic bedrock or exposed granitic rock.

Similar to CH 0+000 to 10+000, it should be appropriate to implement cut-fill construction for this segment of the railway. The cut material is likely to comprise either frozen gravelly sand or sound durable rockfill and the risk of ground ice is judged to be low provided the alignment is not pushed too far north of the Tote Road. The gravelly sand could be used for fill provided that it is passed through a cone crusher and then spread in thin lifts using a large dozer (i.e., D8 or larger) and compacted to break down the frozen pieces.

Photographs 59 and 60 show the Tote Road Bridge No. 4, which is situated on the sand and gravel alluvial plain associated with the unnamed creek.

The rail alignment has been moved north of Bridge No. 4 into the rocky terrain in order to generate rockfill from cut-fill earthworks. Photograph 61 illustrates the predominant terrain for the rail alignment.

4. Quarries

Table 4-1 summarizes the potential quarry sites identified by the author. Fifteen potential quarry sites have been identified that are capable of yielding sufficient quantities of material for rail embankment construction, as discussed below.

Generally, there are three main rock types in which quarries can be developed, notably, granitic rock, medium strong durable limestone and weak limestone or sandstone. The granitic rock and strong durable limestone beds are suitable for run-of-quarry rockfill; the granitic rock is also suitable for ballast. The weak limestone and sandstone bedrock must be treated as a soft rock during fill placement. The quarried materials from the weaker bedrock sources will need to be broken down during borrow and placement by mechanical means as discussed below (i.e., thin lifts and compaction/crushing with large dozers and heavily loaded trucks).

PQ01: There are three permitted quarries in the granitic ridge located east of Phillips Creek between CH 0+000 and 10+000. Notably, Drawing H352034-GEOSKT-229-292-0002 shows quarries at CH 0+000, 5+800 and 8+300. The granitic rock is ideal for quarry-run rock fill and it will also be acceptable for use as ballast. As discussed above, the rail has been routed immediately adjacent to the granitic ridge in order to create rockfill from cut-fill operations. Additional quarries can be established in the ridge as needed.

PQ2: There is an approximately 1 km long gently sloped possibly granitic rock outcrop situated east of the existing Tote Road between CH 26+000 and 28+000. A quarry at this location should provide suitable rockfill and possibly ballast. Because the majority of the rock is below ground, however, it may be difficult to produce major quantities from this site without impacting a large area.

PQ3: There are shallow limestone beds situated approximately 1.5 km and 3 km east of the Tote Road at approximately CH32+000. Occasionally, the beds are exposed in the creek bottoms that generally flow from southeast to northwest. At the lower elevations (i.e., closer to the Tote Road), the beds were found to consist of soft and weathered sandstone; the beds were harder at higher elevations and comprised mainly limestone. Softer bedrock beds can be utilized for embankment fill provided sufficient mechanical energy is used during borrow and placement to break the rock down.

PQ4 and PQ5: These quarries are located at the north end of the limestone ridge or mesa that runs parallel to the Tote Road from CH 42+000 to CH 58+600 between el 750 ft and el 850 ft. The limestone beds at the north end are less prominent than the ridges further south; however, contractors should be able to develop quarries and produce reasonable quantities of rockfill from these limestone units, if required.

PQ6, PQ7, PQ08, PQ09 and PQ11: All of these potential quarry sites are situated in hard massive limestone bedrock primarily between el 750 ft and el 850 ft. Quarried rock produced from these sources should be suitable for rockfill embankments but is unlikely to be suitable for ballast. The quantity of material available far exceeds the quantities required for construction of the railway. Access is feasible but will need to be planned through areas where the ridge is buried such as shown on Photograph 26. Access roads may require multiple switchbacks due to the grades. Given the difficulty of operating haul trucks on sloping arctic terrain, a conveyor system may be preferred to move the material from the higher elevation quarries to stockpiles adjacent to the Tote Road.

PQ10 and PQ12: These quarry sites consist of shallow limestone beds overlain by less than 2 m of glacial till. The rock at these locations comprises limestone interbedded with weak shale partings and beds. The shale is weaker and friable. Material derived from these sources will be suitable for use as rockfill but it will need to be broken down by mechanical means during exploitation and placement, as discussed above.

PQ13, PQ14, and PQ15: Most of these potential quarry sites consist of granitic bedrock with a thin veneer of gravelly sand or sand overlying the rock. These quarries should be suitable for producing rockfill as well as ballast and there should be more than enough material to meet the project needs. The overburden thickness at PQ14 is not known and could be too thick to allow easy development. As noted in Section 3, there is a diabase dyke situated 1.5 km north of PQ13 and at PQ15. The diabase is very hard and would be an excellent site for ballast production. The hardness of the diabase will make it difficult to quarry and crush, and given the reasonably good quality of the granitic borrow sources, utilizing the dyke is probably not necessary.

Table 4-1: List of Potential Quarries

Proposed Quarry	Photograph Reference	Rail Chainage (m)	Rock Type	Overburden (m)	Quality	Description	Development Potential
PQ01	1	0+000 to 11+000	Granitic Gneiss*	0	Good to Excellent	Approx. 10 km long bedrock ridge along east of the existing Tote Road. Suitable ballast material.	Very Good to Excellent
PQ02	None	21+000 to 22+000	Granitic Gneiss*	0.5 to 3	Good to Excellent	An approximately 1 km long possibly granitic rock outcrop gently sloped east of the existing Tote Road between Chainage 26+000 and 28+000. Suitable rockfill and ballast material	Moderate to Good
PQ03	None	32+000 to 36+000	Dolomitic Limestone/ Sandstone	2 to 3 m	Poor to Moderate	Approx. bedrock ridge 2-3 km east of the existing Tote Road. Covered in till veneer but exposed in the creek beds with harder limestone beds at higher elevations.	Poor to Moderate
PQ04	None	42+000	Dolomitic Limestone/ Sandstone	2 to 3	Poor to Moderate	Approx. 1 km long bedrock ridge along east of the existing Tote Road. Covered in till veneer but exposed in the creek beds with harder limestone beds.	Poor to Moderate
PQ05	None	44+000 to 46+000	Dolomitic Limestone	0	Moderate to Good	Approx. 4 km long bedrock ridge east of the existing Tote Road. Large ice jacked blocks.	Moderate to Good
PQ06	21, 26	51+000 to 58+000	Dolomitic Limestone	0	Moderate to Good	Approx. 7 km long bedrock ridge east of the existing Tote Road.	Good to Very Good
PQ07	22,26	58+000	Dolomitic Limestone	0 to 3	Moderate to Good	Outcropping east of the existing Tote Road.	Good to Very Good
PQ08	31	60+000	Dolomitic Limestone	Greater than 3	Moderate to Good	Located west of the existing Tote Road at km 65.	Moderate to Good
PQ09	39**	66+000	Dolomitic Limestone	0 to 3	Good to Excellent	West of the proposed Rail Alignment at the deviation from Tote Road.	Good to Excellent
PQ10	39**	74+000	Dolomitic Limestone	0 to 3	Moderate to Good	North of the proposed Rail Alignment at the deviation from Tote Road.	Poor to Moderate
PQ11	47	84+000	Dolomitic Limestone	0	Moderate to Good	North of the proposed Rail Alignment along the existing Tote Road. Massive cliff with challenging access.	Moderate to Good
PQ12	49	82+000	Dolomitic Limestone	1 to 2	Poor to Moderate	North of the proposed Rail Alignment at the deviation from Tote Road. Veneered Till overburden. Limited vertical development.	Poor to Moderate
PQ13	54 a,b	86+000	Grandiorite*	0 to 2	Very Good to Excellent	Approx. 2 km north of the existing Tote Road/ Rail Alignment.	Very Good to Excellent
PQ14	55**, 65	96+000 to 104+000	Undifferentiated Mafic/Granitic Rock*	1 to 3	Very Good to Excellent	North end of an approx. 8 km long bedrock ridge roughly 1 km north of the existing Tote Road.	Moderate
PQ15	55**, 65	96+000 to 104+000	Diabase*	1 to 3	Very Good to Excellent	South end of an approx. 8 km long bedrock ridge roughly 1 km north of the existing Tote Road; adjacent to the Rail Alignment.	Good to Very Good

* Likely suitable for Ballast
**Photograph is from a nearby similar location and representative of general rock conditions; however, it does not capture the actual location

5. Aerial Photograph Assessment

The results of aerial photograph analysis are attached in Appendix C. Select stereo pairs were analyzed to evaluate the accuracy of public domain geologic maps (see Appendix A). The results are presented in Appendix C. In general, the analyses confirmed that the terrain assessment summarized on the maps listed in Section 2 and transposed onto Drawing H352034-GEOSKT-229-292-0002 Sheets 1 to 4 are satisfactory. The boundary between the terrain units is approximate and should not be relied on as being highly accurate; however, the overall map boundaries and terrains should be on average representative.

The following summarizes the key findings:

- The number of bedrock outcrops is uncertain between CH 0+000 and 8+000 west of the exposed granitic ridge. The terrain consists of sand and gravel and silty sand and gravel overlying bedrock. Locally, the soil cover has been eroded away to expose the bedrock. The rail alignment may need to be pushed further east to take advantage of the granitic ridge.
- The extent of the ice rich soils is greater than that shown on the public domain maps used to generate Drawings H352034-GEOSKT-229-292-0002 Sheets 1 to 4. Despite this, the rail alignment appears to have avoided the obvious ice rich soil deposits except between CH10+000 and CH 11+00, CH 46+000 and CH 48+500, CH 76+000 and CH 80+000, CH81+500 and CH 83+000 and CH 86+000 and CH 89+000. Cuts should be avoided in these areas or designed with care, supported by borehole investigations.
- Cuts are likely required where the railway traverses across the esker deposit at CH 98+200. Additional boreholes may be required in this area to assess if ground ice exists.
- The extent of outcropping rock between CH100+000 and 105+000 is variable; however, cuts in this section of the alignment should yield mainly granitic rockfill.
- The terrain units and rock types identified on the maps attached in Appendix A are generally confirmed by the site visit and subsequent aerial photograph assessment. Local variations should be expected from these maps but as a whole the maps should serve as a reasonable design basis for the railway supplemented by a geotechnical drilling program.

Appendix A
Reference Geologic Maps

SURFICIAL DEPOSITS
QUATERNARY
HOLOCENE

Ice: glacier

COLLUVIUM: block and rubble accumulations, 1-50 m thick

- **Ca** — **Talus:** active block and rubble accumulations as much as 50 m thick forming talus (scree) aprons and fans below cliffs resulting from rock falls and debris flows; commonly crossed by debris flow channels and levées
- **Cr** — **Rock glacier debris:** talus, generally 10-50 m thick, deformed by active flow of interstitial or buried ice to form rock (talus) glaciers with transverse ridges and furrows, and pits, and with steep, unstable sides and fronts

FLUVIAL SEDIMENTS: alluvium; gravel and sand, 2-20 m thick

- **Ap** — Alluvial plains; active braided floodplains; includes active proglacial outwash
- **At** — Alluvial terraces
- **Af** — Alluvial fans

MARINE AND GLACIAL MARINE SEDIMENTS: gravel, sand, silt, and clay, 1-20 m thick, deposited in deltaic and beach environments during regression of the postglacial sea

- **Mr** — **Beach sediments:** gravel and sand, 1-5 m thick, forming ridges and swales
- **Mt** — **Deltaic sediments:** clay, silt, sand, and gravel, 5-20 m thick, forming coarsening upward sequences under dissected terraces
- **Mv** — **Deepwater proglacial silt veneers:** silt, clay silt, and fine sand with dropstones, 1-2 m thick
- **Mb** — **Deepwater proglacial silt blankets:** silt, clay silt, and fine sand with dropstones and minor gravel, 2-10 m thick

GLACIAL LACUSTRINE SEDIMENTS: clay, silt, sand, and gravel deposited in glacier dammed lakes in deepwater and deltaic environments

- **Lt** — **Deltaic sediments:** clay, silt, sand, and gravel, 5-20 m thick, forming coarsening upward sequences under dissected terraces
- **Lv** — **Deepwater proglacial silt veneers:** silt, clay silt, and fine sand with dropstones, 1-2 m thick
- **Lb** — **Deepwater proglacial silt blankets:** silt, clay silt, and fine sand with dropstones, 2-5 m thick

GLACIOFLUVIAL SEDIMENTS: gravel and sand, 1-10 m thick, deposited behind, at, and in front of the ice margin

- **Gp,t,f** — **Proglacial outwash:** gravel and sand, 1-10 m thick, forming braided floodplains, Gp; terraces, Gt; and fans, Gf
- **Gr,h** — **Ice contact stratified drift:** gravel and sand, 1-5 m thick, forming eskers, Gr; and kames, Gh

EARLY HOLOCENE AND WISCONSINAN

TILL: nonsorted stony muds, 0.5-60 m thick, deposited in subglacial and ice marginal environments; lithic composition generally reflects underlying bedrock

- **Tm** — **End moraines:** 5-60 m high, composed of or mantled by till, extensively kettled in places; large features mainly cored by debris-rich relict glacier ice
- **Tv** — **Till veneer:** 0.5-2 m thick and discontinuous
- **Tb** — **Till blanket:** 2-10 m thick forming an undulating blanket with drumlins and ribbed moraines in places

PRE-QUATERNARY

- **R** — **ROCK:** rock of various compositions and ages (Jackson and Sangster, 1987) variously modified by glacial erosion during the Quaternary; hilly and hummocky surfaces, ice moulded in places, with lake basins in subglacially scoured regions; smooth surfaces exhibiting little or no sign of glacial erosion in peninsular interiors (Dyke, 1993); cliffs resulting from glacial over-steepening

0 3 6 km

Modified from

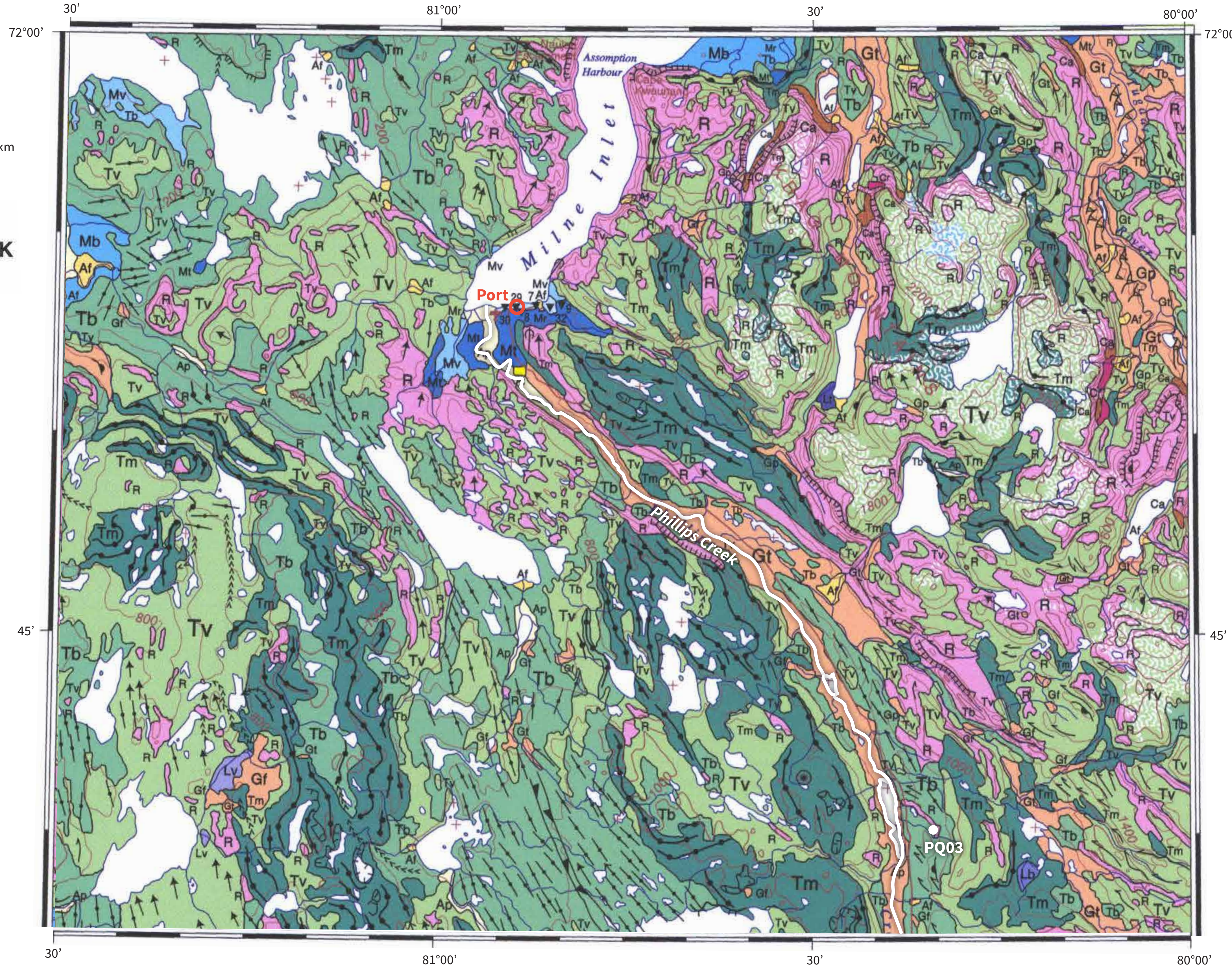
MAP 1961A

SURFICIAL GEOLOGY

PHILLIPS CREEK

BAFFIN ISLAND

NUNAVUT



Geological boundary
Areas covered by perennial icefields during the Little Ice Age (indicated by a white pattern)
Area of active wind erosion; minor attached dunes (indicated by a white pattern)
Direction of eroding wind
Small rock glacier
Pingo
Kettle (large,small)
Glacial lake spillway
Glacial lake limit
Marine limit
Bouldery ridge; subglacially deformed felsenmeer

Lateral meltwater channel; barb on upslope side
Subglacial and proglacial meltwater channel (large, small)
Esker
Ice contact face
Ribbed moraines
Lateral moraine
End moraine
Lateral shear moraine
Margin of dispersal train; teeth toward axis, steep side of teeth face down ice

Drumlinoid hill
Crag and tail
Ice moulded bedrock
Striae (ice flow direction known, unknown)
Cirque
Cliff in bedrock
Radiocarbon date (Date | Material / Lab no | Elevation (m))
Radiocarbon date with field number

Baffinland
12 Mtpa Expansion Project PFS
Surficial Geology - Phillips Creek - Map 1 of 2

HATCH

SURFICIAL DEPOSITS
QUATERNARY
HOLOCENE

- **Ice:** glacier

COLLUVIUM: block and rubble accumulations, 1-50 m thick

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EARLY HOLOCENE AND WISCONSINAN

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- Tv — **Till veneer:** 0.5-2 m thick and discontinuous
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PRE-QUATERNARY

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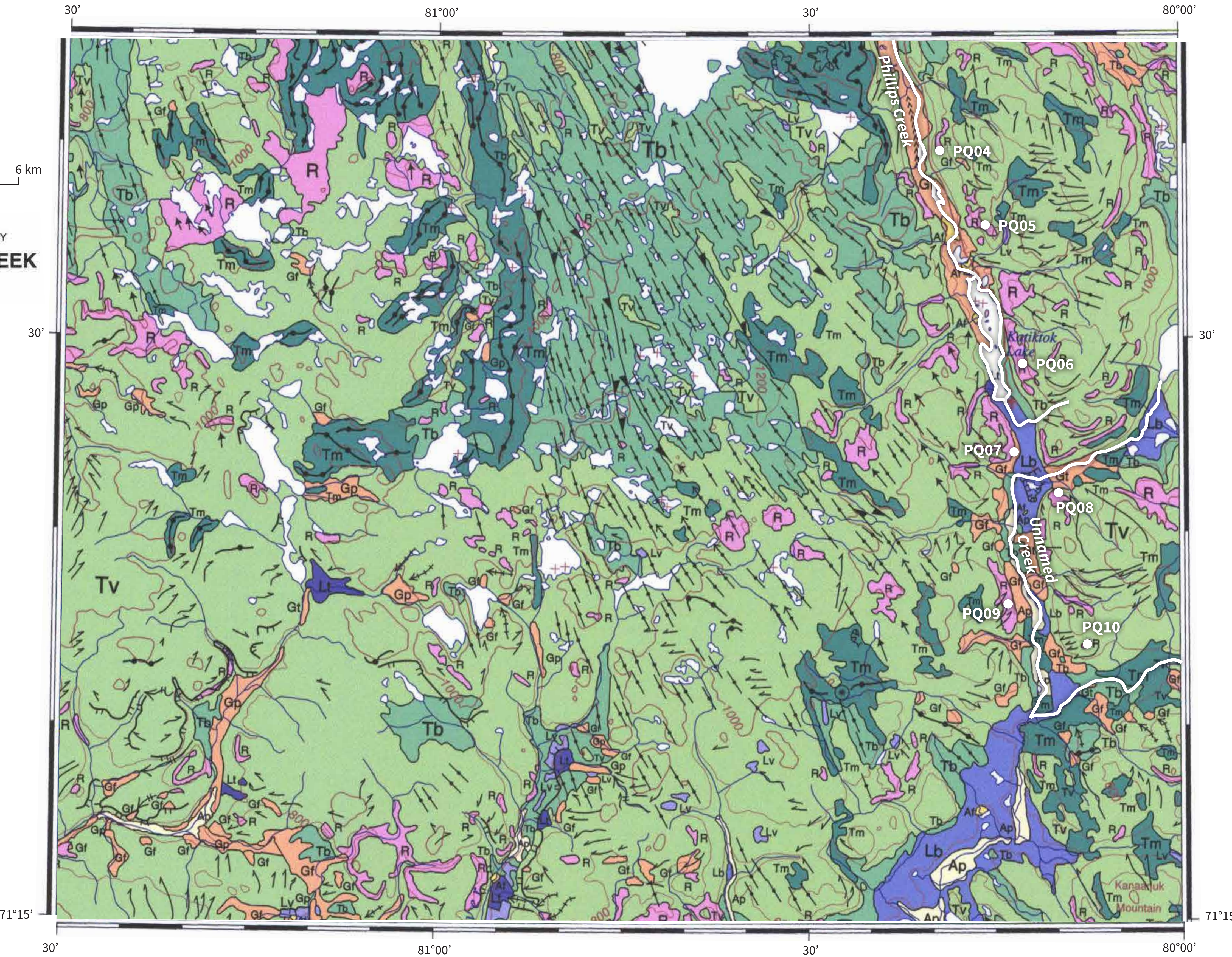
0 3 6 km

Modified from
MAP 1961A
SURFICIAL GEOLOGY

PHILLIPS CREEK

BAFFIN ISLAND
NUNAVUT



Geological boundary
Areas covered by perennial icefields during the Little Ice Age (indicated by a white pattern)
Area of active wind erosion; minor attached dunes (indicated by a white pattern)
Direction of eroding wind
Small rock glacier
Pingo
Kettle (large,small)
Glacial lake spillway
Glacial lake limit
Marine limit
Bouldery ridge; subglacially deformed felsenmeer

Lateral meltwater channel; barb on upslope side
Subglacial and proglacial meltwater channel (large, small)
Esker
Ice contact face
Ribbed moraines
Lateral moraine
End moraine
Lateral shear moraine
Margin of dispersal train; teeth toward axis, steep side of teeth face down ice

Drumlinoid hill
Crag and tail
Ice moulded bedrock
Striae (ice flow direction known, unknown)
Cirque
Cliff in bedrock
Radiocarbon date

Date	Material
Lab no	Elevation (m)

Radiocarbon date with field number 175

Baffinland
12 Mtpa Expansion Project PFS
Surficial Geology - Phillips Creek - Map 2 of 2

HATCH

QUATERNARY

SURFICIAL DEPOSITS

HOLOCENE

NONGLACIAL ENVIRONMENTS

ALLUVIAL SEDIMENTS: predominantly composed of sorted and commonly stratified gravel, sand, minor silt and organic detritus deposited by post-glacial fluvial processes; fan deposits may include gravelly diamictons.

- Av — **Alluvial veneer:** thin, discontinuous deposit; thickness is less than 1 m.
- Ap — **Alluvial floodplain:** typically forms a single level within approximately 1 m of active stream channel; thickness ranges from 1 to 5 m.
- At — **Alluvial terrace:** deposits are of floodplain origin and presently are isolated from flooding by stream incision; thickness ranges from less than 1 to 10 m.
- Af — **Alluvial fan:** forms fan-shaped landforms with gentle slopes where streams enter larger valleys; thickness can reach up to 10 m.

COLLUVIAL DEPOSITS: mass wasting debris (i.e. deposited by direct gravity-induced movement that may involve water and/or ice); typically unsorted, but may be stratified as a result of gravity induced movement (e.g. debris flows); the character of the deposit depends primarily on its parent material.

- Cv — **Colluvial veneer:** thin, discontinuous deposit; thickness is less than 1 m.
- Cb — **Colluvial blanket:** a mantle of sediment; thickness is greater than 1 m.
- Ca — **Colluvial apron:** forms a slope deposit comprising debris flows, avalanche-dominated fans, and solifluction sediments derived from bedrock and glacial sediment sources; thickness is up to 10 m, thinning at head and toe of the deposit.

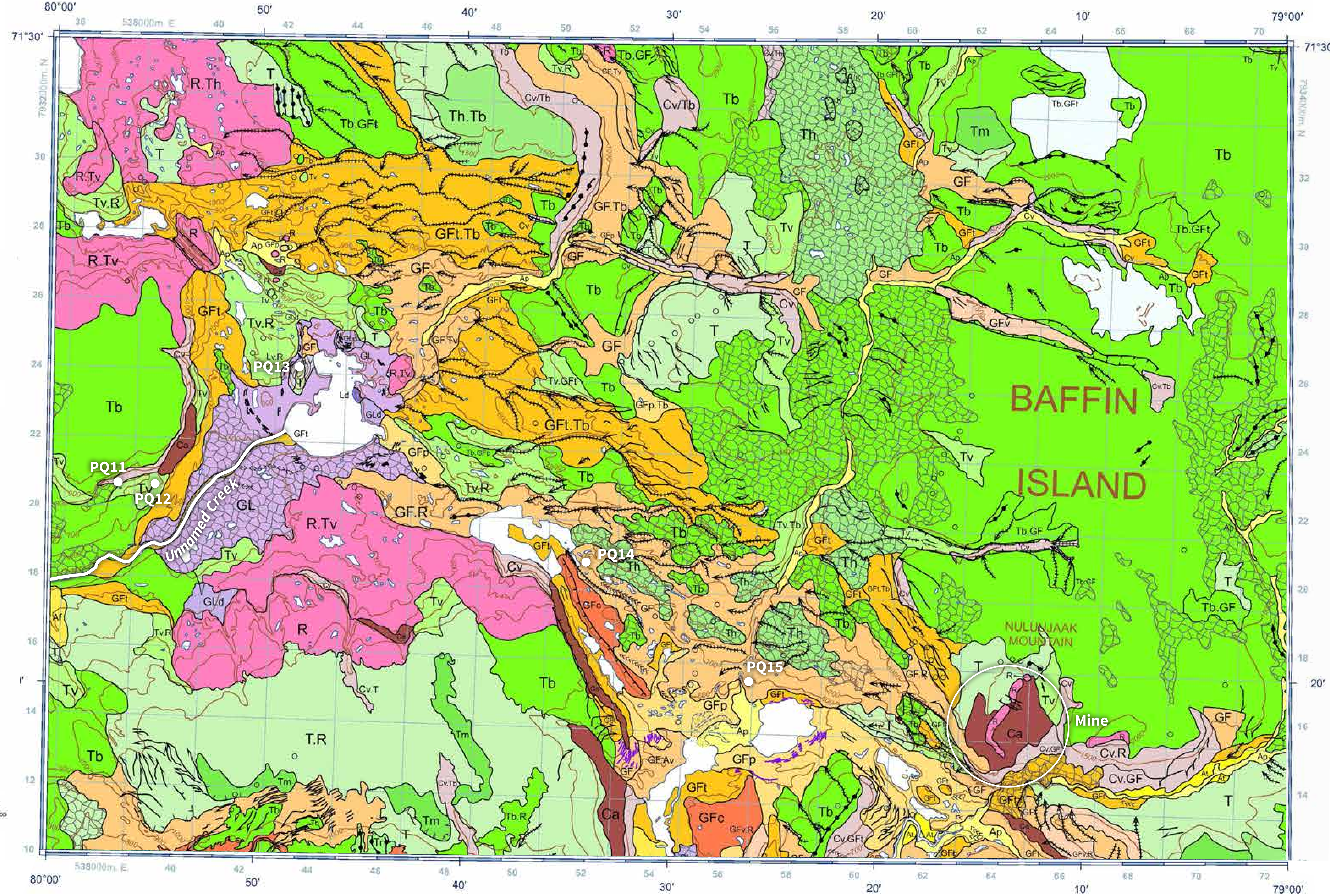
GLACIAL ENVIRONMENT

- GLd — **Glaciolacustrine delta:** sediment built-up from flowing glacially derived water entering a glacial lake; the feature may have gently or steeply-dipping fronts; thickness ranges from 3 m to greater than 10 m.
- GL — **Undifferentiated glaciolacustrine complex:** consists primarily of glaciolacustrine materials but may contain pockets of till, glaciofluvial, glaciomarine, marine, colluvium and/or alluvium sediments, that are too small to be represented at the scale of mapping; in upper slopes of valleys with cross-valley (DeGeer) moraines, more till is present and is inferred to represent the wasting zone of a paleo-lake; thickness is greater than 1 m.

EARLY HOLOCENE AND PLEISTOCENE

GLACIOFLUVIAL SEDIMENTS: well to poorly stratified gravel, sand and silt; minor diamicton; deposited behind, at, or in front of the ice margin by glacial meltwater,

- GFv — **Glaciofluvial veneer:** thin to discontinuous deposit; thickness is less than 1 m.
- GFp — **Glaciofluvial plain:** typically forms a single level plain; thickness ranges from 1 m to greater than 5 m.
- GFt — **Glaciofluvial terraces:** typically forms terraces separated by scarps; patches of colluvium that are too small to be represented at the scale of mapping may be present along the scarps; thickness ranges from 1 to 20 m.
- GFc — **Ice contact glaciofluvial:** kettle and kame topography, including esker ridges; thickness ranges from less than 5 m to greater than 15 m.
- GF — **Undifferentiated glaciofluvial complex:** undifferentiated glaciofluvial complex consists primarily of glaciofluvial materials but may contain pockets or till, glaciolacustrine, glaciomarine, marine, colluvium and/or alluvium sediments, that are too small to be represented at the scale mapping; thickness is greater than 1 m.
- Tv — **Till veneer:** thin, discontinuous deposit; thickness is less than 1 m.
- Tb — **Till blanket:** surface morphology ranges from conforming to underlying bedrock topography to rolling plain masking the underlying topography; may exhibit crag-and-tails and/or flutings; occasionally exhibits roches moutonnées in areas of thin till blankets (e.g., 1 to 2 m); thickness ranges from 1 m to 20 m.
- Tm — **Rolling till plain:** surface morphology forms gently rolling plains with 1 to 2 m relief; may exhibit flutings and/or other drumlinoid forms; generally masks underlying topography; thickness is greater than 5 m.
- T — **Undifferentiated till complex:** consists primarily of till but may contain pockets of glaciofluvial, glaciolacustrine, glaciomarine, lacustrine, marine, colluvium and/or alluvial sediments that are too small to be represented at the scale of mapping; thickness is greater than 1 m.



PRE-QUATERNARY

BEDROCK

- R — **Bedrock:** outcrops of bedrock, may have thin mantle greater than 10 cm of unconsolidated or organic material.
- **Patterned ground:** area exhibits a hexagonal polygon network where polygon diameter ranges from 20 to 50 m. may indicate the presence of buried glacial ice at depth.

NOTES:

Compound units: in areas where the surficial geology types are interspersed in patches or patterns too small to be discerned at the scale of mapping, compound units are used. The dominant component is listed first and separated from the secondary unit by a dot (e.g. Tb.O).

Stratigraphic relationship: where underlying units are known, the unit label shows the surface unit above underlying unit with a single slash (e.g. Tb/R).

- Kettle
- Geological boundary, defined
- Geological boundary, approximate
- Beach crest
- Druminoid (fluting)
- Esker ridge (flow direction known)
- Esker ridge (flow direction unknown)
- Fluted bedrock (ice flow direction known)
- Ice-contact terrace scarp
- Limit of submergence, marine, defined
- Meltwater channel, major (arrow indicates flow direction)
- Meltwater channel, minor (flow direction known)
- Meltwater channel, minor (flow direction unknown)
- Lateral meltwater channel, uphill left
- Lateral meltwater channel, uphill right
- Moraine ridge, minor
- End moraine ridge, major
- Lateral moraine ridge, major
- Terrace scarp, unspecified
- Delta, glaciolacustrine
- Station location, ground observation

0 3 6 km

Modified from

CANADIAN GEOSCIENCE MAP 74

SURFICIAL GEOLOGY

ICEBOUND LAKES (SOUTHWEST)

Baffin Island, Nunavut

Baffinland

12 Mtpa Expansion Project PFS

Surficial Geology - Icebound Lakes

HATCH

CENOZOIC

QUATERNARY

Q — *Drift and unconsolidated sediments*

PALAEOZOIC

ORDOVICIAN AND SILURIAN

LATE MIDDLE ORDOVICIAN TO MIDDLE SILURIAN

OSba — *BAILLARGE FORMATION: dolomitic limestone, in part shaly; minor dolomite*

ORDOVICIAN

MIDDLE AND (?) LOWER ORDOVICIAN

Osp — *SHIP POINT FORMATION: dolomite, in part silty and shaly; dolomitic intraformational conglomerate*

CAMBRIAN AND/OR ORDOVICIAN

CAMBRIAN AND/OR EARLY LOWER ORDOVICIAN

ADMIRALTY GROUP

€Oad — *GALLERY AND TURNER CLIFFS FORMATIONS UNDIVIDED: quartzose sandstone; minor siltstone, conglomerate, shale; a little breccia; dolomite, shaly, silty, sandy, pure; quartzose sandstone, in part dolomitic; dolomitic intraformational conglomerate; minor siltstone, shale, mostly dolomitic*

MIDDLE AND LOWER ORDOVICIAN AND (?) CAMBRIAN

€Oad,sp — *Admiralty Group and Ship Point Formations undivided*

(?) CAMBRIAN TO MIDDLE SILURIAN

€OS ad,sp,ba — *Admiralty Group, Ship Point and Baillarge Formations undivided*

PROTEROZOIC

HELIKIAN

Hg — *Gabbro dykes*

Hab — *ARCTIC BAY FORMATION: calcareous shale; dolomite*

P — *Proterozoic undivided; probably A*

APHEBIAN

A — *Granitic and gneissic rocks: >gt, granite, quartz-feldspar gneiss; &mg, migmatite; &bd, banded and lit-par-lit gneiss*

Geological boundary (defined, approximate, assumed)

Bedding, tops known (inclined)

Foliation (inclined, vertical)

Structural trend (in part from air photographs)

Lineament (from air photographs)

Fault (defined)

Geology of Precambrian rocks by R. G. Blackadar and W. L. Davison, 1963

Geology of Palaeozoic rocks by H. P. Trettin, 1963

Geological cartography by the Geological Survey of Canada, 1967

Horizontal control point

Intermittent stream

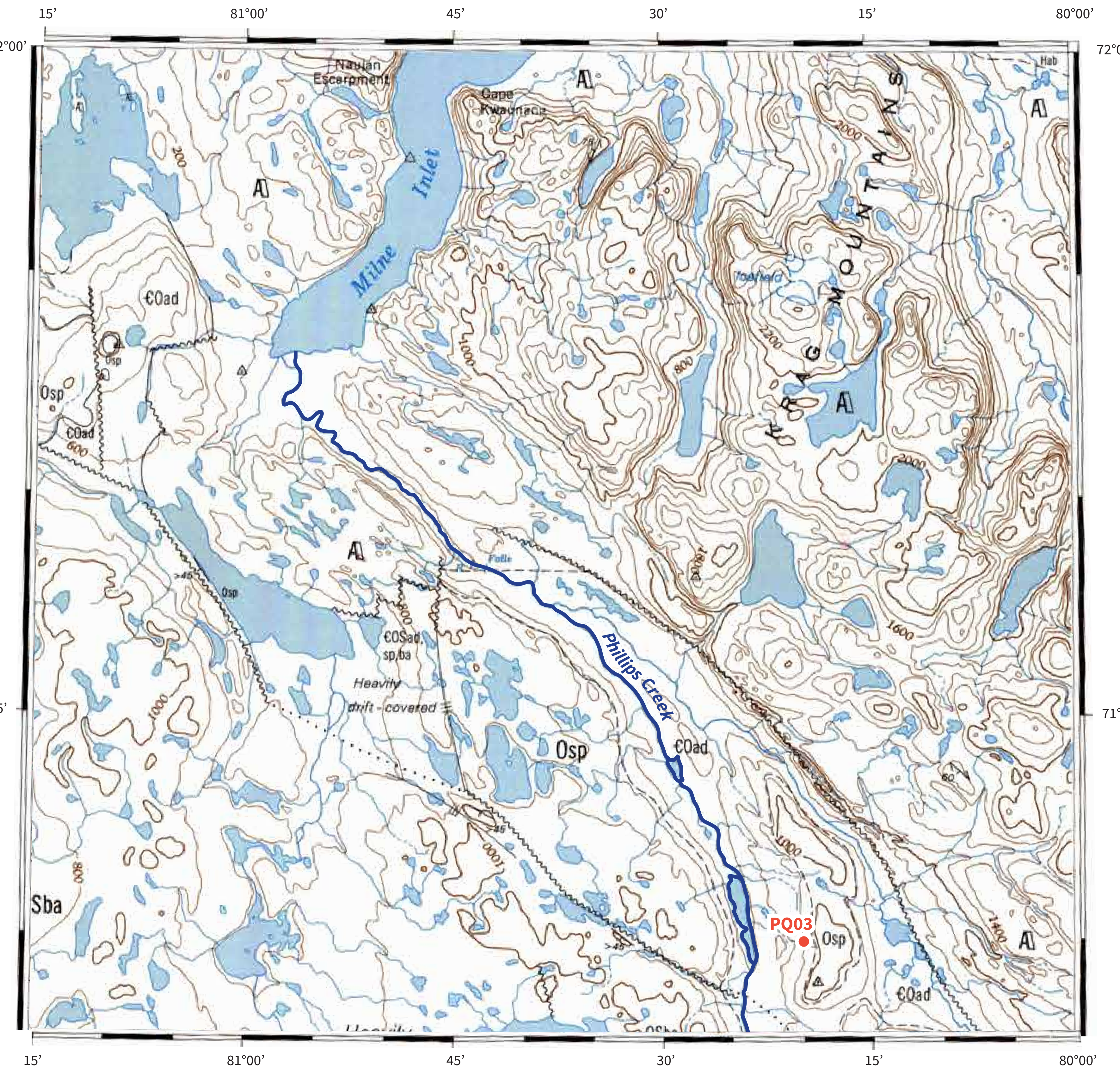
Dry river bed with channel

Rapids, falls

Contours (interval 200 feet)

Base-map compiled and drawn by the Surveys and Mapping Branch, 1964

Magnetic declination 1967 varies from 62° westerly at centre of west edge to 65° westerly at centre of east edge. Mean annual change, decreasing 29.8'.



0 3 6 km

Modified from

MAP 1239A

GEOLOGY

PHILLIPS CREEK

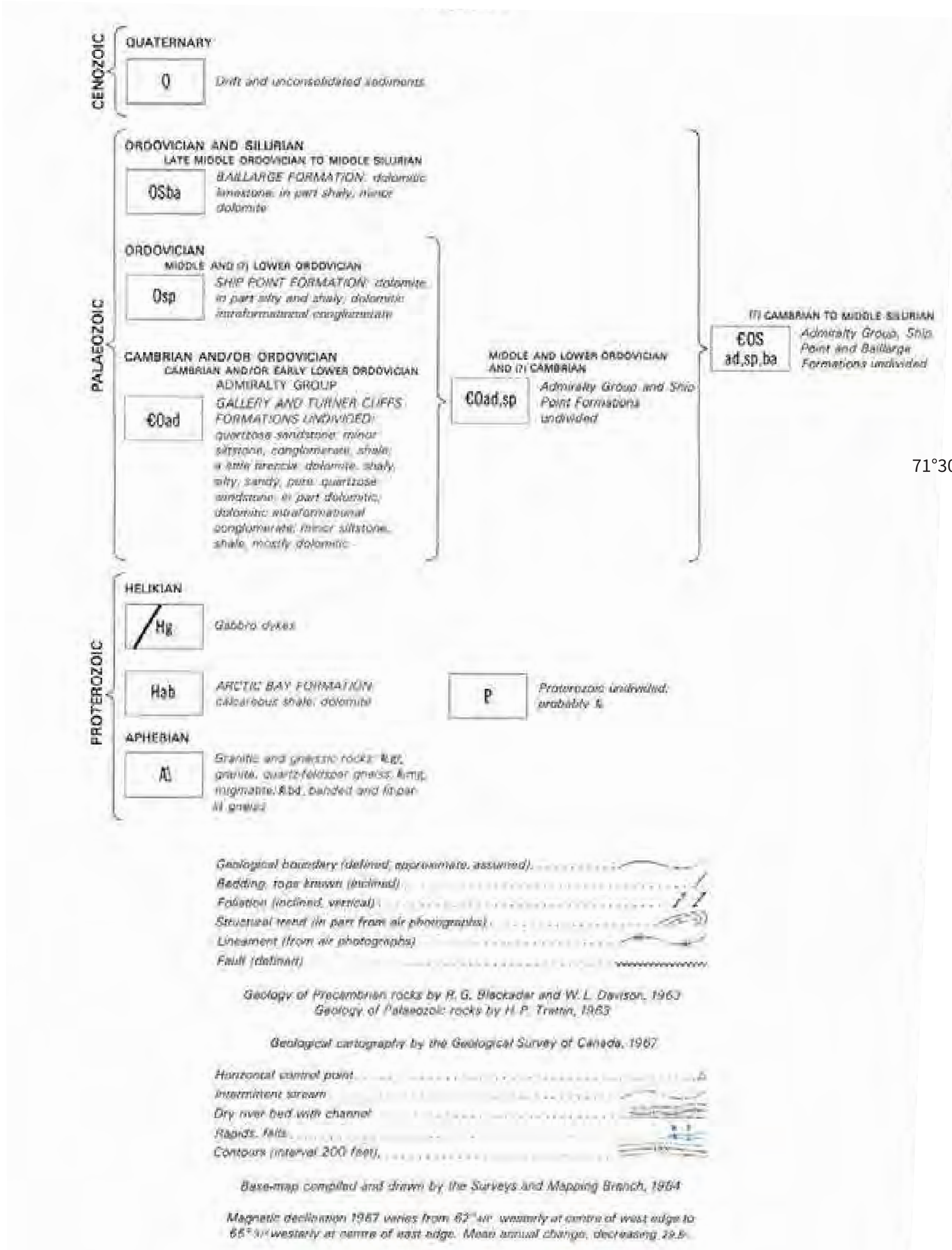
DISTRICT OF FRANKLIN

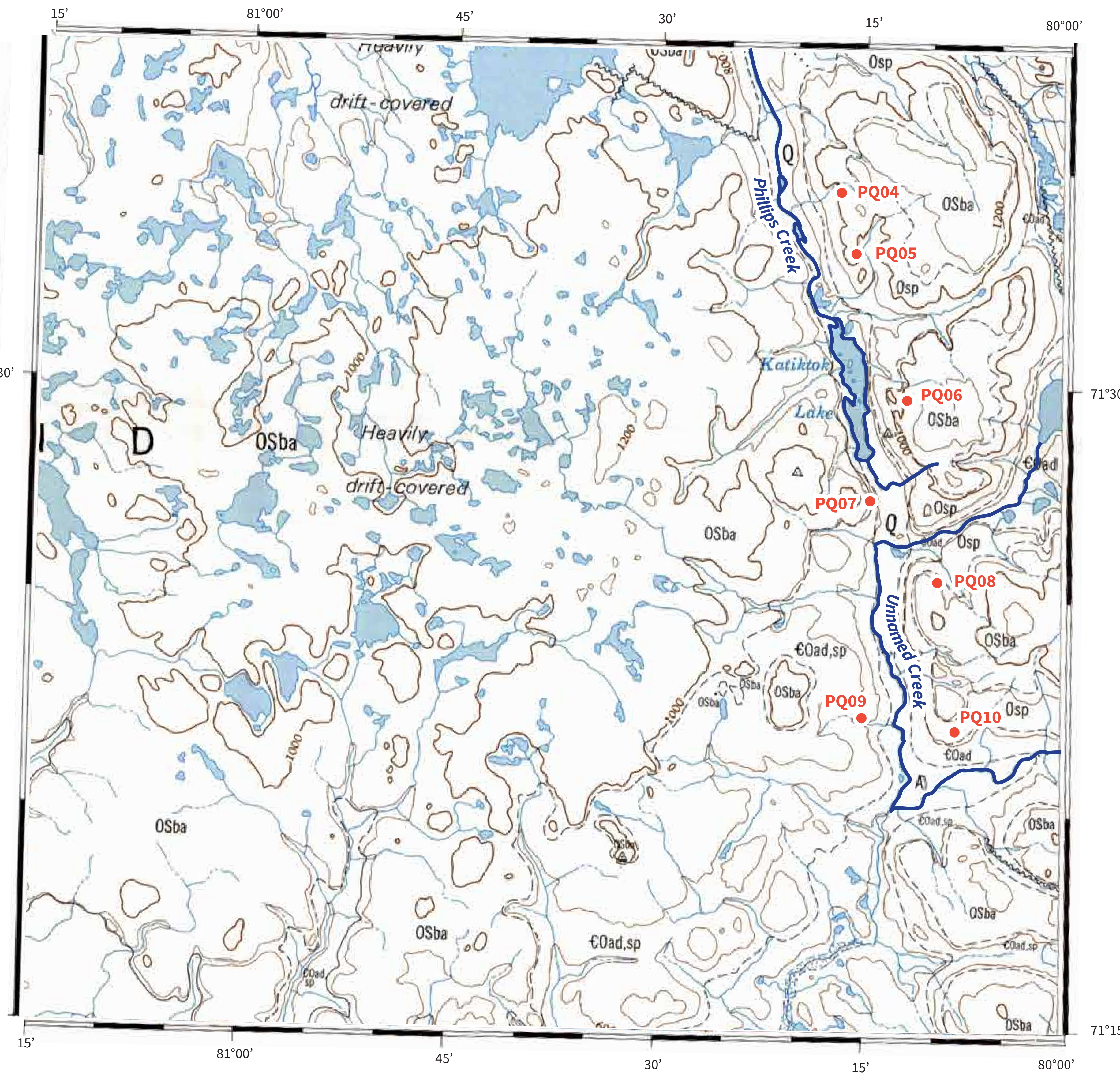
Baffinland

12 Mtpa Expansion Project PFS

Geology - Phillips Creek - Map 1 of 2

HATCH

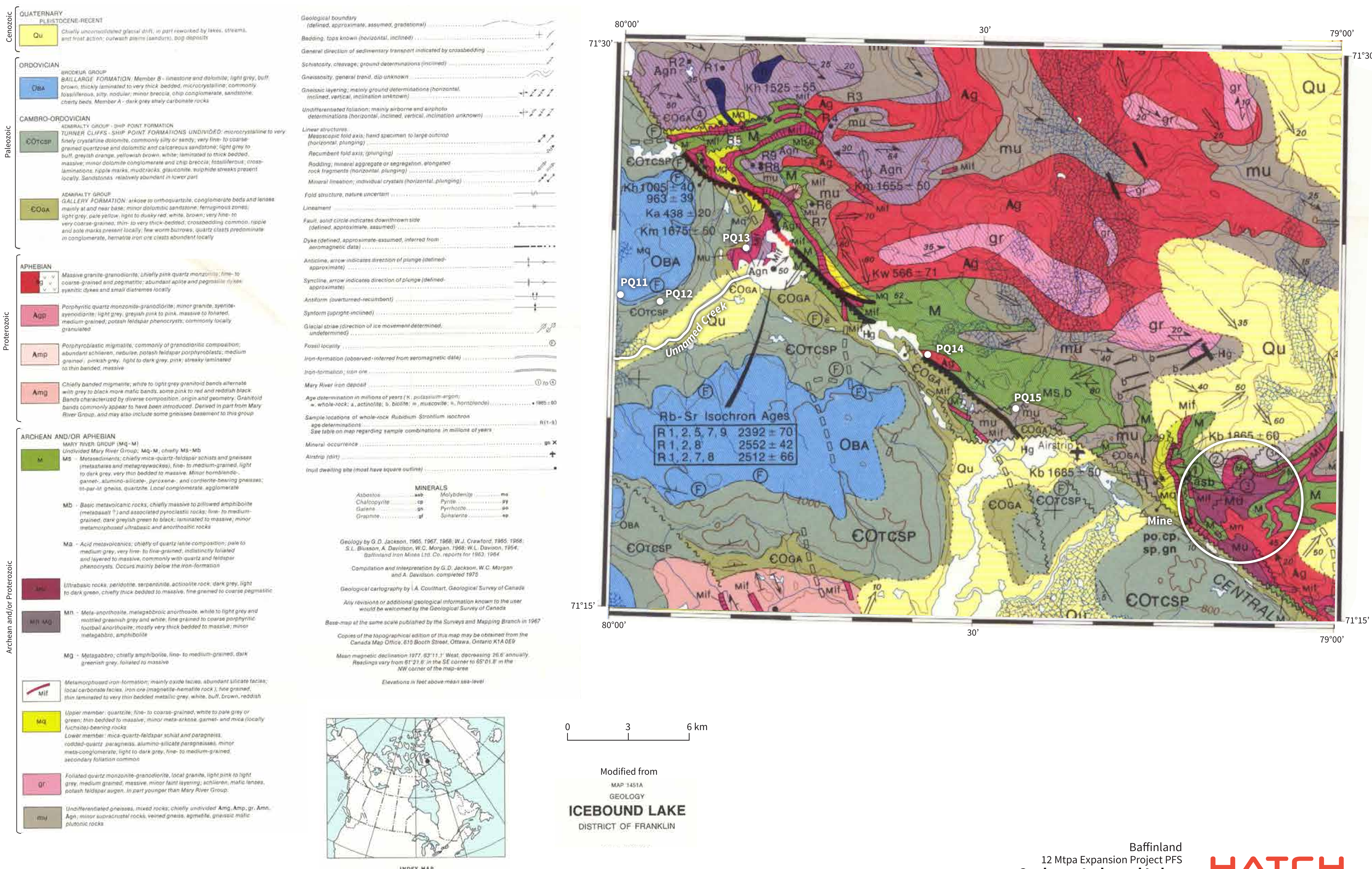




0 3 6 km

Modified from

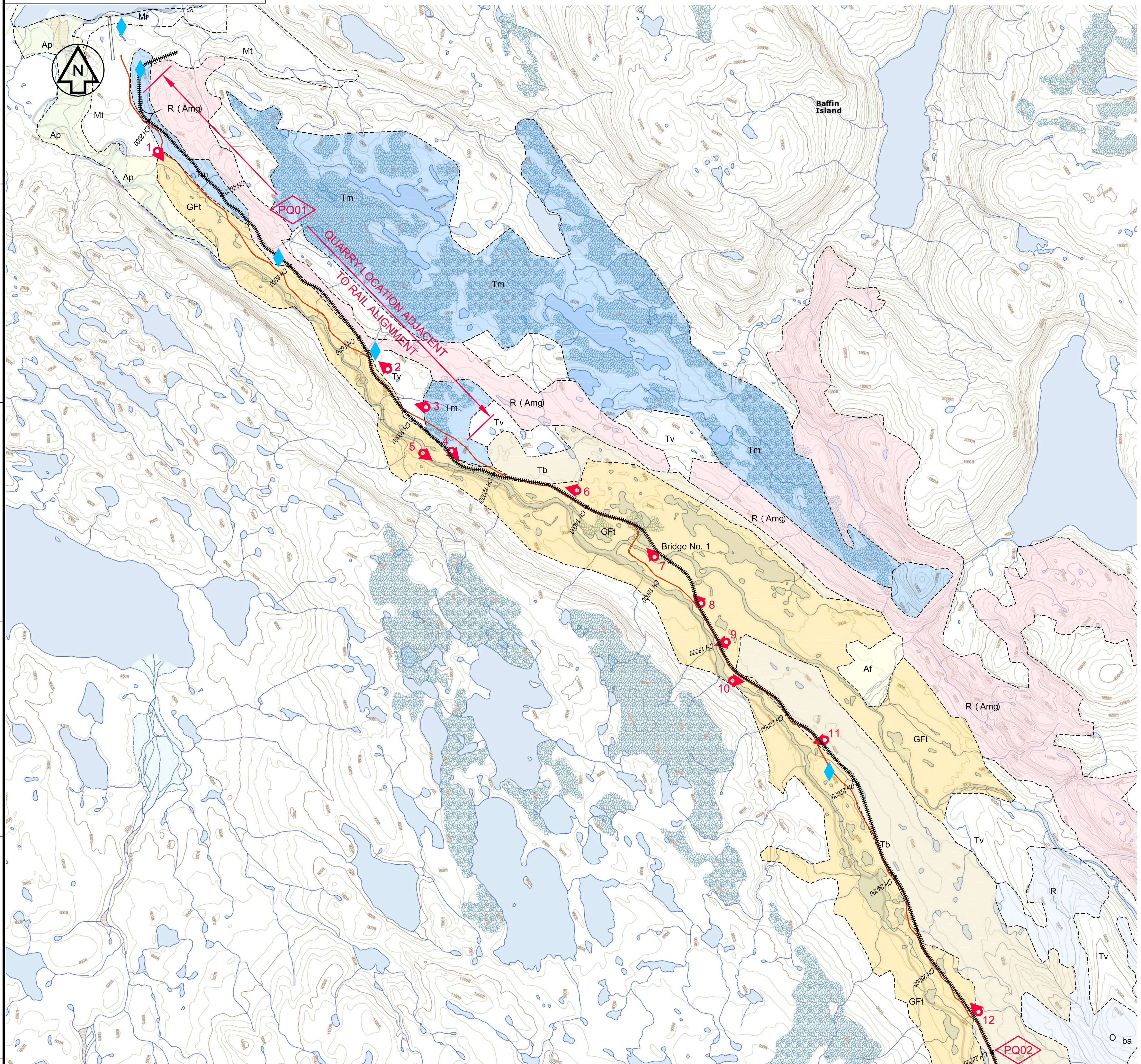
MAP 1239A
GEOLOGY
PHILLIPS CREEK
DISTRICT OF FRANKLIN



Baffinland
12 Mtpa Expansion Project PFS
Geology - Icebound Lakes

HATCH

Appendix B
Site Photographs



SCALE 1:50 000 (B1 SHEET)

0 1 2 3 4 5 KILOMETRES

NOTE:

THE TERRAIN UNITS AND BOUNDARIES SHOWN ON THIS DRAWING ARE APPROXIMATE AND ARE BASED ON THE PUBLICALLY AVAILABLE GEOLOGIC MAPS LISTED BELOW. THIS DRAWING IS INTENDED TO ILLUSTRATE GENERAL TRENDS AND IT IS SUITABLE FOR PLANNING PURPOSES FOR PREFEASIBILITY AND FEASIBILITY STUDIES. A SUITABLE GEOTECHNICAL INVESTIGATION PROGRAM SHOULD BE UNDERTAKEN IF UNCERTAINTY IN THE GROUND TYPE AND THE BOUNDARIES BETWEEN UNITS WILL AFFECT DESIGN OR CONSTRUCTION PLANNING. USE OF THIS DRAWING SHOULD TAKE INTO ACCOUNT ITS APPROXIMATE NATURE.

- LITTLE, E.C., HOLME, P.J., AND KERR, D.E., 2013. SURFICIAL GEOLOGY ICEBOUND LAKES (SOUTHWEST) BAFFIN ISLAND, NUNAVUT, GEOLOGICAL SURVEY OF CANADA MAP 74 (PRELIMINARY), SCALE 1:100,000.
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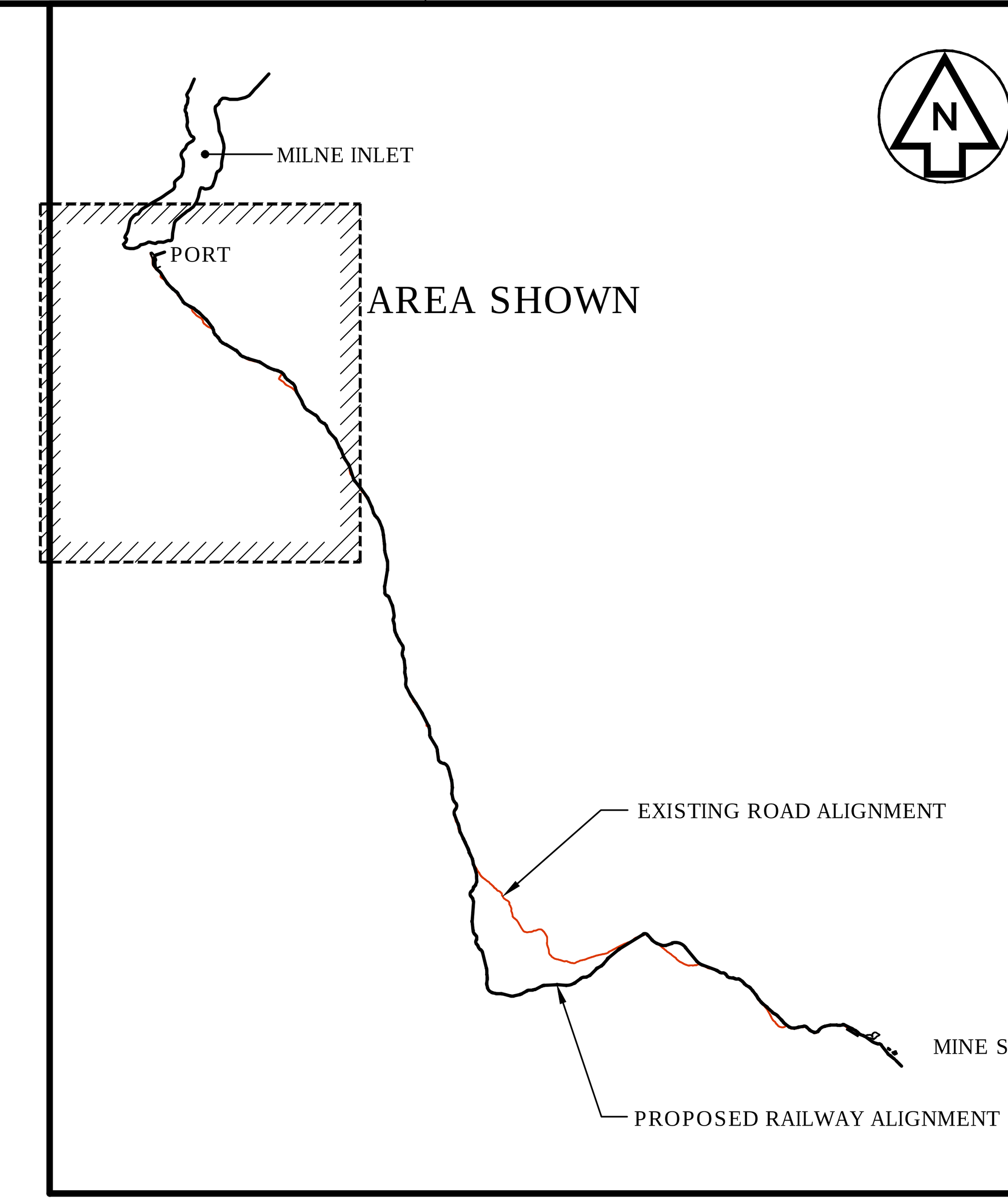

KEY PLAN

0 10 20 30 40 50 kilometres

SCALE 1:500 000

LEGEND

55 PHOTOGRAPH LOCATION AND DIRECTION

PQ02 POTENTIAL QUARRY

CURRENT LEASED/PERMITTED QUARRY

ICE RICH SOIL

UNIT	DESCRIPTION
R (Amg)	UNDIFFERENTIATED GNEISS AND GRANITIC ROCKS
R	SEDIMENTARY ROCK
R,GF	VENEERED ROCK: UNDULATING ROCK COVERED BY A DISCONTINUOUS VENEER OF GLACIAL FLUVIAL SAND AND GRAVEL. NUMEROUS OUTCROPS
Ap	ALLUVIAL PLANES: ACTIVE BRAIDED FLOODPLAINS; INCLUDES ACTIVE PROGLACIAL OUTWASH
Co	COLLUVIUM
Lb	DEEPWATER PROGLACIAL DEPOSITS: SILT AND CLAYEY SILT BLANKET, WITH FINE SAND WITH ICE RAFTED STONES
Mt	DELTAIC SEDIMENTS: CLAY SILT, SAND AND GRAVEL
Mr	BEACH SEDIMENTS: SAND
GFt,p,f	GLACIOFLUVIAL OUTWASH: TERRACES (t), PLANES (p) AND FANS (f)
GFc	GLACIOFLUVIAL ICE CONTACT DEPOSIT: ESKER
GL	GLACIOLACUSTRINE DEPOSIT: CONTAINS MIXED SAND, AND SILT. INCLUDES BEACH DEPOSITS
Tb	TILL BLANKET: 2-10m THICK FORMING AN UNDULATING BLACKET WITH DRUMLINS AND RIBBED MORAINES IN PLACES
Tv	TILL VENER: 0.5-2m THICK; DISCONTINUOUS
Tm	GLACIAL END MORAINE: 5-60m HIGH, COMPOSED OF OR MANTLED BY TILL, EXTENSIVELY KETTLED IN PLACES; FLARE FEATURES WITH DEBRIS-RICH RELICT GLACIER ICE
	POTENTIAL QUARRY

HATCH

Baffinland

No.	DESCRIPTION	BY	CHK'D	DATE
D	CLIENT REVIEW	KK	WH	2017-03-17
C	DRILLING PROGRAM STATUS AS OF DECEMBER 09, 2016 (END OF 2016 SEASON)	DP	WH	2016-12-16
B	PHOTOGRAPH LOCATIONS ADDED	DP	WH	2016-10-15

REVISIONS

ROLE	NAME	SIGNATURE	DATE
DRAFTSPERSON	N DONNELLY	NR	
DESIGNER	U KHAN	NR	
CHECKER			
DESIGN COORD.	W HOYLE		
RESP. ENG.			
LEAD DISC. ENG.	S HINCHBERGER		
ENG. MANAGER			
PROJ. MANAGER	J CLELAND		

DRAWING APPROVAL STATUS: Client Review

DRAWING No.	DRAWING TITLE

REFERENCE DRAWINGS

REG. PROFESSIONAL

BAFFINLAND EXPANSION 12 MTPA MINE OPTION PRE FEASIBILITY STUDY

2016 GEOTECHNICAL INVESTIGATIONS GEOLOGICAL MAPPING SHEET 1 OF 4

SCALE 1:50,000 OR AS NOTED

DWG. No. H352034-GEOSKT-229-292-0002

REV D

SHEET SIZE: D

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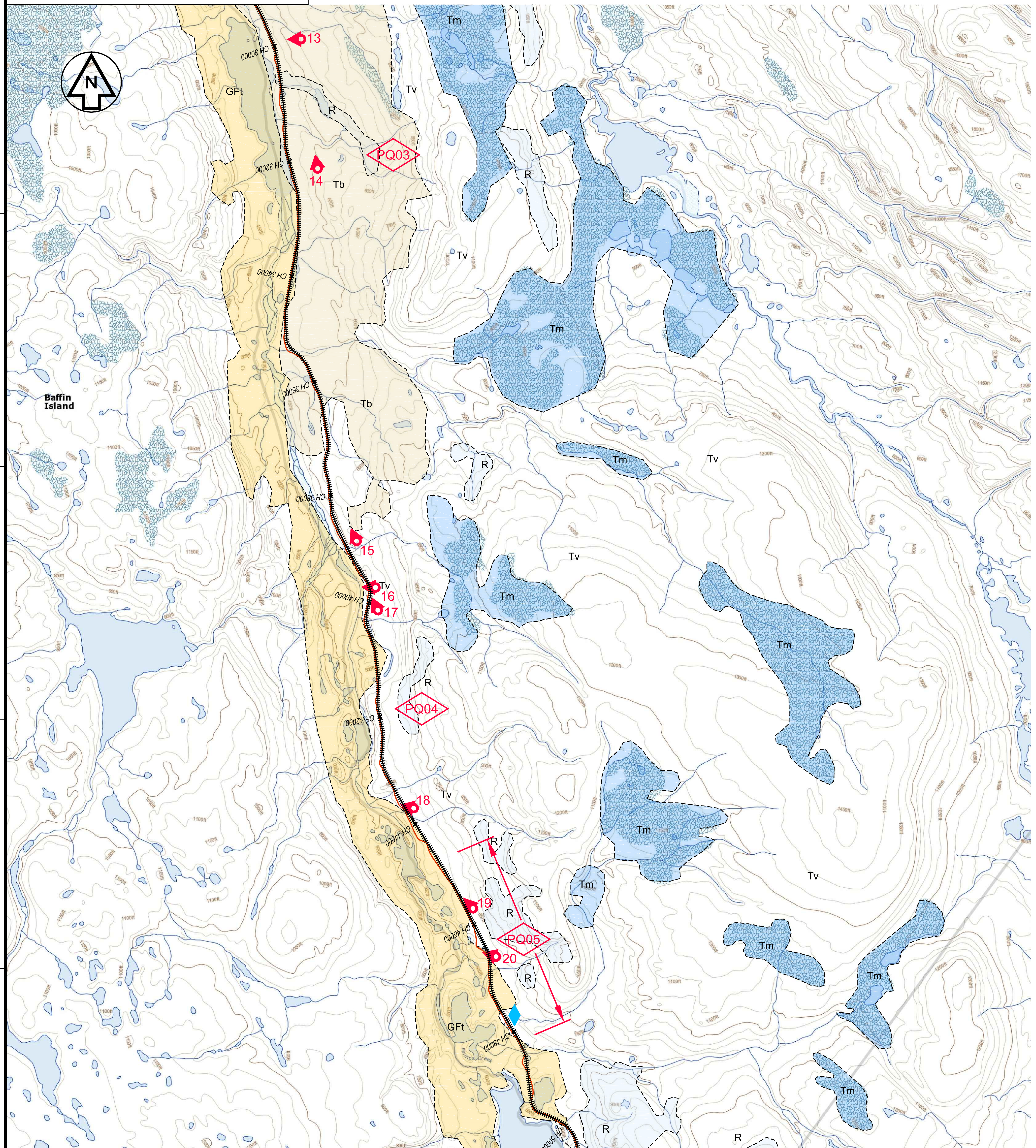

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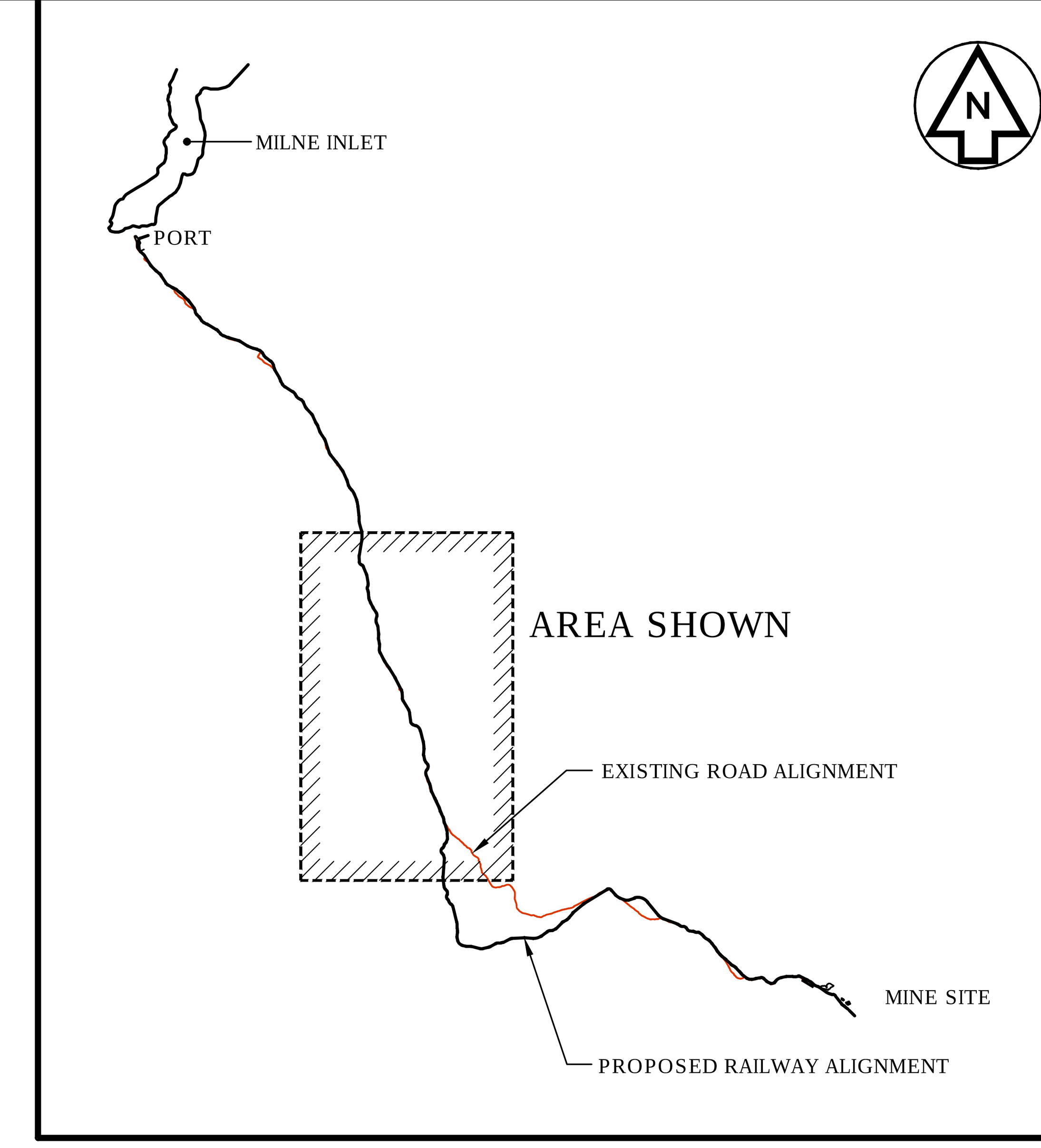

KEY PLAN

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SCALE 1:500 000

LEGEND

55 PHOTOGRAPH LOCATION AND DIRECTION

PQ02 POTENTIAL QUARRY

CURRENT LEASED/PERMITTED QUARRY

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GL	GLACIOLACUSTRINE DEPOSIT: CONTAINS MIXED SAND, AND SILT. INCLUDES BEACH DEPOSITS
Tb	TILL BLANKET: 2-10m THICK FORMING AN UNDULATING BLACKET WITH DRUMLINS AND RIBBED MORAINES IN PLACES
Tv	TILL VENER: 0.5-2m THICK; DISCONTINUOUS
Tm	GLACIAL END MORAINE: 5-60m HIGH, COMPOSED OF OR MANTLED BY TILL, EXTENSIVELY KETTLED IN PLACES; FLARE FEATURES WITH DEBRIS-RICH RELICT GLACIER ICE
	POTENTIAL QUARRY

0 1 2 3 4 5 KILOMETRES

SCALE 1:50 000 (B1 SHEET)

HATCH

Baffinland

DRAWING No.	DRAWING TITLE
REFERENCE DRAWINGS	

REG. PROFESSIONAL

No.	DESCRIPTION	BY	CHK'D	DATE
D	CLIENT REVIEW	KK	WH	2017-03-17
C	DRILLING PROGRAM STATUS AS OF DECEMBER 09, 2016 (END OF 2016 SEASON)	DP	WH	2016-12-16
B	PHOTOGRAPH LOCATIONS ADDED	DP	WH	2016-10-15

REVISIONS

ROLE	NAME	SIGNATURE	DATE
DRAFTSPERSON	N DONNELLY	NR	
DESIGNER	U KHAN	NR	
CHECKER			
DESIGN COORD.	W HOYLE		
RESP. ENG.			
LEAD DISC. ENG.	S HINCHBERGER		
ENG. MANAGER			
PROJ. MANAGER	J CLELAND		

DRAWING APPROVAL STATUS: Client Review

BAFFINLAND EXPANSION 12 MTPA MINE OPTION
PRE FEASIBILITY STUDY

2016 GEOTECHNICAL INVESTIGATIONS
GEOLOGICAL MAPPING
SHEET 2 OF 4

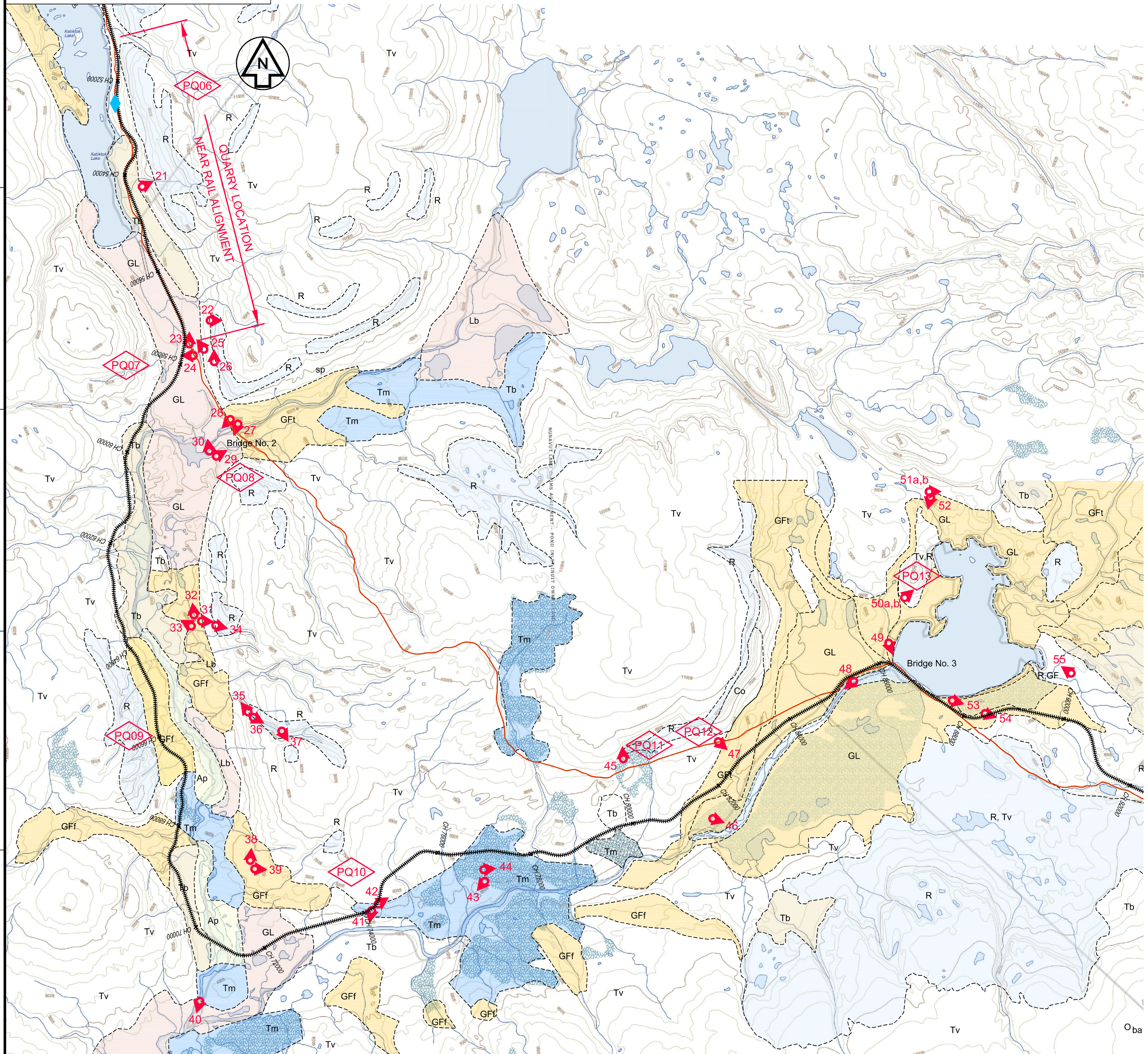
SCALE 1:50,000 OR AS NOTED

DWG. No. H352034-GEOSKT-229-292-0002

REV D

$USERNAME$ $DATE$ $FILE$ $TIME$

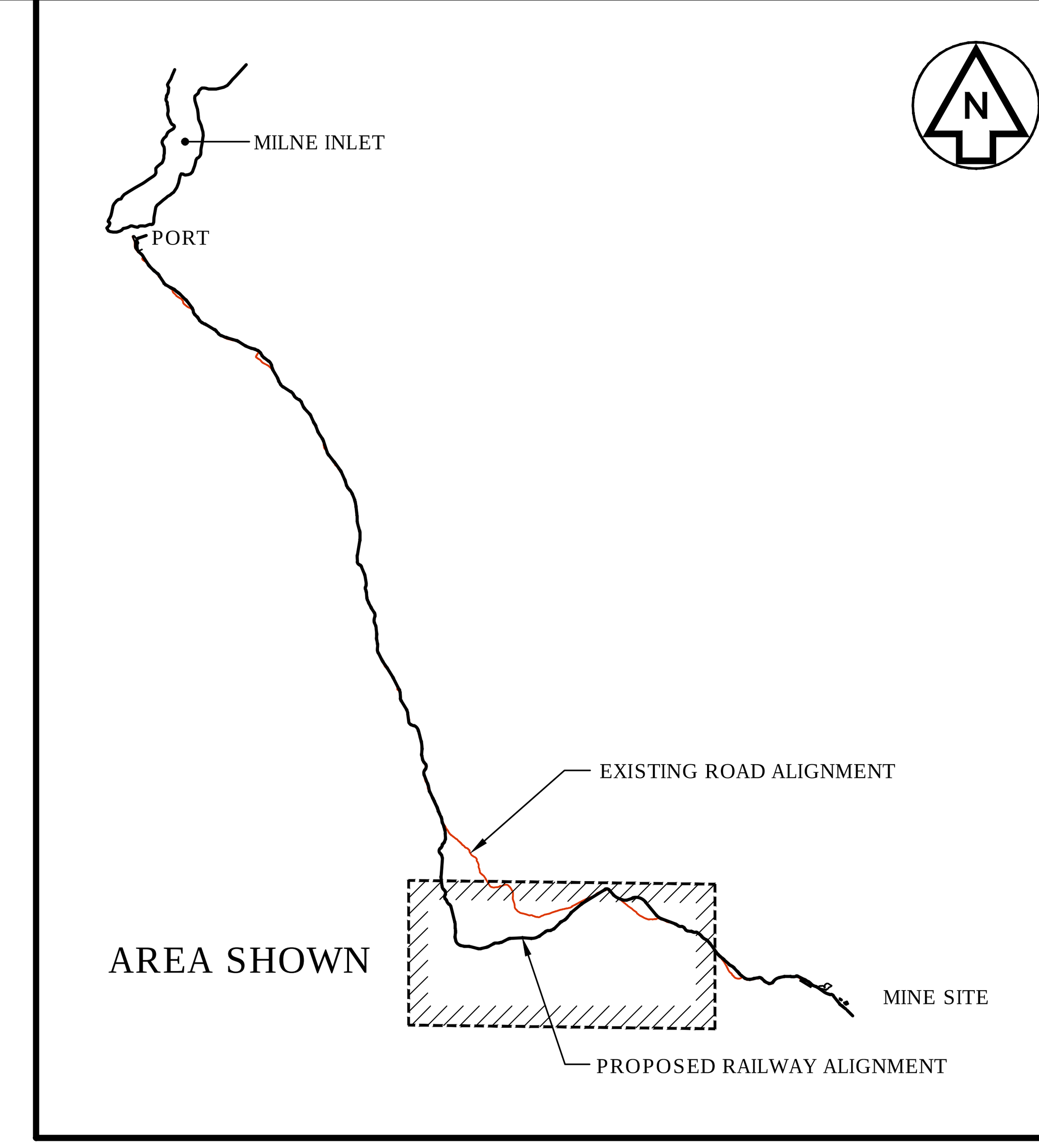
SHEET SIZE: D



NOTE:

THE TERRAIN UNITS AND BOUNDARIES SHOWN ON THIS DRAWING ARE APPROXIMATE AND ARE BASED ON THE PUBLICALLY AVAILABLE GEOLOGIC MAPS LISTED BELOW. THIS DRAWING IS INTENDED TO ILLUSTRATE GENERAL TRENDS AND IT IS SUITABLE FOR PLANNING PURPOSES FOR PREFEASIBILITY AND FEASIBILITY STUDIES. A SUITABLE GEOTECHNICAL INVESTIGATION PROGRAM SHOULD BE UNDERTAKEN IF UNCERTAINTY IN THE GROUND TYPE AND THE BOUNDARIES BETWEEN UNITS WILL AFFECT DESIGN OR CONSTRUCTION PLANNING. USE OF THIS DRAWING SHOULD TAKE INTO ACCOUNT ITS APPROXIMATE NATURE.

- LITTLE, E.C., HOLME, P.J., AND KERR, D.E., 2013. SURFICIAL GEOLOGY ICEBOUND LAKES (SOUTHWEST) BAFFIN ISLAND, NUNAVUT, GEOLOGICAL SURVEY OF CANADA MAP 74 (PRELIMINARY), SCALE 1:100,000.
- DYKE, A.S. 2000, SURFICIAL GEOLOGY PHILLIPS CREEK, BAFFIN ISLAND, NUNAVUT, GEOLOGICAL SURVEY OF CANADA, MAP 1961A, SCALE 1:250,000.



KEY PLAN

0 10 20 30 40 50 kilometres

SCALE 1:500 000

LEGEND

55 PHOTOGRAPH LOCATION AND DIRECTION

PQ02 POTENTIAL QUARRY

CURRENT LEASED/PERMITTED QUARRY

ICE RICH SOIL

UNIT	DESCRIPTION
R (Amg)	UNDIFFERENTIATED GNEISS AND GRANITIC ROCKS
R	SEDIMENTARY ROCK
R,GF	VENEERED ROCK: UNDULATING ROCK COVERED BY A DISCONTINUOUS VENEER OF GLACIAL FLUVIAL SAND AND GRAVEL. NUMEROUS OUTCROPS
Ap	ALLUVIAL PLANES: ACTIVE BRAIDED FLOODPLAINS; INCLUDES ACTIVE PROGLACIAL OUTWASH
Co	COLLUVIUM
Lb	DEEPWATER PROGLACIAL DEPOSITS: SILT AND CLAYEY SILT BLANKET, WITH FINE SAND WITH ICE RAFTED STONES
Md	DELTAIC SEDIMENTS: CLAY SILT, SAND AND GRAVEL
Mr	BEACH SEDIMENTS: SAND
GFt,p,f	GLACIOFLUVIAL OUTWASH: TERRACES (t), PLANES (p) AND FANS (f)
GFc	GLACIOFLUVIAL ICE CONTACT DEPOSIT: ESKER
GL	GLACIOLACUSTRINE DEPOSIT: CONTAINS MIXED SAND, AND SILT. INCLUDES BEACH DEPOSITS
Tb	TILL BLANKET: 2-10m THICK FORMING AN UNDULATING BLACKET WITH DRUMLINS AND RIBBED MORAINES IN PLACES
Tv	TILL VENER: 0.5-2m THICK; DISCONTINUOUS
Tm	GLACIAL END MORAINE: 5-60m HIGH, COMPOSED OF OR MANTLED BY TILL, EXTENSIVELY KETTLED IN PLACES; FLARE FEATURES WITH DEBRIS-RICH RELICT GLACIER ICE
	POTENTIAL QUARRY

0 1 2 3 4 5 KILOMETRES

SCALE 1:50 000 (B1 SHEET)

No.	DESCRIPTION	BY	CHK'D	DATE
D	CLIENT REVIEW	KK	WH	2017-03-17
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REVISIONS

DRAWING No.	DRAWING TITLE

REFERENCE DRAWINGS

REG. PROFESSIONAL

ROLE	NAME	SIGNATURE	DATE
DRAFTSPERSON	N DONNELLY	NR	
DESIGNER	U KHAN	NR	
CHECKER			
DESIGN COORD.	W HOYLE		
RESP. ENG.			
LEAD DISC. ENG.	S HINCHBERGER		
ENG. MANAGER			
PROJ. MANAGER	J CLELAND		

DRAWING APPROVAL STATUS: Client Review

BAFFINLAND EXPANSION 12 MTPA MINE OPTION
PRE FEASIBILITY STUDY

2016 GEOTECHNICAL INVESTIGATIONS
GEOLOGICAL MAPPING
SHEET 3 OF 4

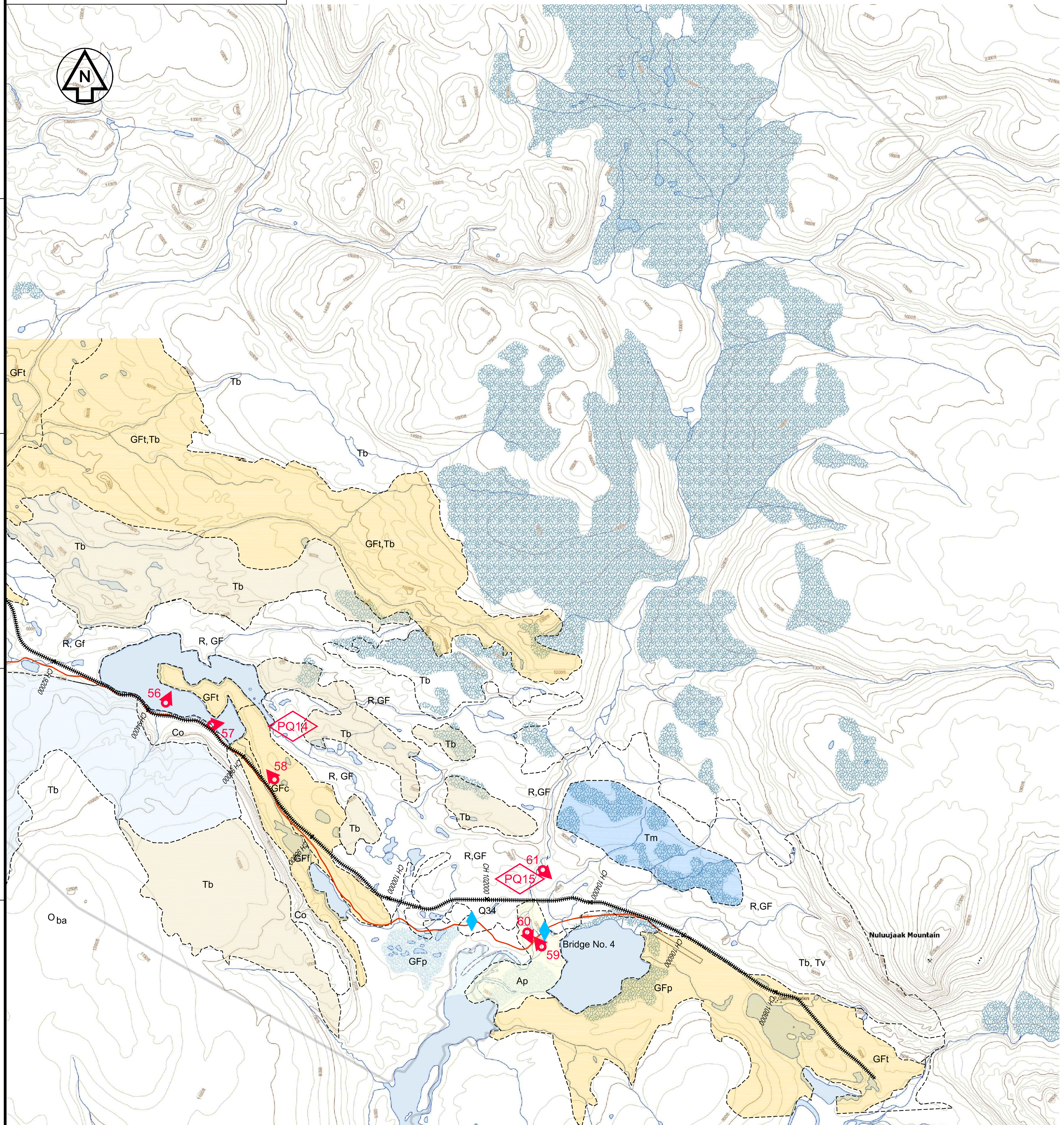
SCALE 1:50,000 OR AS NOTED

DWG. No. H352034-GEOSKT-229-292-0002

REV D

SHEET SIZE: D

$USERNAME$ $DATE$ $TIME$ $FILE$



NOTE:

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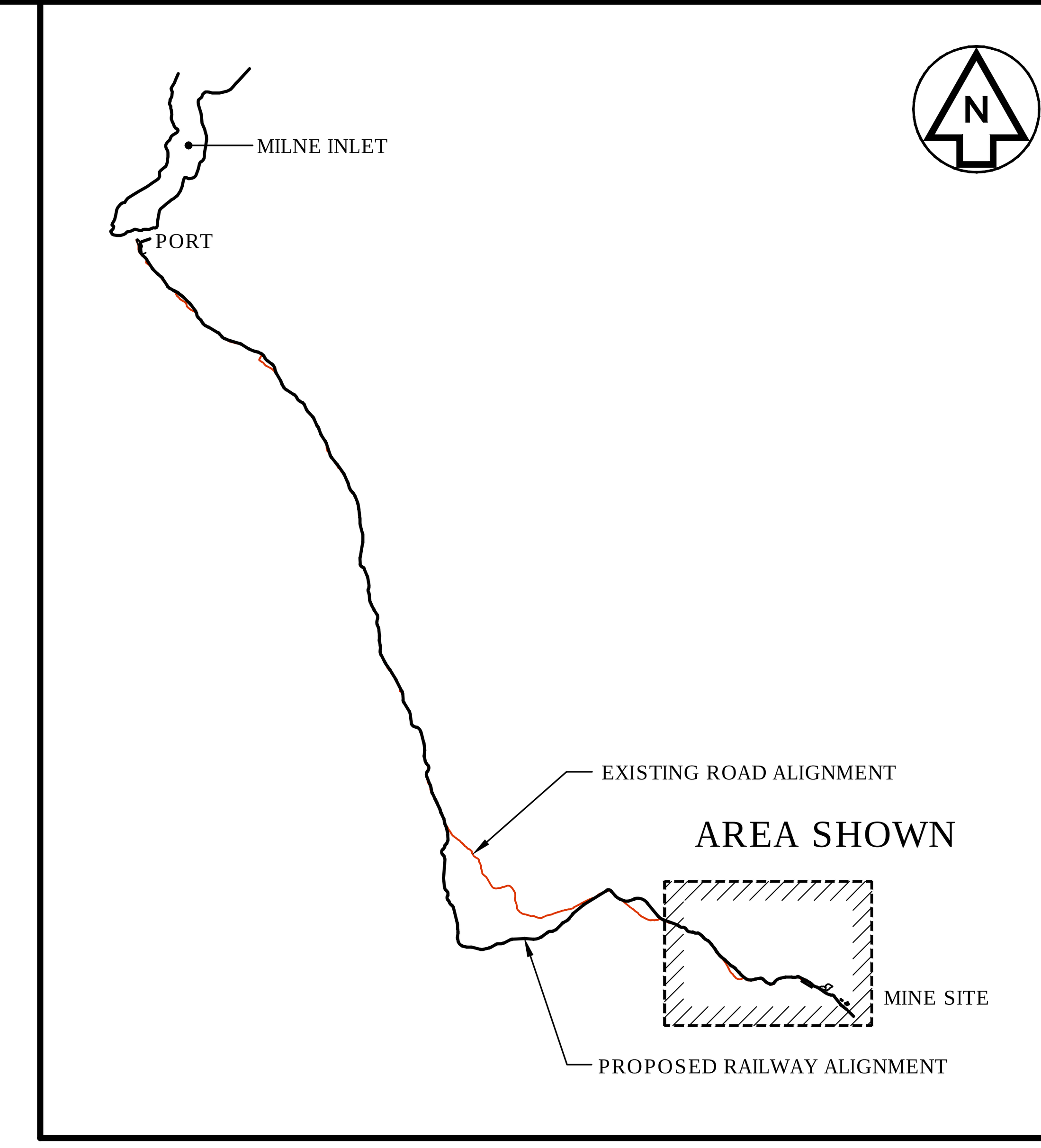
0 1 2 3 4 5 KILOMETRES

SCALE 1:50 000 (B1 SHEET)



KEY PLAN

0 10 20 30 40 50 kilometres

SCALE 1:500 000

LEGEND

55 — PHOTOGRAPH LOCATION AND DIRECTION

PQ02 — POTENTIAL QUARRY

CURRENT LEASED/PERMITTED QUARRY

ICE RICH SOIL

UNIT	DESCRIPTION
R (Amg)	UNDIFFERENTIATED GNEISS AND GRANITIC ROCKS
R	SEDIMENTARY ROCK
R,GF	VENEERED ROCK: UNDULATING ROCK COVERED BY A DISCONTINUOUS VENEER OF GLACIAL FLUVIAL SAND AND GRAVEL. NUMEROUS OUTCROPS
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Lb	DEEPWATER PROGLACIAL DEPOSITS: SILT AND CLAYEY SILT BLANKET, WITH FINE SAND WITH ICE RAFTED STONES
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	POTENTIAL QUARRY

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REG. PROFESSIONAL

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REVISIONS

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DESIGNER	U KHAN	NR	
CHECKER			
DESIGN COORD.	W HOYLE		
RESP. ENG.			
LEAD DISC. ENG.	S HINCHBERGER		
ENG. MANAGER			
PROJ. MANAGER	J CLELAND		

DRAWING APPROVAL STATUS: Client Review

Baffinland

BAFFINLAND EXPANSION 12 MTPA MINE OPTION
PRE FEASIBILITY STUDY

2016 GEOTECHNICAL INVESTIGATIONS
GEOLOGICAL MAPPING
SHEET 4 OF 4

SCALE 1:50,000 OR AS NOTED

DWG. No. H352034-GEOSKT-229-292-0002

REV D

SHEET SIZE: D

$USERNAME$ $DATE$ $FILE$ $TIME$

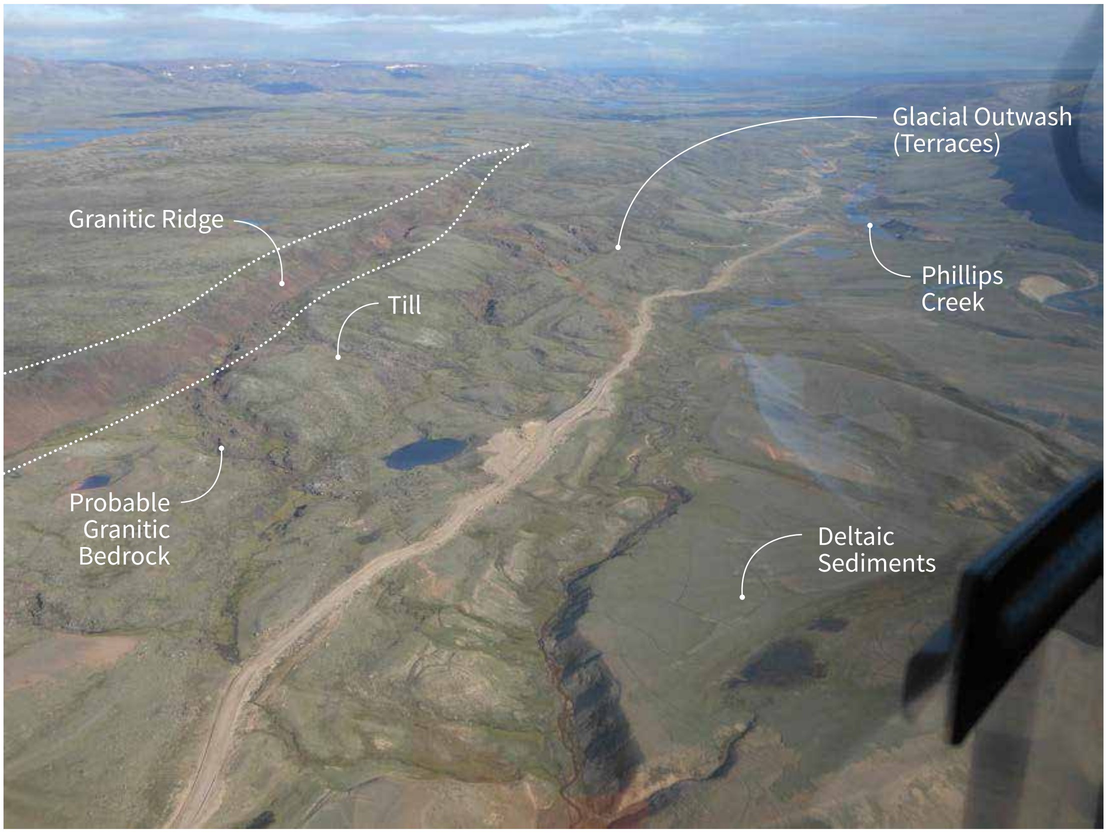

Photo 1

Photo 2

Photo 3

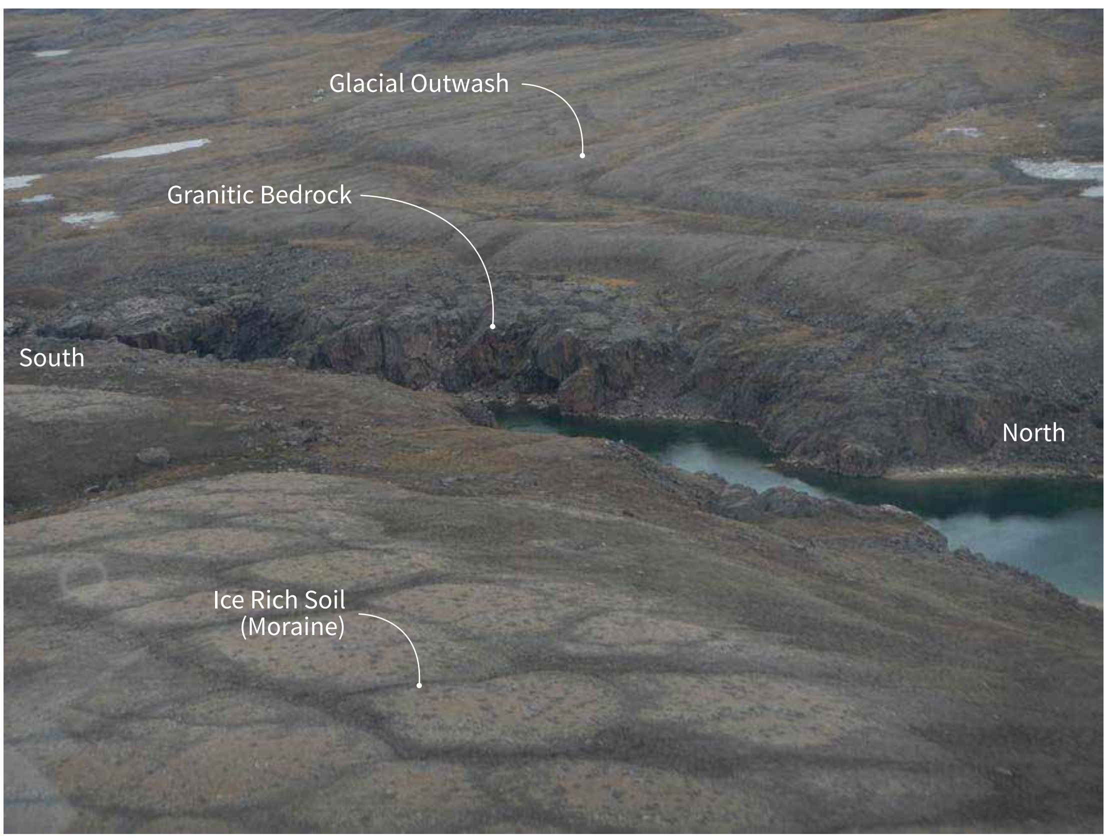

Photo 4

Photo 5

Photo 6

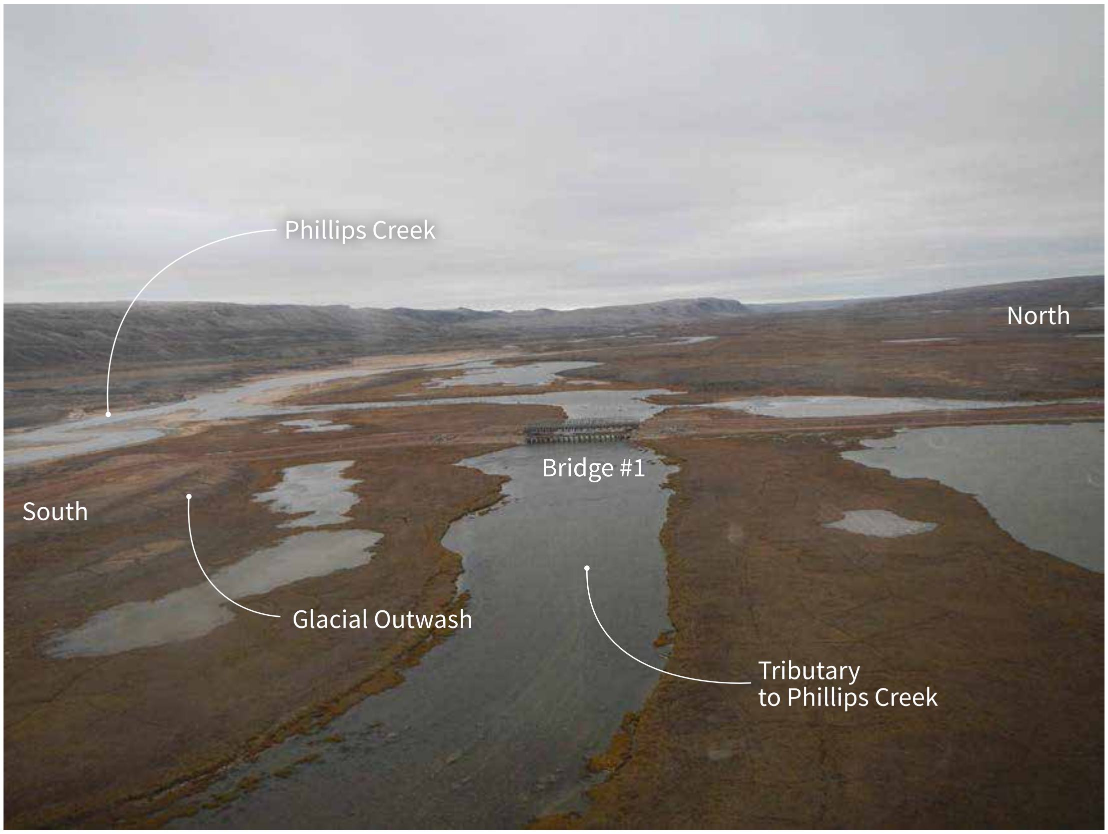

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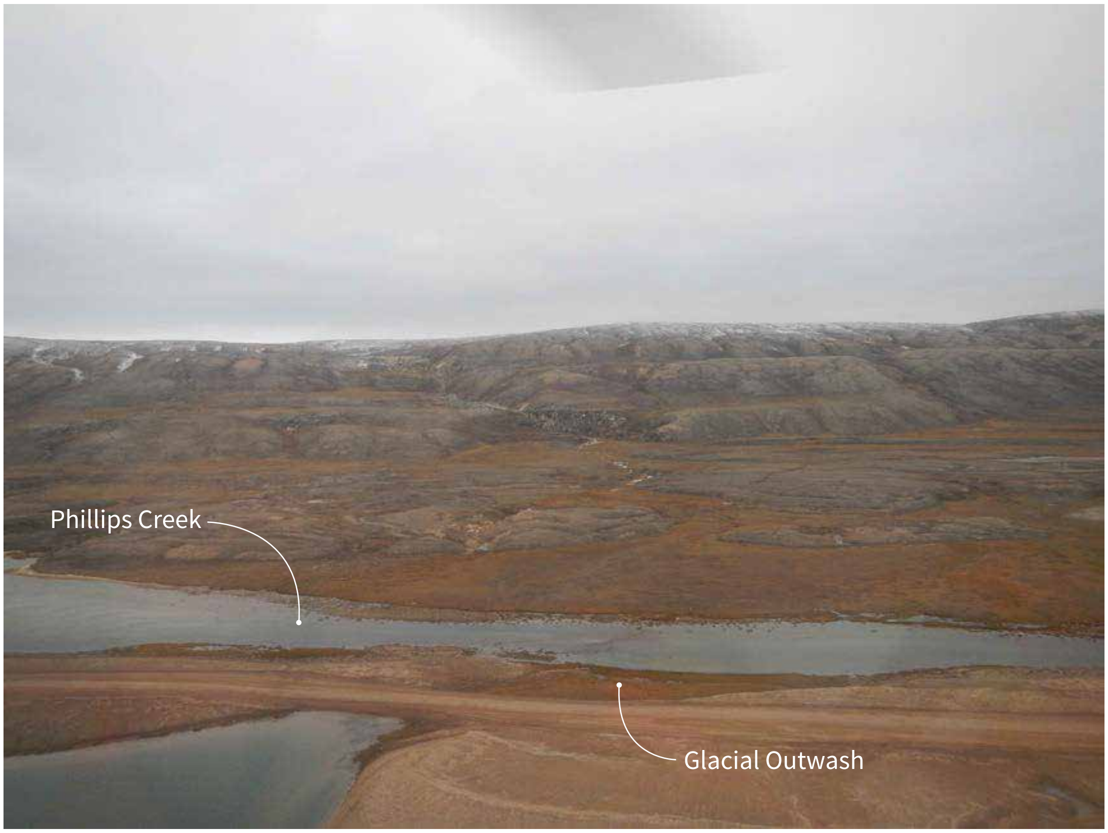
Photo 8



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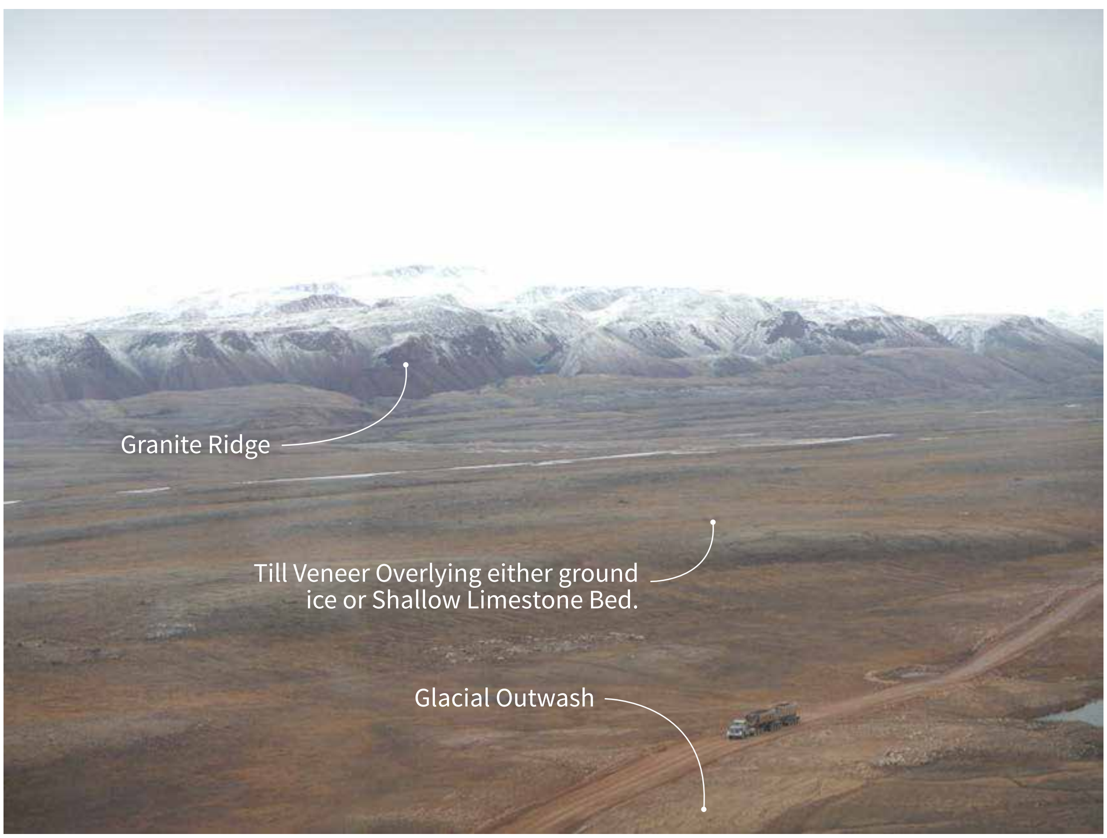


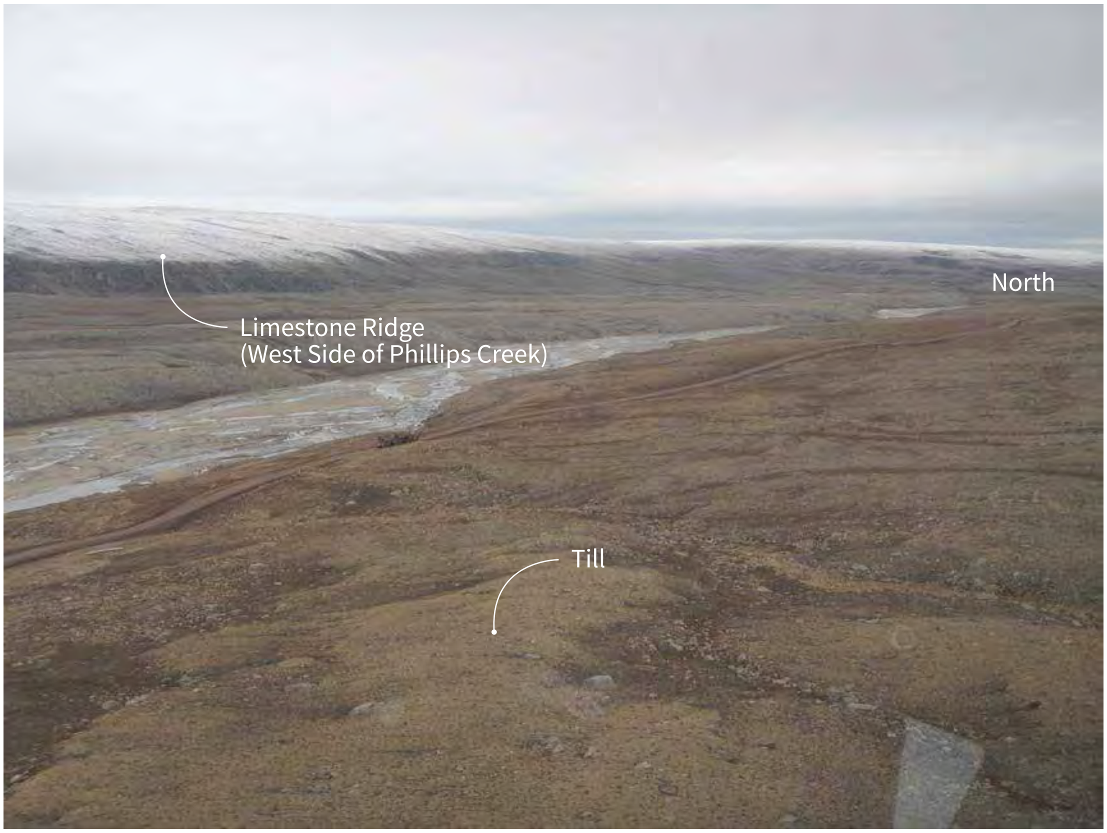
Photo 10

Photo 11

Photo 12

Photo 13

Photo 14



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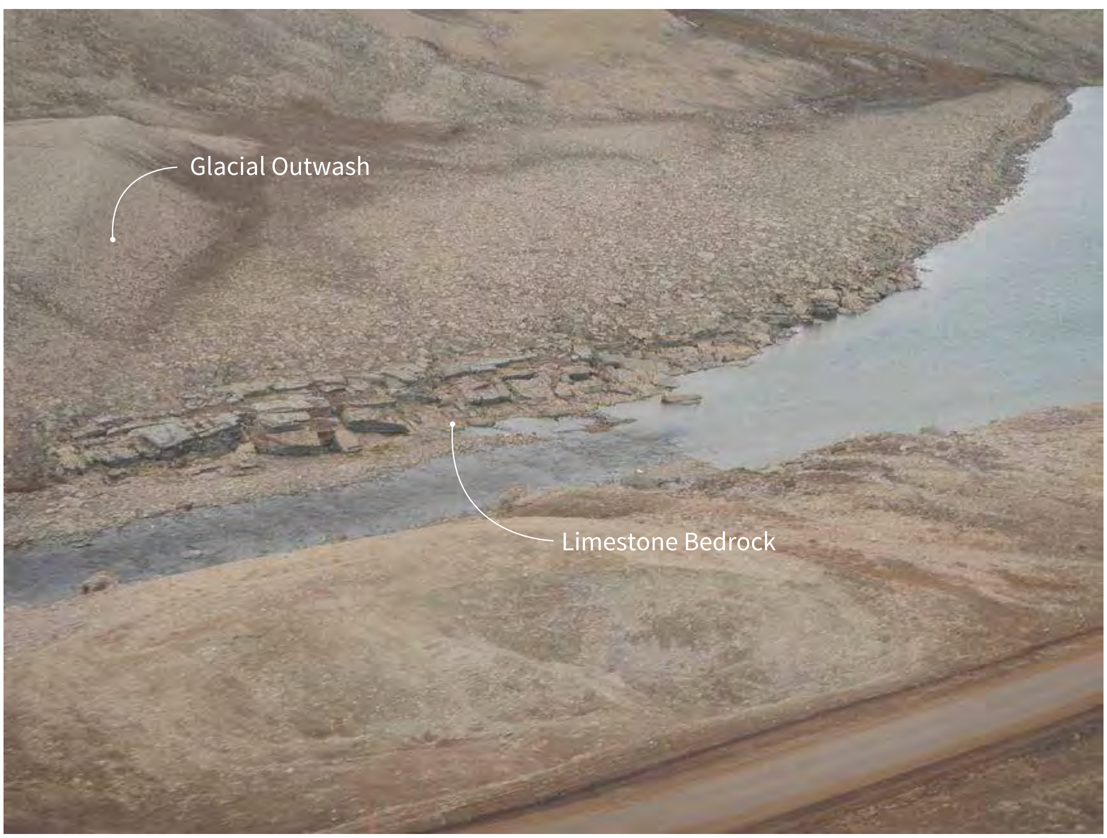

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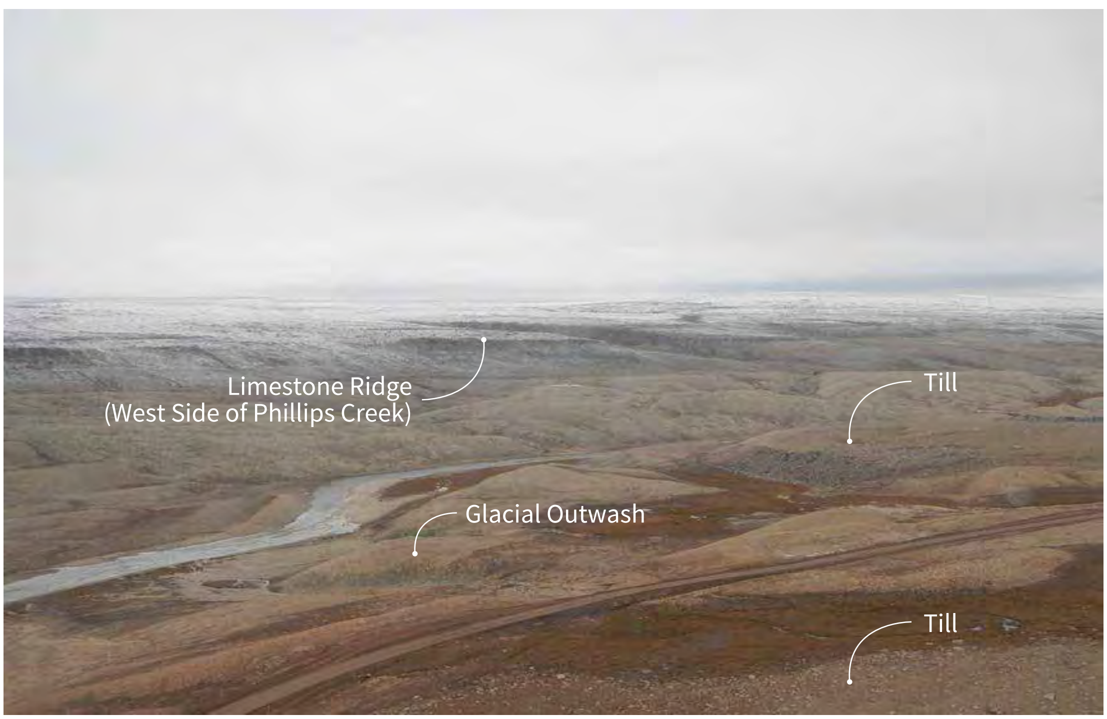

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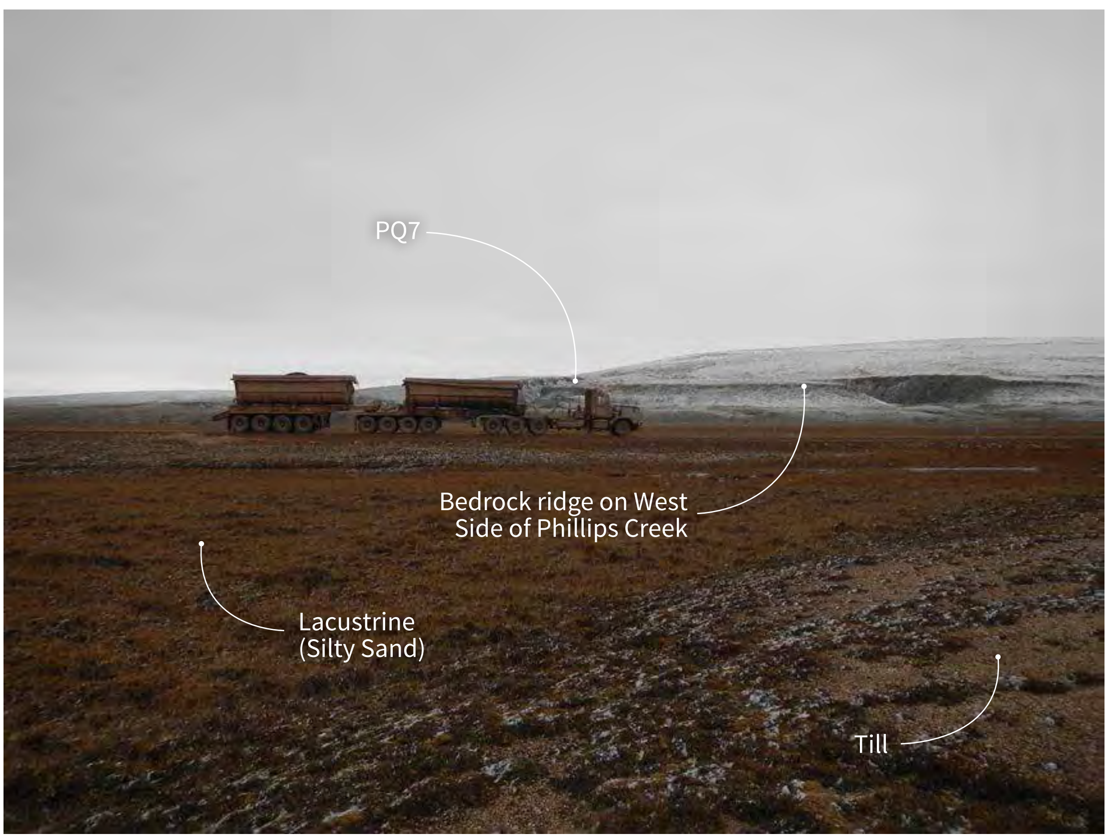
Photo 19

Photo 20

Photo 21

Photo 22

Photo 23



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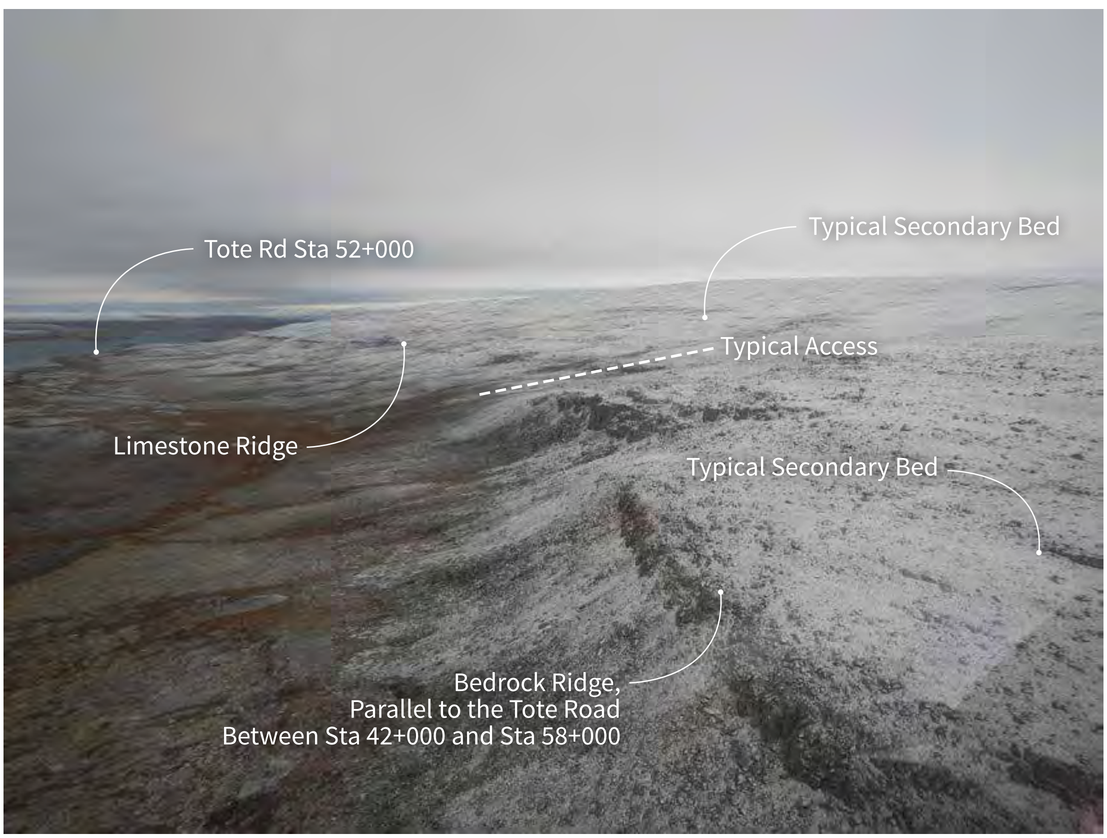

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Photo 27

Photo 28

Photo 29

Photo 30

Photo 31

Photo 32

Photo 33

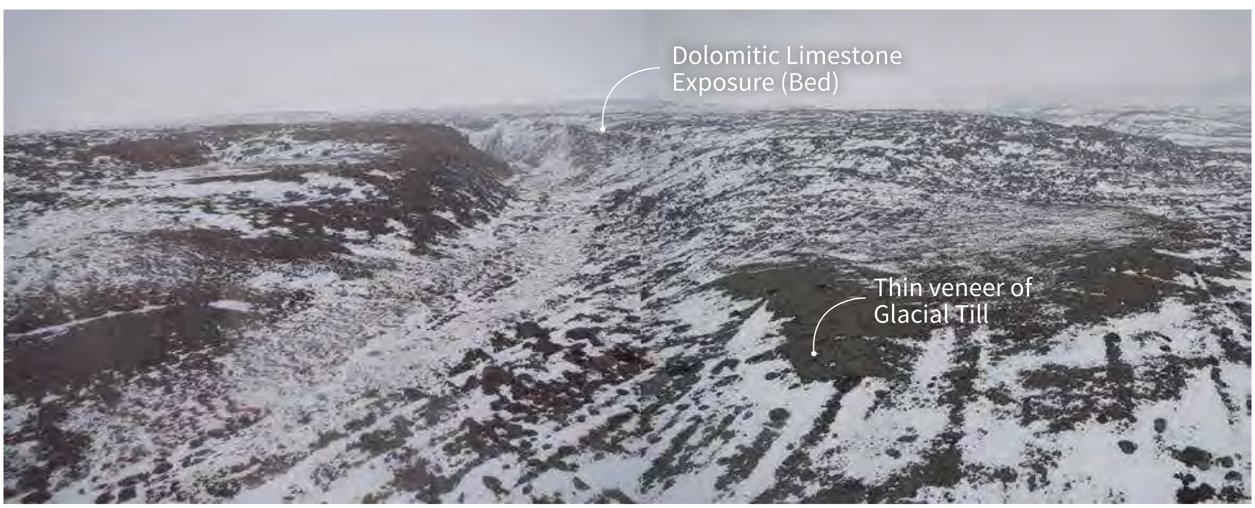

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Photo 36

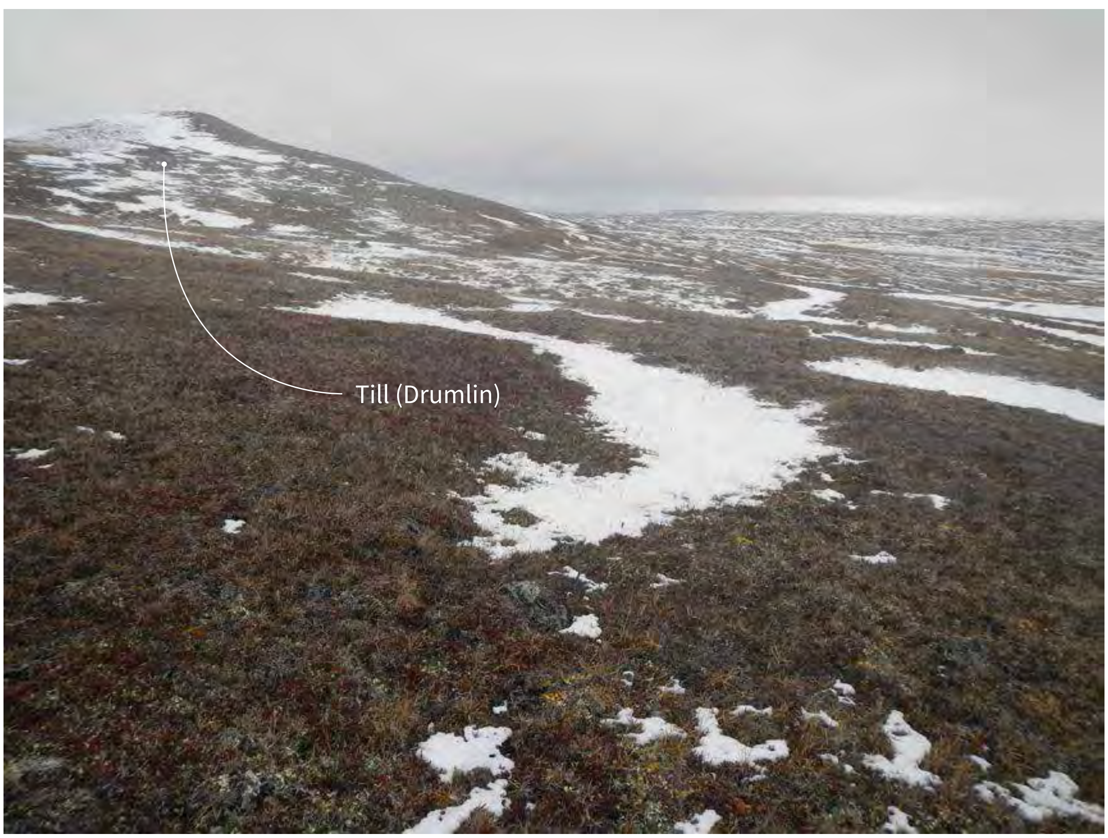
Photo 37

Photo 38

Photo 39

Photo 40

Photo 41



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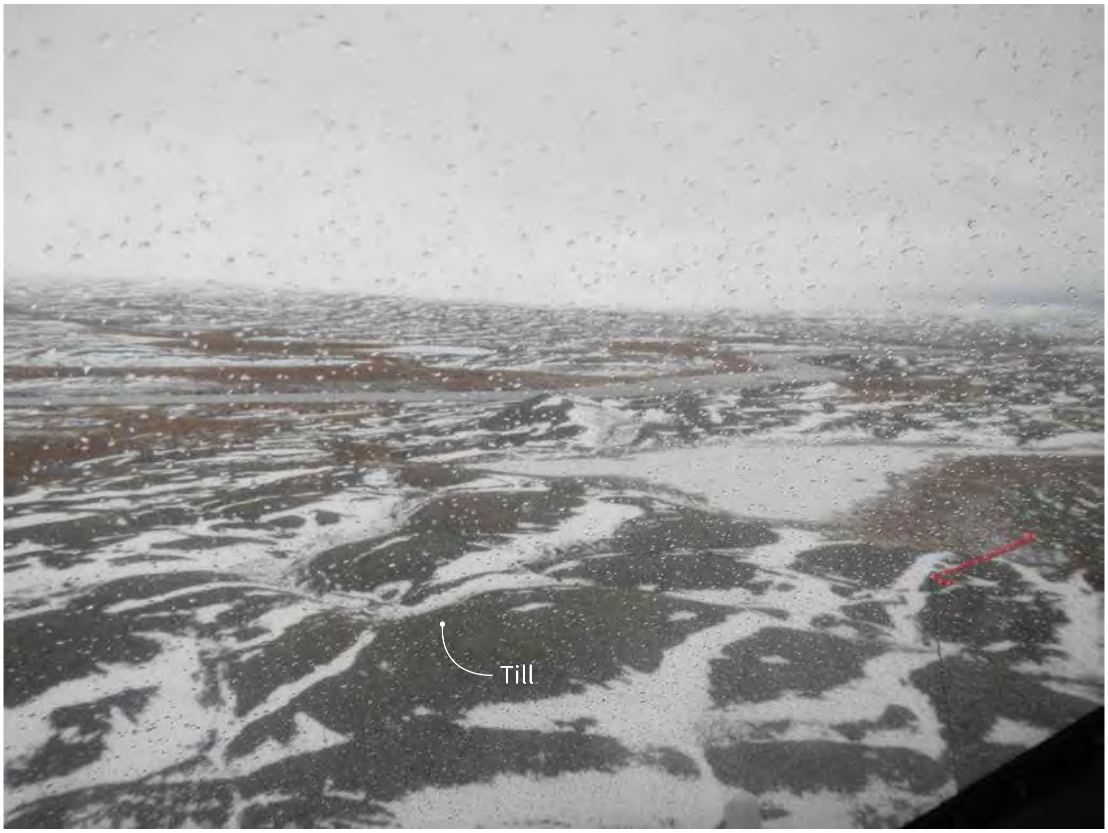

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Photo 44

Photo 45

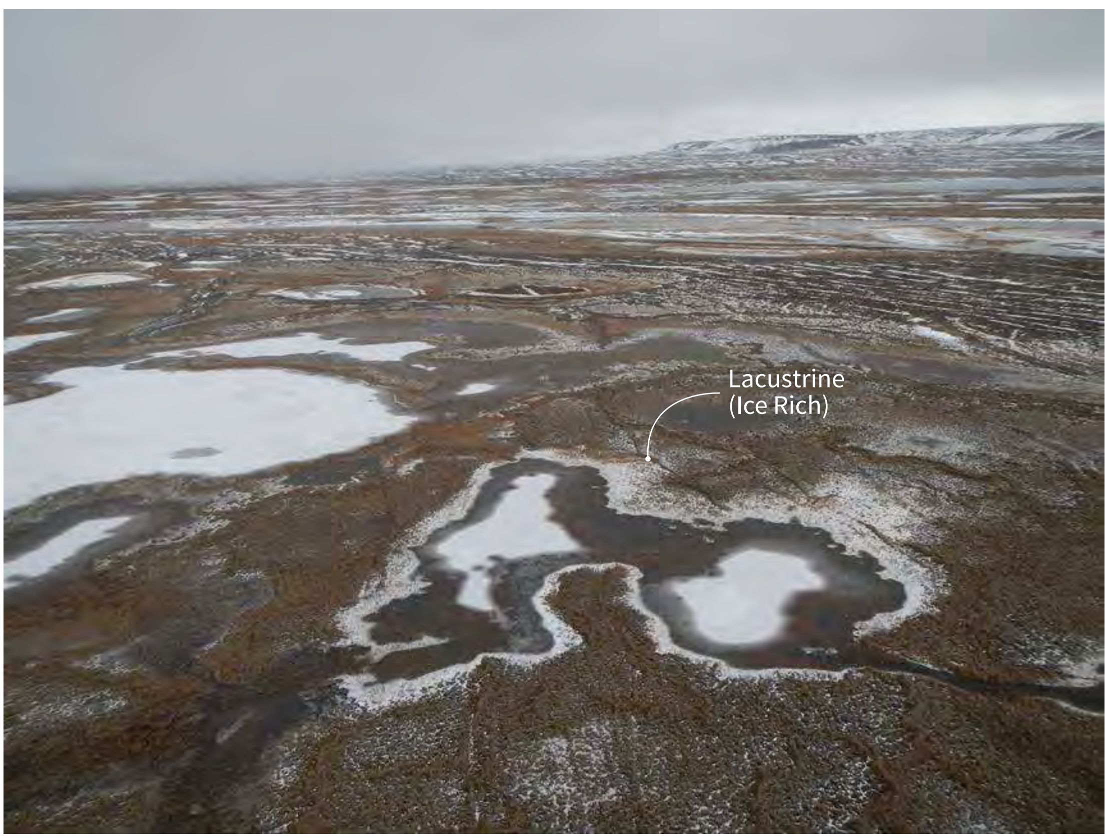


Photo 46

Photo 47

Photo 48

Photo 49

Photo 50a

Photo 50b

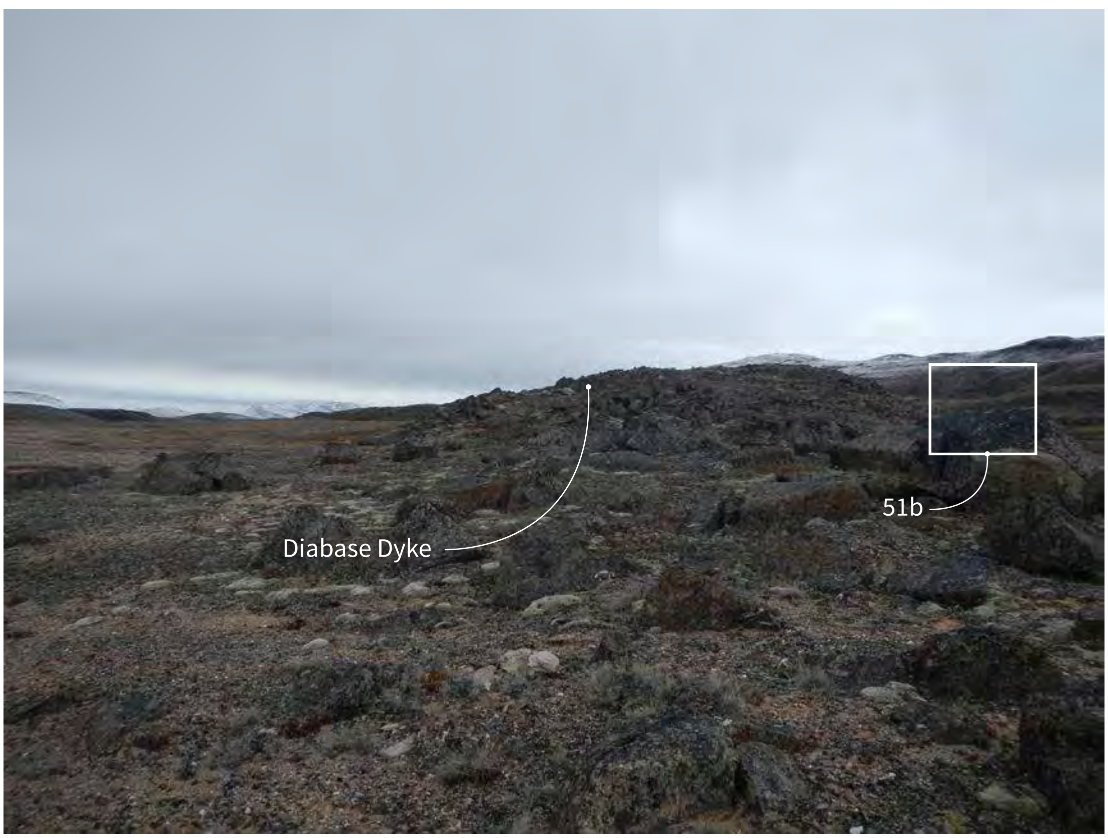


Photo 51a

Photo 51b

Photo 52

Photo 53

Photo 54

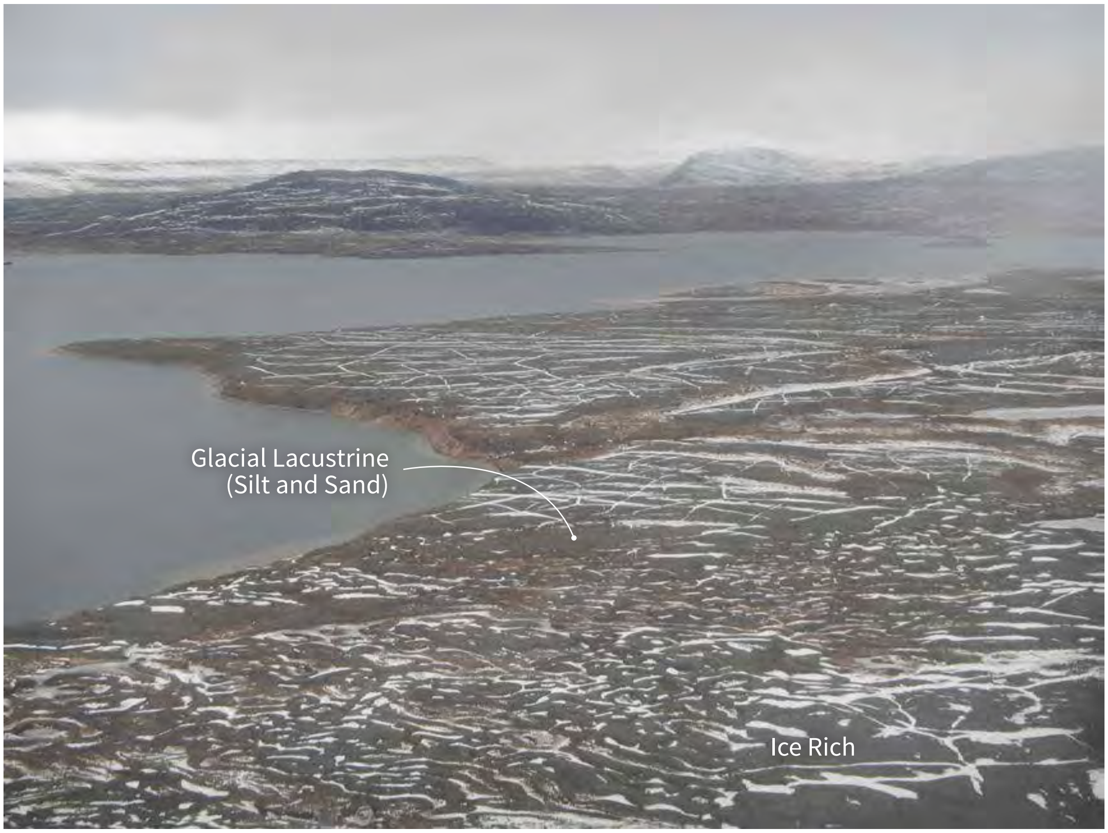


Photo 55

Photo 56

Photo 57

Photo 58

Photo 59

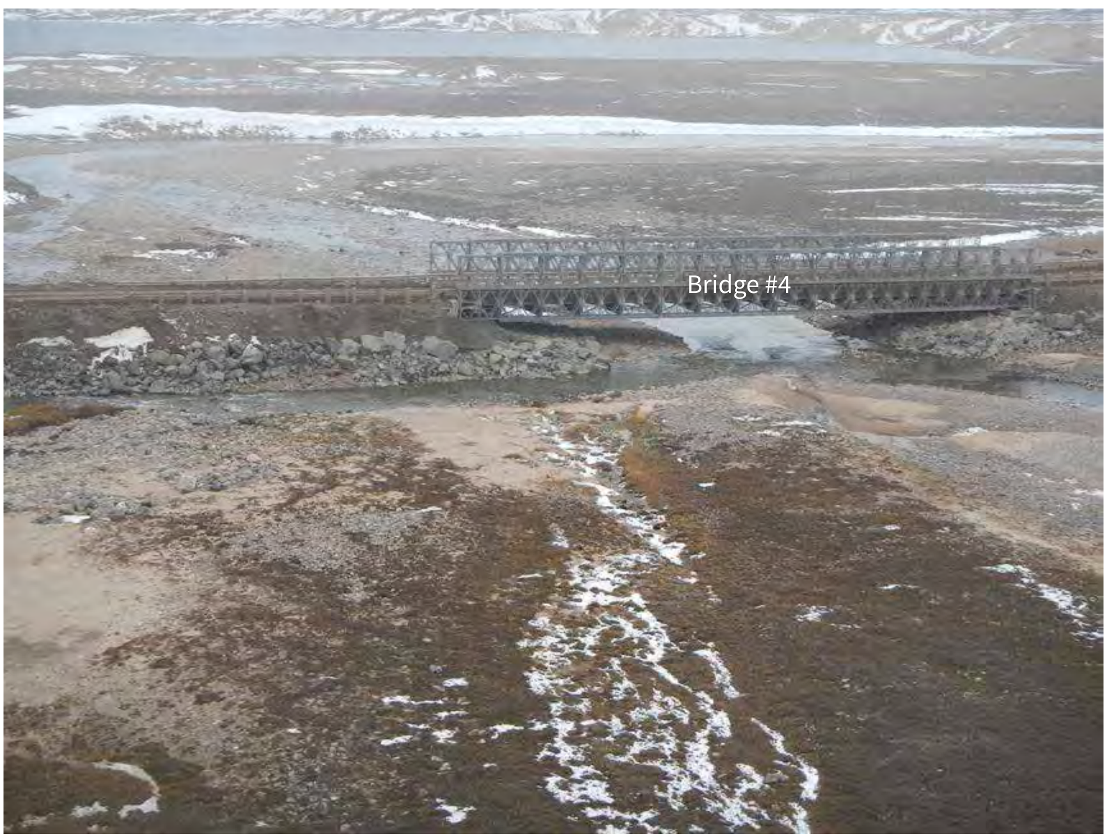
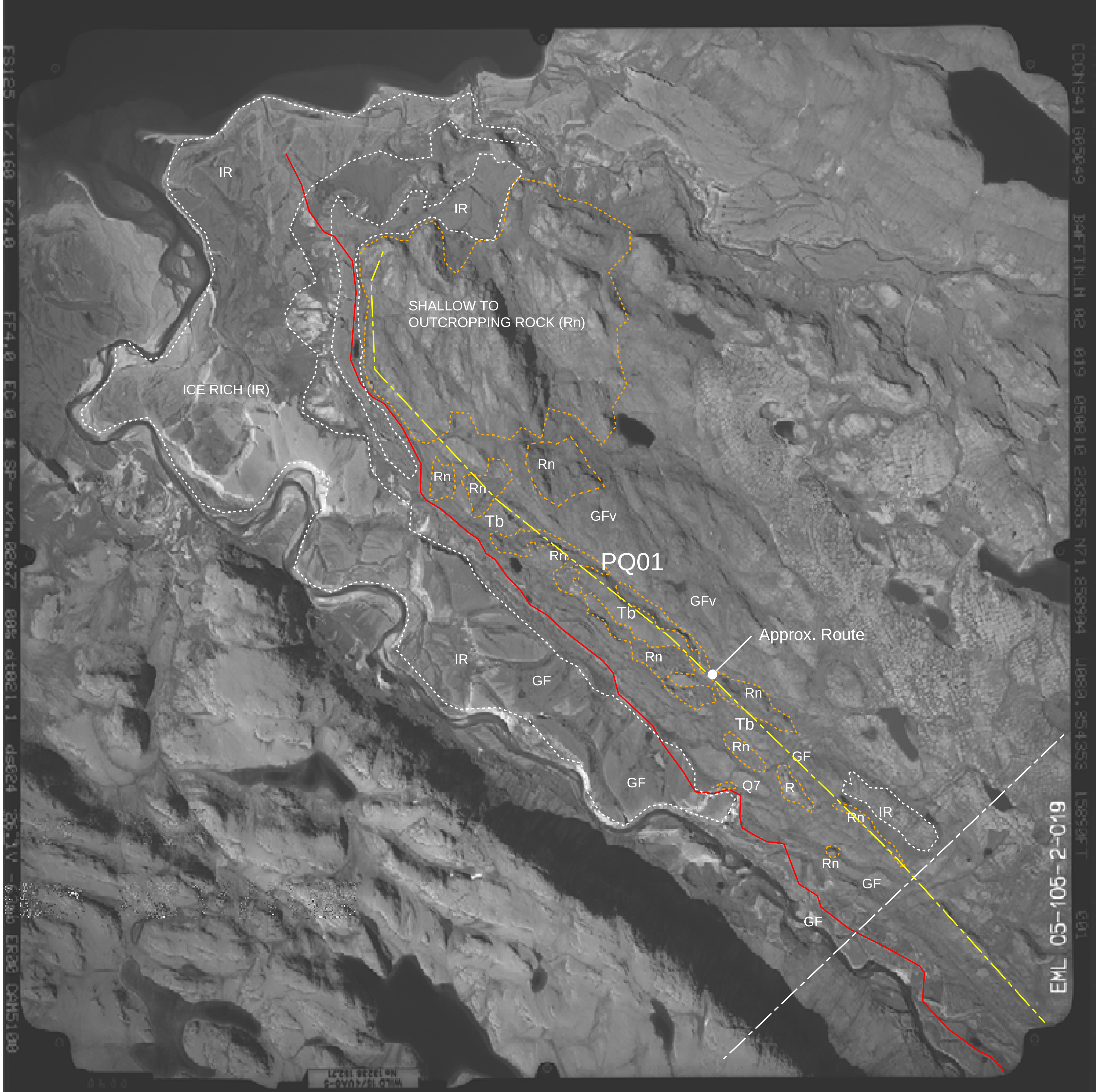


Photo 60

Photo 61

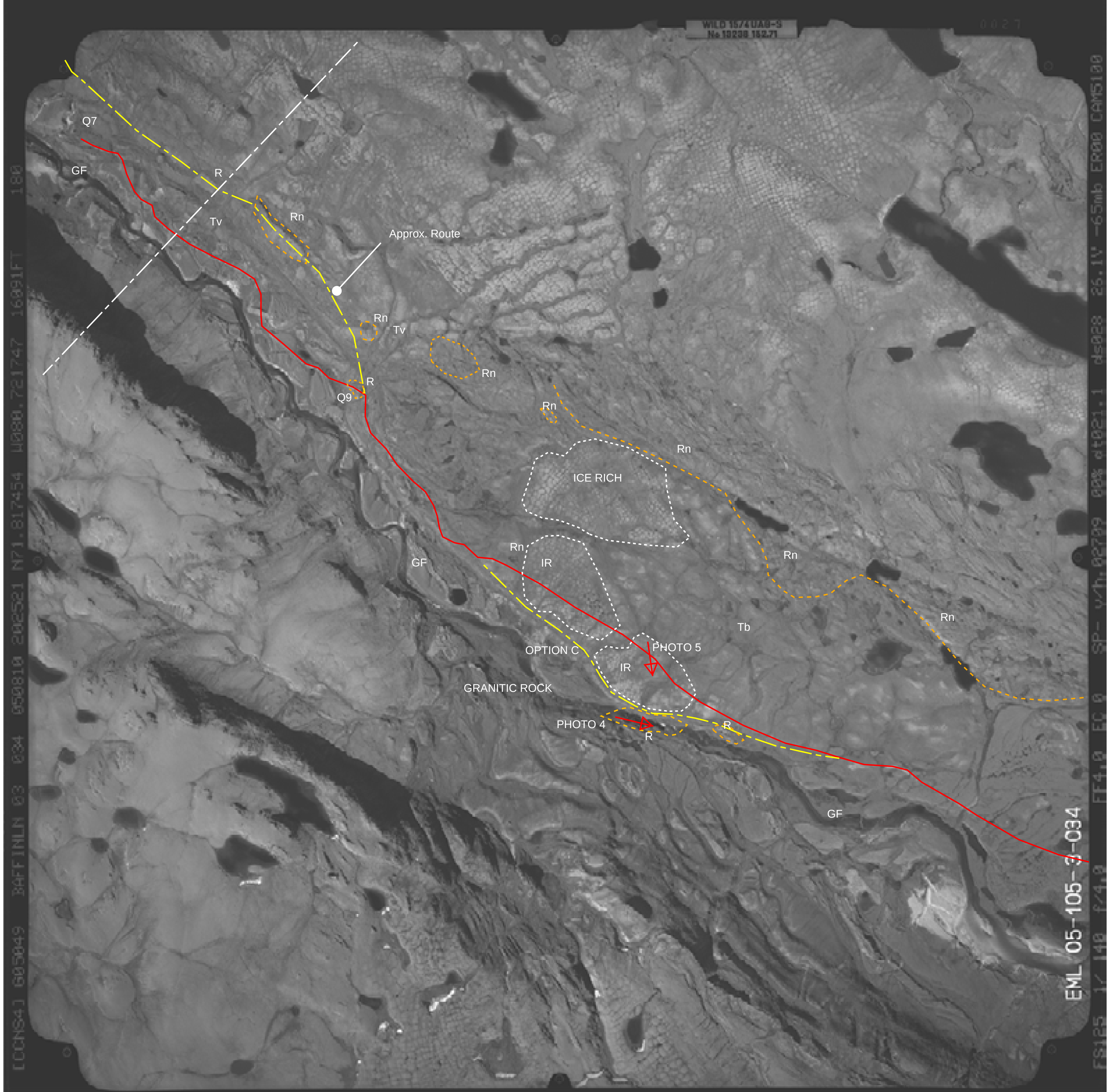
Appendix C
Aerial Photographs



Legend

R - Confirmed or High Probability Rock Outcrop
Rn - Rock knobs, thin soil veneer suspected occasional to frequent outcrops.
GF - Glaciofluvial/fluvial sands and gravels (v-denotes veneer)
Tv - Till Veneer (0-2m thick)
Tb - Till Blanket (>2m thick)
IR - Ice Rich
Al - Alluvium
Tb, Co - Talus over Till

CH0+000 to 8+000



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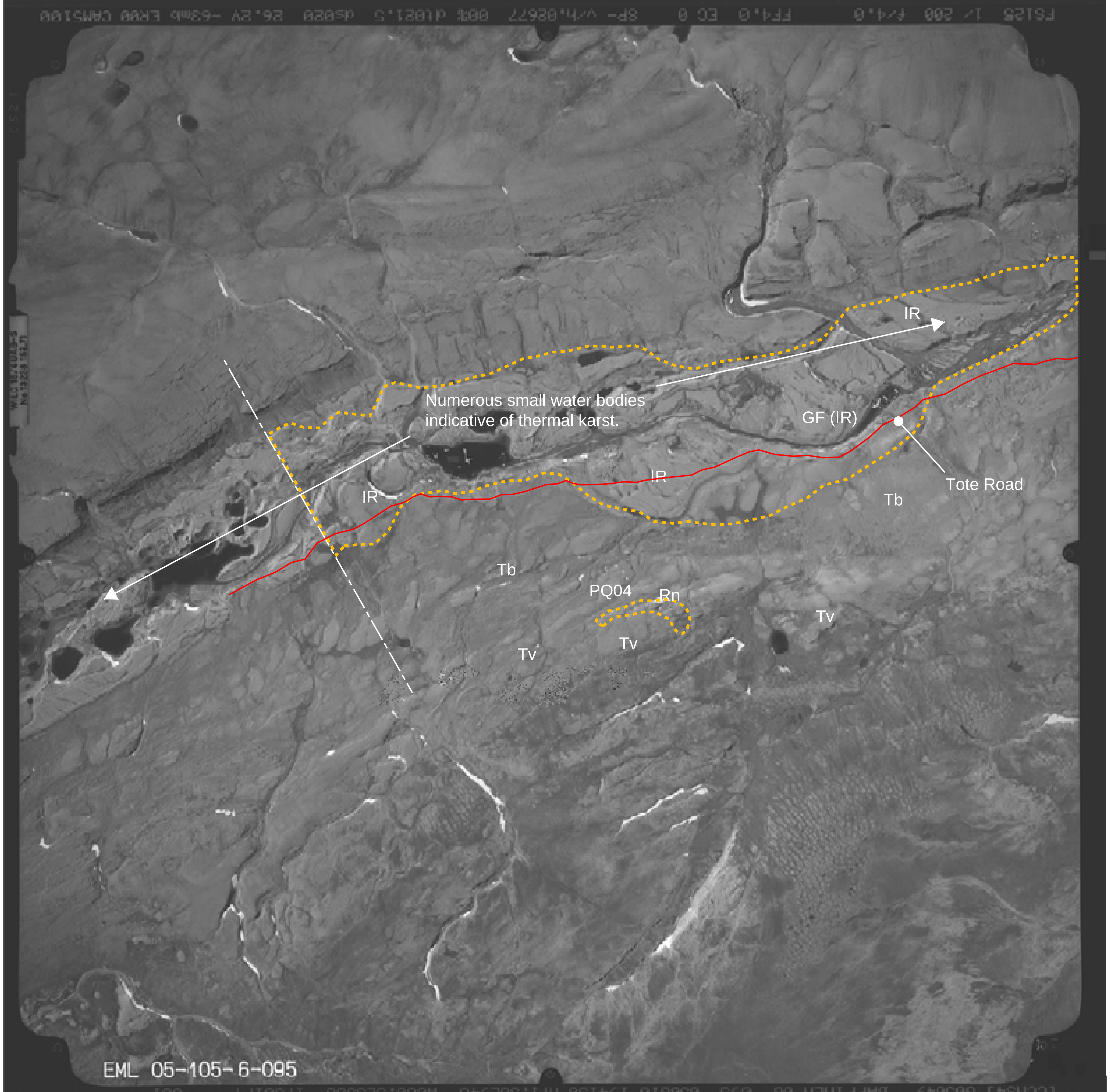
CH 6+000 to CH 14+000



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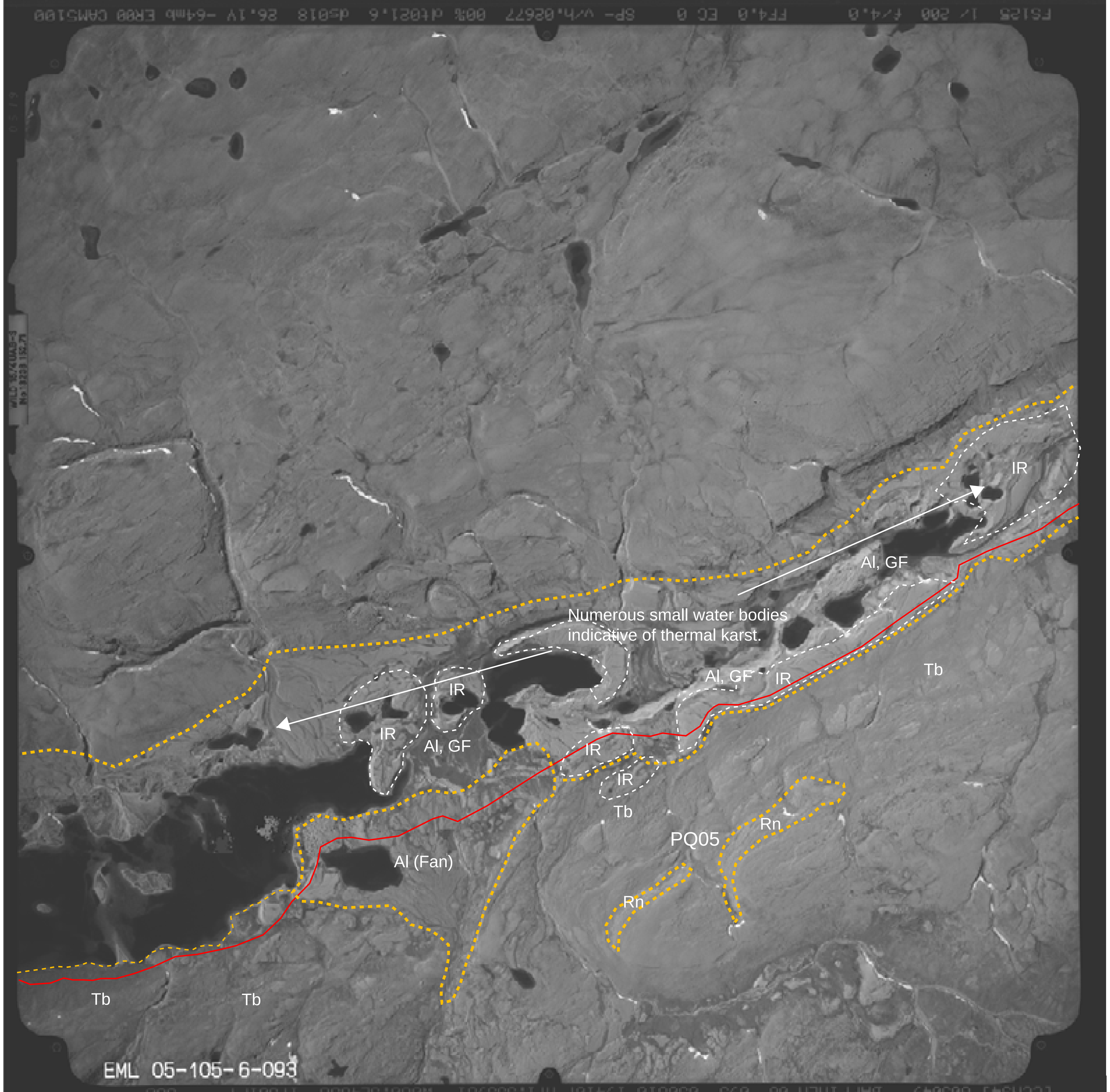
IR - Ice Rich
Al - Alluvium
Tb, Co - Talus over Till

CH 38+000 to 46+000



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R - Confirmed or High Probability Rock Outcrop

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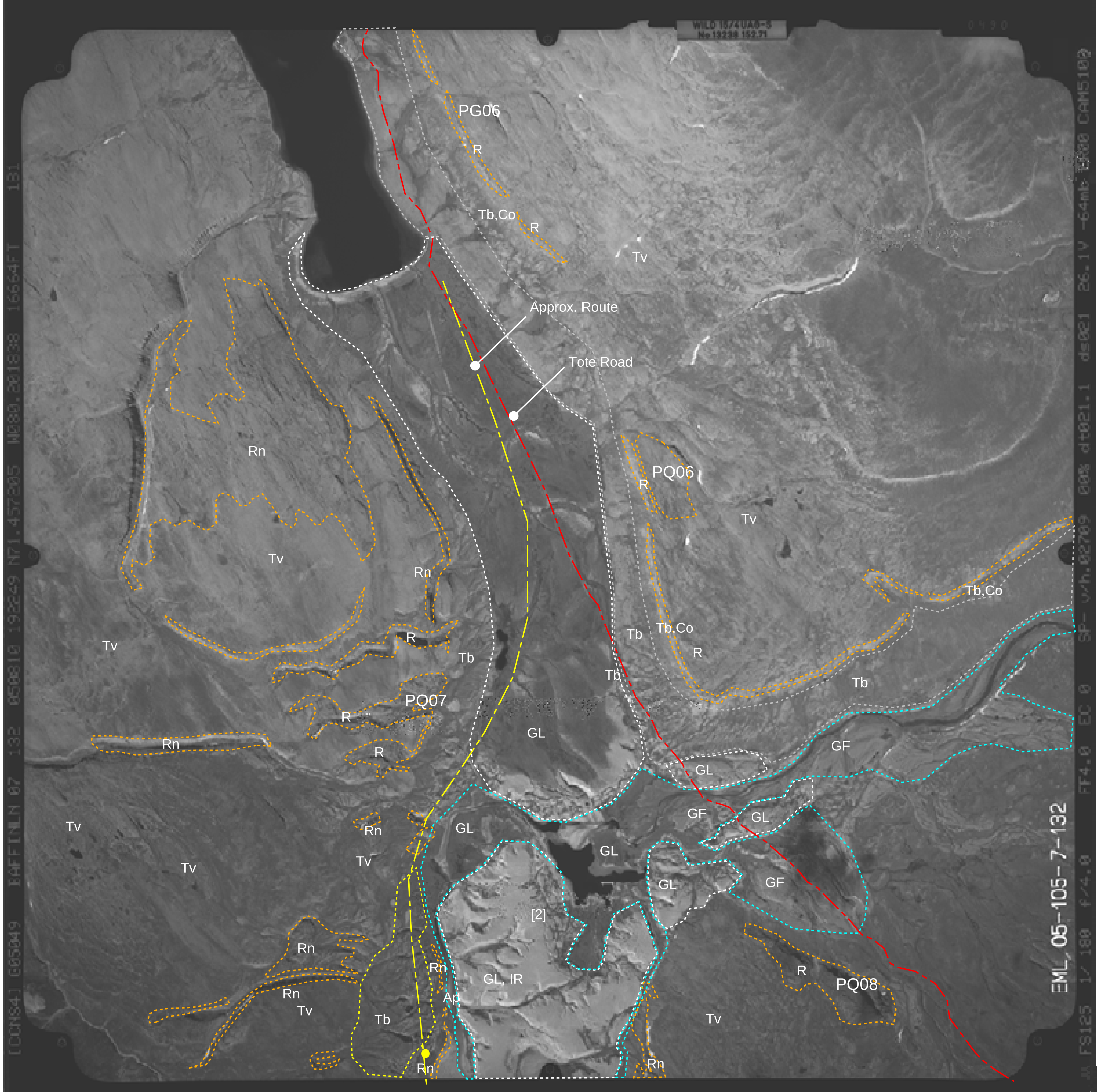
Tb - Till Blanket (>2m thick)

IR - Ice Rich

Al - Alluvium

Tb, Co - Talus over Till

CH 42+500 to 46+000



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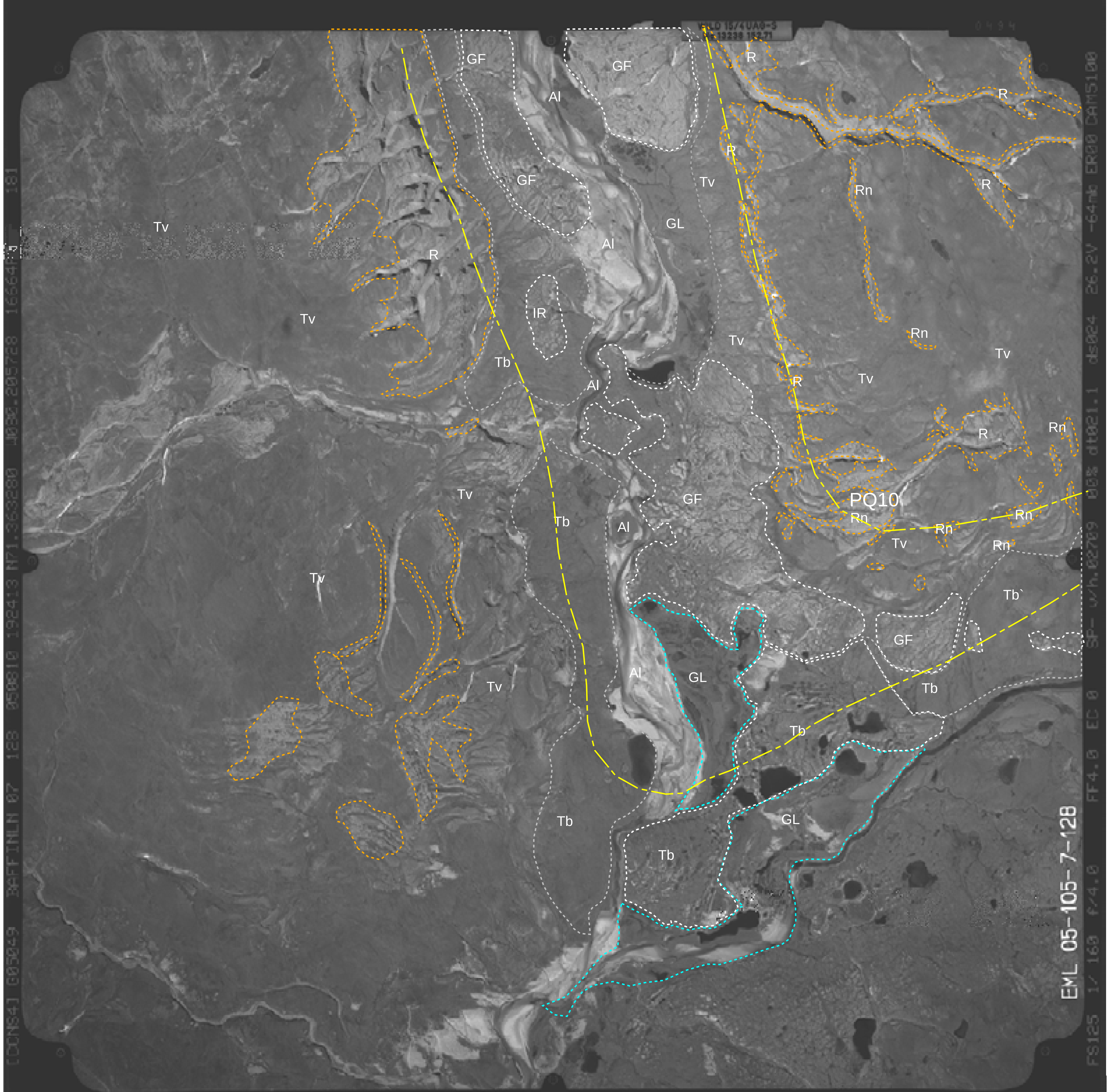
Tb, Co - Talus over Till

CH 55+000 to CH 62+000



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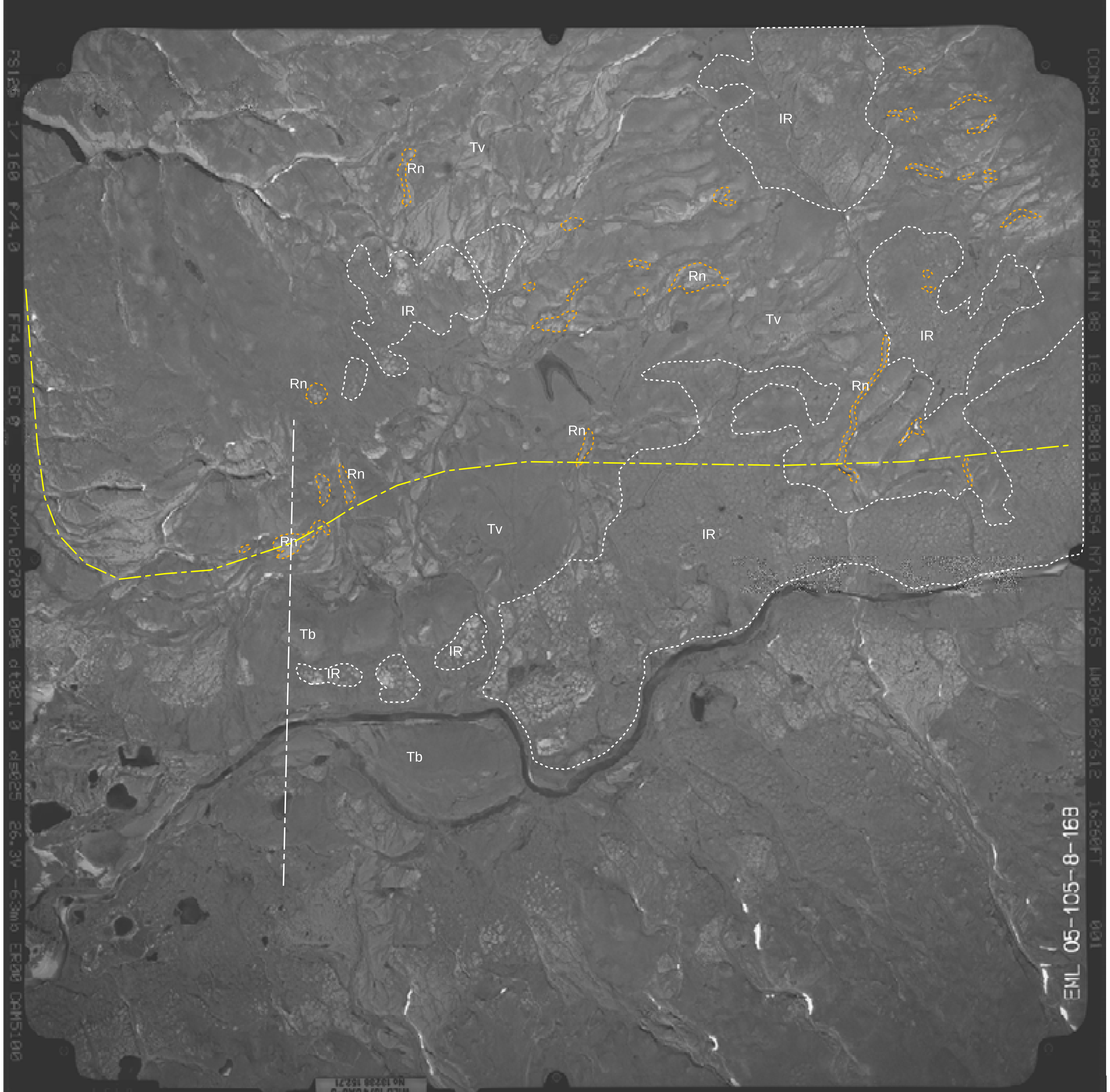
Al - Alluvium
Tb, Co - Talus over Till

CH 64+000 to CH 70+000



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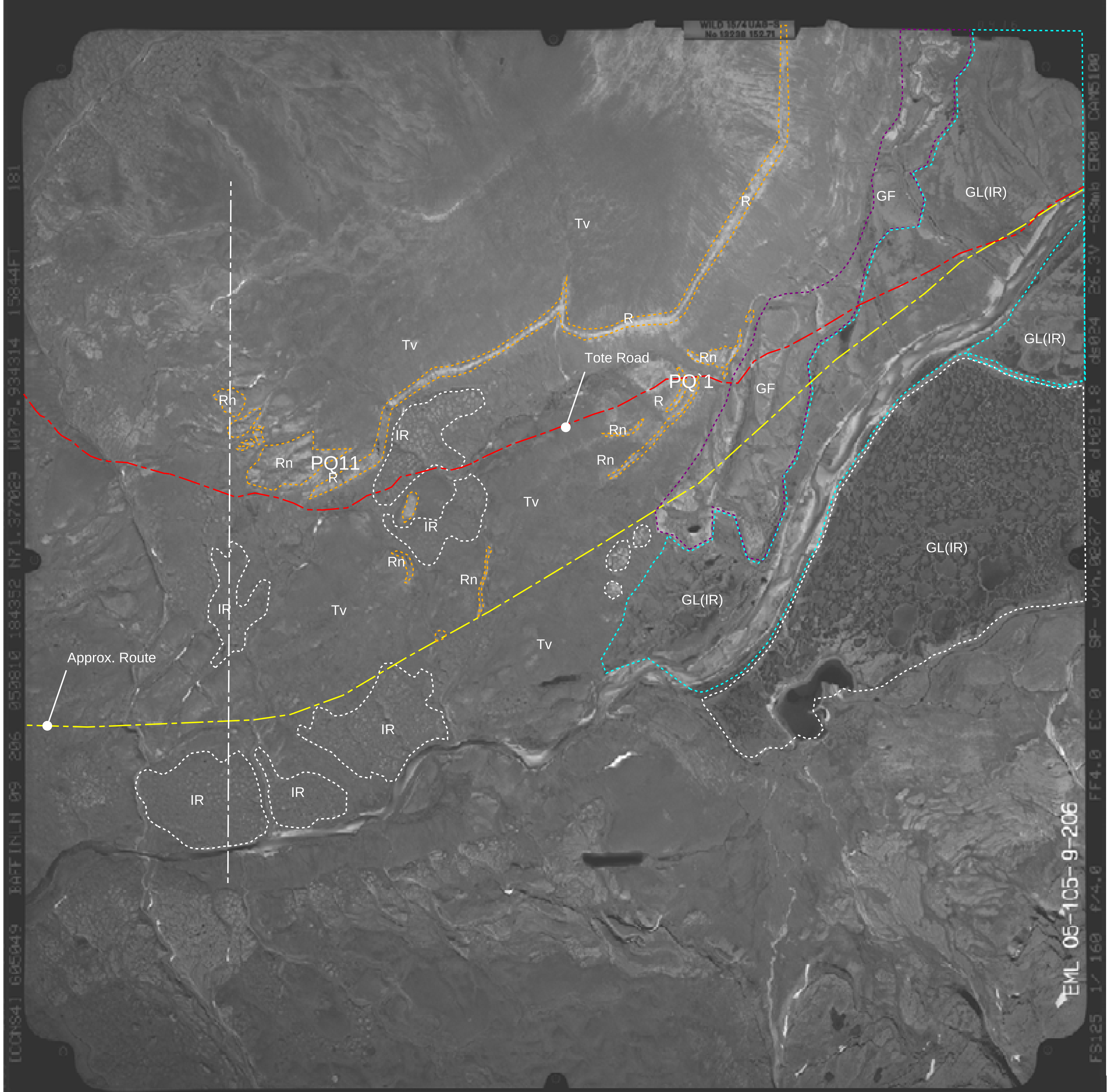
CH 67+000 to CH 76+000



Legend

R - Confirmed or High Probability Rock Outcrop

Rn - Rock knobs, thin soil veneer suspected occasional to frequent outcrops.

GF - Glaciofluvial/fluvial sands and gravels (v-denotes veneer)

Tv - Till Veneer (0-2m thick)

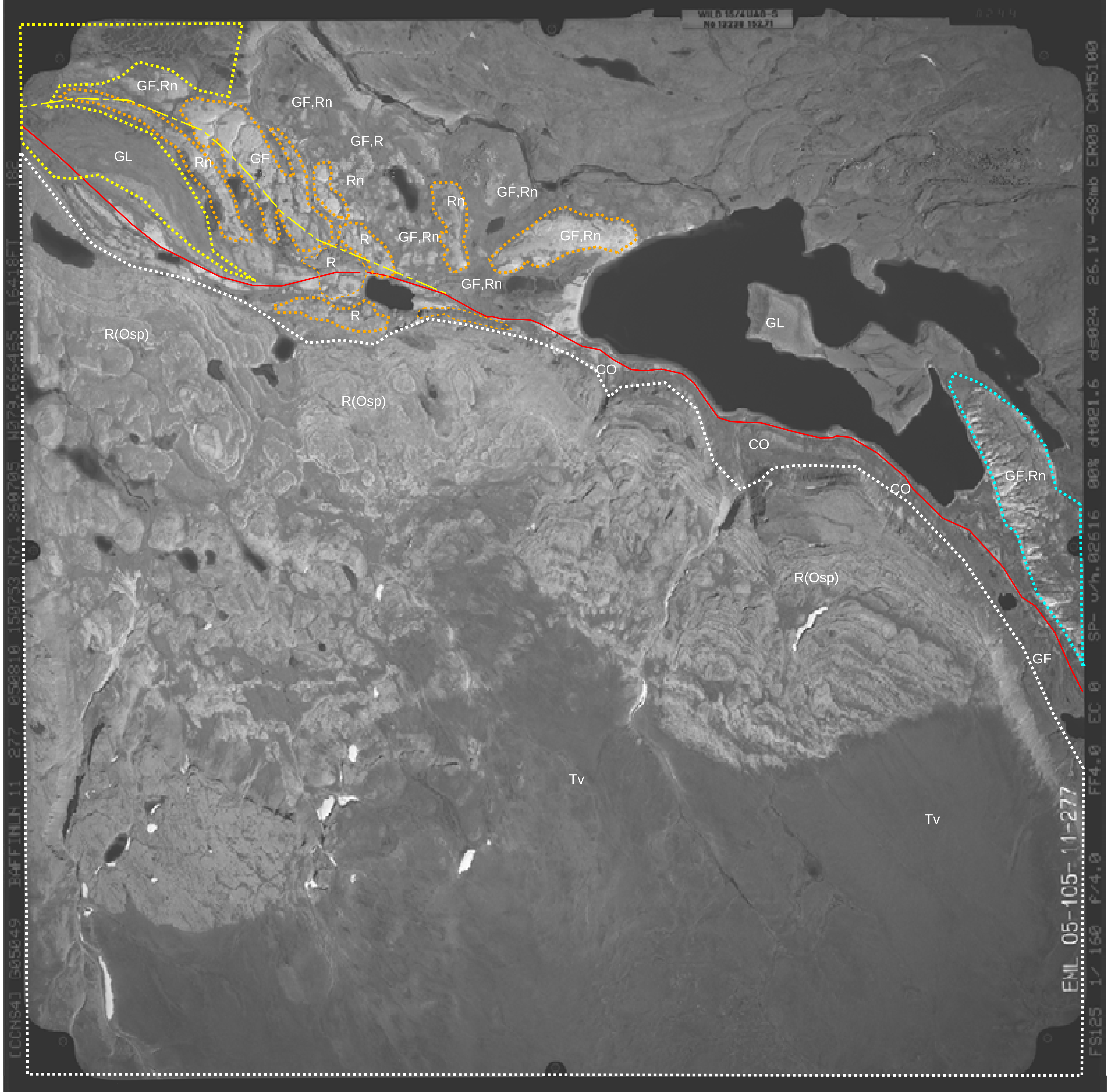
Tb - Till Blanket (>2m thick)

IR - Ice Rich

Al - Alluvium

Tb, Co - Talus over Till

CH 74+000 to CH 81+000



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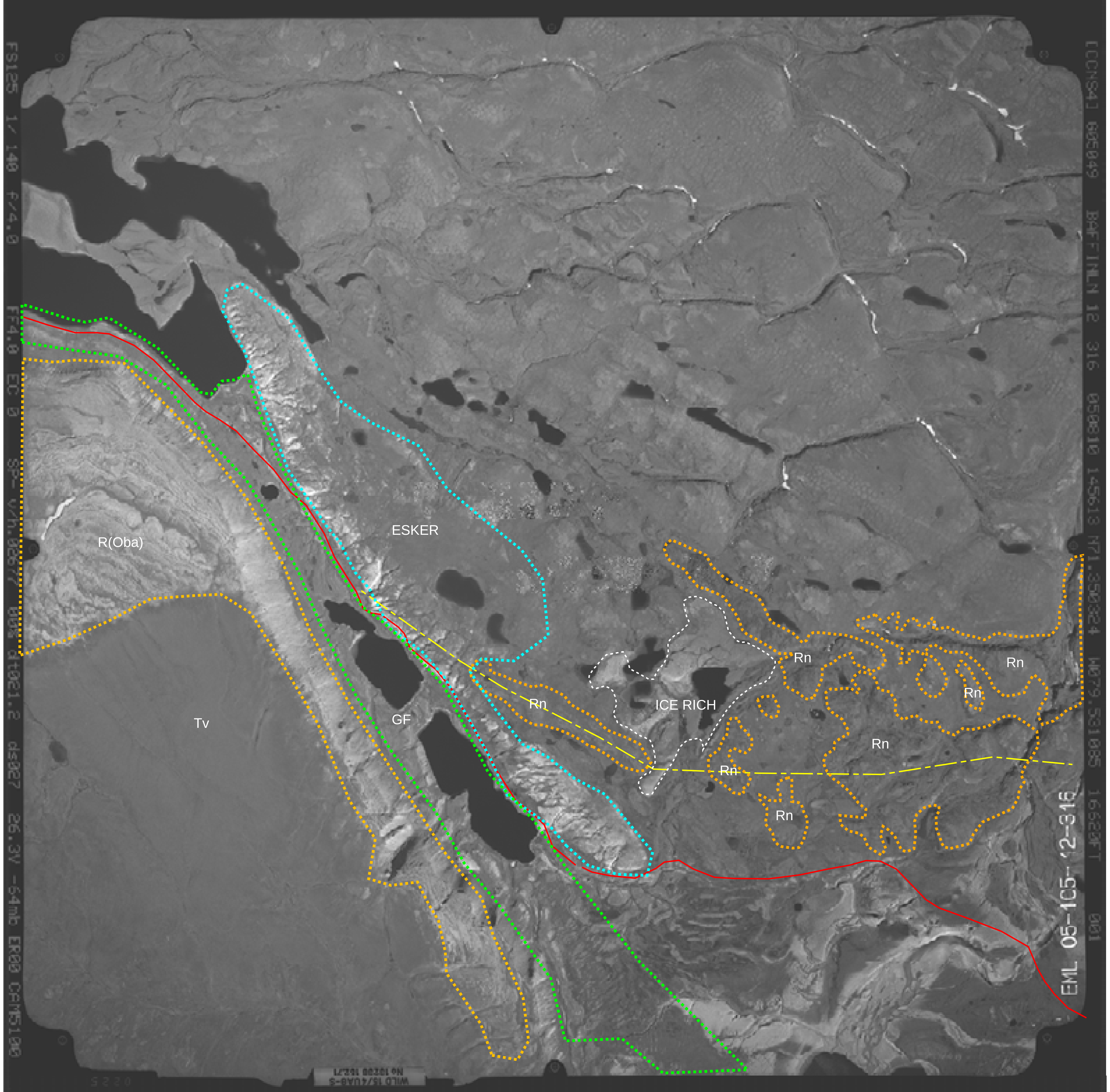
Al - Alluvium
Tb, Co - Talus over Till

CH 84+000 to CH 94+000



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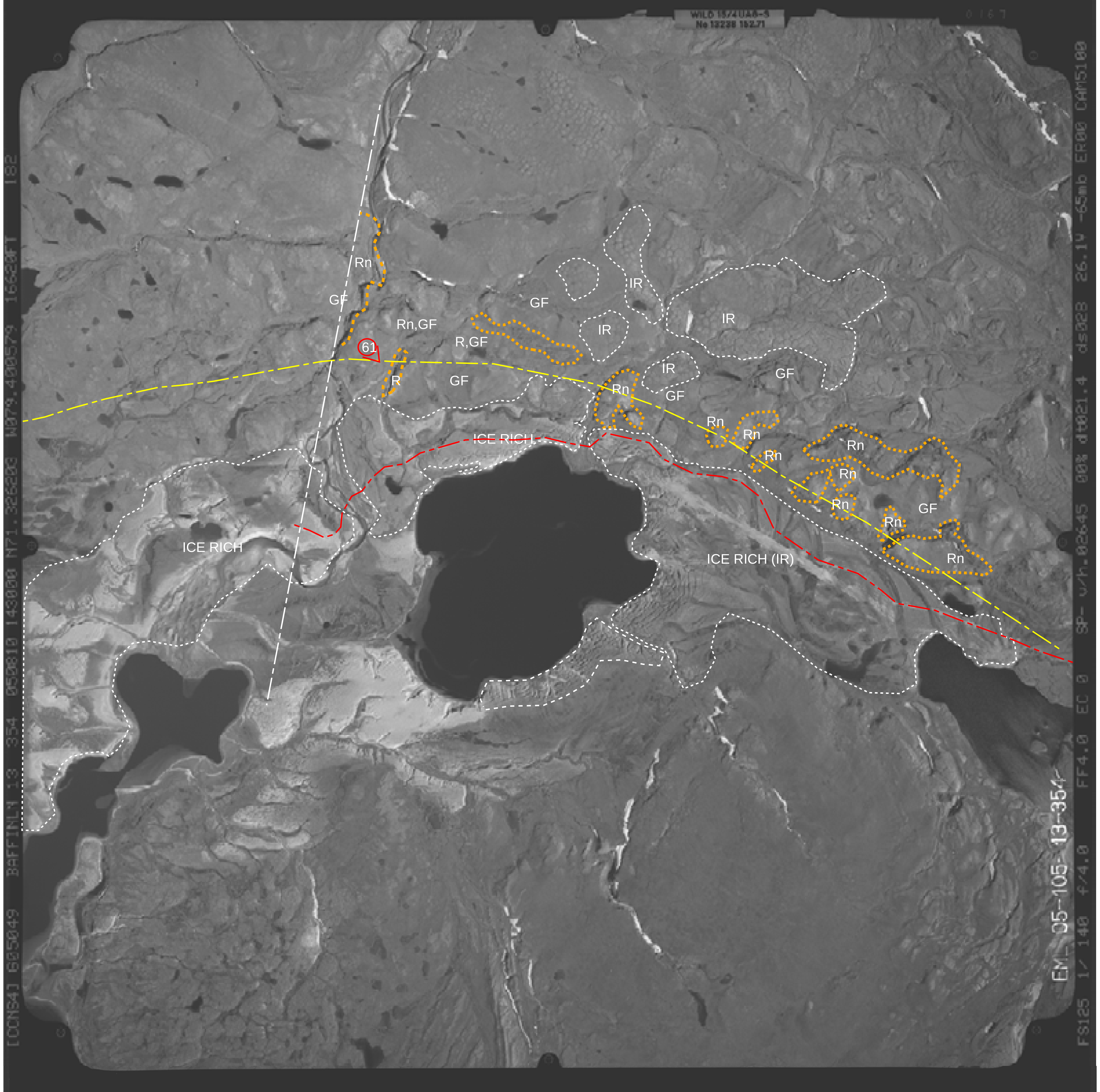
CH 90+500 to CH 96+500



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IR - Ice Rich
Al - Alluvium
Tb, Co - Talus over Till

CH 96+000 to 105+000