APPENDIX C.3

2024 Tote Road Priority Actions

In 2023-2024, a third-party engineering consultant completed a re-assessment of the Tote Road borrow areas, which informs a detailed action plan for addressing geotechnical risks associated with identified borrow areas. Ninety (90) sites or areas of concern were documented and evaluated in the 2023 inspection. The inspection report is included as Attachment C.3.1.

A multi-year remediation plan was developed based on the rankings given in the 2023 inspection, as well as input from Baffinland considering constructability constraints and available resources. The full detailed plan is currently being finalized between Baffinland and the consultant, however in summary the plan consists of the following actions.

Of the 90 identified borrow areas along the tote road, there are 17 identified as having higher risk associated with them. These areas are targeted for remediation between 2025 and 2029. The planned remediation involves:

i. Ensuring the disturbed area will not impact road stability through sufficient buttressing and/or slope flattening;
ii. Proper water management to ensure standing water is diverted away from the Tote Road and volumes kept to a minimum; and
iii. Allowing the shallow cut "back" slopes (on the tundra side) to seek their own long-term condition, rather than risk further permafrost impacts through additional disturbance.

Borrow pit areas along the Tote Road will be monitored for changing conditions annually.

Baffinland's planned implementation of these actions is included in the attached Table C.3.1.

Table C.3.1: 2024 Updated Tote Road Priority Item Action Schedule

Site No.	KM Post	Priority	2023 Comments	Proposed Timeline for Completion[1]	2024 Update
71	20.7 R	A++++	Steep high roadway embankment. Presence of pooled water at the embankment toes. The pooled water may have resulted from poor surface water management and/or permafrost degradation. No signs of slope movement/instability.	Planned 2025 Remediation.	On 5-Year Plan for completion in 2025.
41	50.6 L	A+	Evidence of ground settlement, deep water pooling (due to permafrost degradation) and excessive erosion. This area needs to be graded (pushing pooled water, filling holes), in addition to improving the erosion protection system at the existing culvert outlet.	Planned 2025 Remediation.	On 5-Year Plan for completion in 2025.
62A	27.8	A+	Deep excavation full of water (high embankment). Granular fill placed over the embankment edge to flatten the steep slope, but this area needs to be drained from standing water, filling/grading, and dressing the surface to properly drain water.	Planned 2025 Remediation.	On 5-Year Plan for completion in 2025.
22	72.4	A+	Earthworks and filling activities were completed prior to the 2023 site inspection and the roadway embankment appeared to be fairly stable. However, additional earthworks and drainage improvement will be required (both sides of the embankment).	Planned 2025 Remediation.	On 5-Year Plan for completion in 2025.
61B	29.1	A++++	Steep and high roadway embankment. Presence of pooled water at the embankment toes. The pooled water may have resulted from poor surface water management and/or permafrost degradation. No signs of slope movement/instability, but the excavation should be filled with imported fill to improve embankment stability and to prevent any slope failure.	Planned 2026 Remediation.	On 5-Year Plan for completion in 2026.
14A	89.3	A	Additional degradation and water ponding along the western edge of the road.	Planned 2026 Remediation.	On 5-Year Plan for completion in 2026.
79.1	12.3 R	A	Large sinkhole filled by water near the right toe of the roadway embankment. The water in the sinkhole indicate the presence of continuing permafrost degradation. This sinkhole should be filled to prevent further expansion that may undermine the roadway embankment stability.	Planned 2026 Remediation.	On 5-Year Plan for completion in 2026.
75	15.0 L&R	A	The right side (heading north) borrow area was graded and filled before the 2023 site inspection, and no further action is required for this side. The left side (heading north) borrow area had ponded water and there is a short section at the south end of the pit where there is a very steep side slope and a considerable drop from the edge of the road down into the water. Ponded water must be drained, the area backfilled, and the surface dressed properly to improve drainage.	Planned 2027 Remediation.	On 5-Year Plan for completion in 2027.
32	56.9 R	A++++	Water ponding and continuing ground settlement due to permafrost degradation. Installed culverts are dysfunctional due to the changing ground conditions. Remediation actions should start as soon as possible to prevent further permafrost degradation, and to reduce the risk of the roadway embankment failure. Pooled water must be drained out or pushed back from the edge by placing additional fill on the side slopes of the road embankment to enhance stability. The water management system must be improved to let the water flow away from the embankment and to prevent further permafrost degradation.	Planned 2027 Remediation.	On 5-Year Plan for completion in 2027.
33	56.7 L	A++++		Planned 2027 Remediation.	On 5-Year Plan for completion in 2027.
68	21.9 R	A++++	Deep water pooling and evidence of continuing permafrost degradation. The existing culvert appeared to be dysfunctional (no proper drainage). No signs of slope movement or instability at this moment (2023 inspection).	Planned 2028 Remediation.	On 5-Year Plan for completion in 2028.
			Deep excavation full of water (high embankment). Granular fill placed over the	Planned 2028 Remediation.	On 5-Year Plan for completion in 2028.

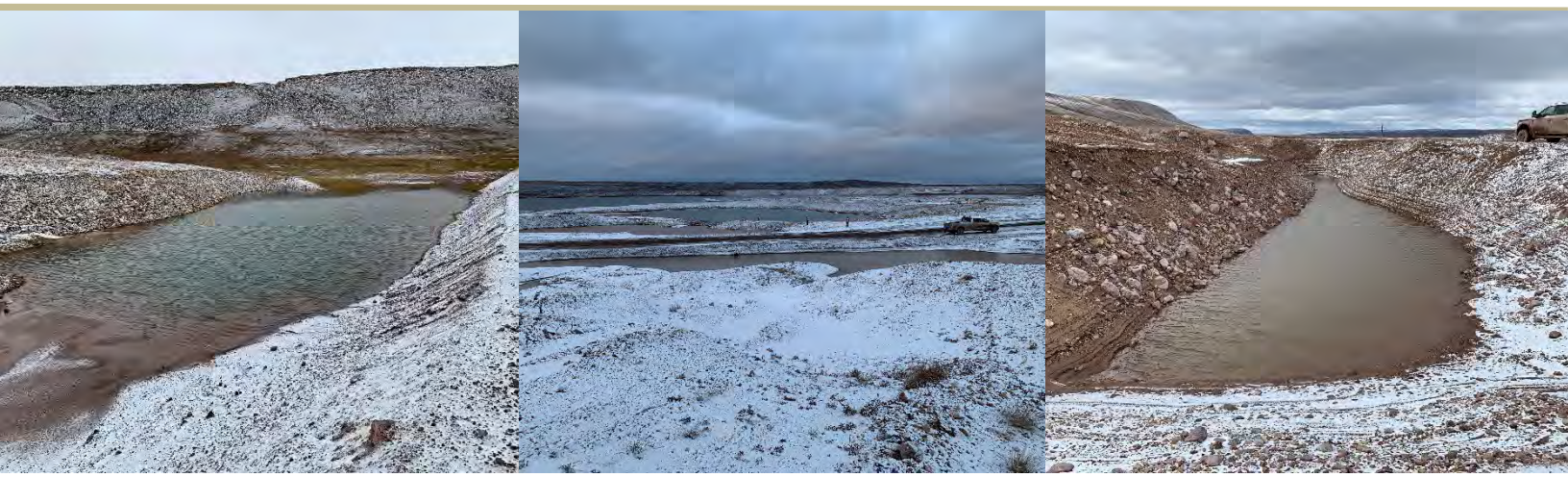
82A	8.8 L	A	embankment edge to flatten the steep slope, but this area needs to be drained from standing water, filling/grading, and dressing the surface to properly drain water.		
14	89.8	A++++	Instability is evident, water is very deep and the embankment side slope on the right side of the road is very steep and shows cracking on the shoulder and side slope.	Planned 2028 Remediation.	On 5-Year Plan for completion in 2028.
79	12.8 L&R	A++++	Large water pooling. Pooled water may have resulted from poor surface water management and/or permafrost degradation. The water level appeared to be close to the roadway surface and might affect the embankment stability and undermine the roadway structure.	Planned 2029 Remediation.	On 5-Year Plan for completion in 2029.
QIA-07	49	A+	No change from 2019 inspection. Embankment slope should be flattened, as such earthwork and filling activities will be required to push the pooled water away from the steep embankment toe.	Planned 2029 Remediation.	On 5-Year Plan for completion in 2029.
65	25.8 L&R	A+	Right borrow area appeared to be dry and stable. The left borrow areas (2 pits) were full of ponded water, and showed evidence of continuing permafrost degradation. Pooled water in the left borrow areas appeared to be deep, but the excavation walls were stable (at the time of the inspection).	Planned 2029 Remediation.	On 5-Year Plan for completion in 2029.
66	23.6 L&R	A+	Right borrow area appeared to be dry and stable. The left borrow was full of ponded water, and showed evidence of continuing permafrost degradation. Pooled water in the left borrow appeared to be deep and may affect the roadway embankment stability.	Planned 2029 Remediation.	On 5-Year Plan for completion in 2029.

[1] Any work undertaken will consider if required changes to the Tote Road may require a Tote Road Amendment Notice (TRAN) and/or changes to reclamation security.

APPENDIX C.3.1

2024 Tote Road Inspection Report

2023 Inspection of the Milne Inlet Tote Road and Associated Borrow Sources



PRESENTED TO

Baffinland Iron Mines Corporation

AUGUST 2, 2024
ISSUED FOR REVIEW-REVISION 2
FILE: 704-ENG.EARC03209-12

This "Issued for Review" document is provided solely for the purpose of client review and presents our interim findings and recommendations to date. Our usable findings and recommendations are provided only through an "Issued for Use" document, which will be issued subsequent to this review. Final design should not be undertaken based on the interim recommendations made herein. Once our report is issued for use, the "Issued for Review" document should be either returned to Tetra Tech Canada Inc. (Tetra Tech) or destroyed.

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EXECUTIVE SUMMARY

Tetra Tech Canada Inc. (Tetra Tech) was retained by Baffinland Iron Mines Inc. (Baffinland) to assess the permafrost conditions along the Milne Inlet Tote Road (Tote Road) and its associated borrow sources as a follow up to site work completed in 2009 (EBA Engineering Consultants Ltd.), 2014 (Tetra Tech EBA Inc.), and 2019 (Tetra Tech Canada Inc.). The Tote Road was constructed in 2008 and is about 100 km long connecting the Mary River Mine/Camp to Milne Inlet. It has a 30 m road alignment right-of-way and over 90 borrow sources along its entire length of which those with concerns are documented and evaluated in the 2009, 2014, 2019, and 2023 inspection reports. The first 150 tonne B-train trucks started hauling crushed ore to Milne Inlet in 2014 and ore is now being hauled at quantities of more than 5 million tonnes per year.

Mary River is located within a zone of continuous permafrost within north central Baffin Island, Nunavut. Most of the Tote Road routing follows glacial valleys that have been infilled with granular material that varies in texture from silty sand to sandy gravel with cobbles and some boulders. Wedge ice occurs throughout the region and can be observed in aerial photos as polygonal patterned ground. Segregated ice (horizontal lenses) and massive ice (tabular bodies of pure ice up to more than 10 m thick) also occur in the upper permafrost soils. Ground ice distribution is erratic, but it is generally found in greater concentrations in naturally wet basins. The active layer, is expected to range from less than 0.5 m thick to 1.5 m or more. Examination of the route in 2014, 2019, and 2023 indicated that in addition to ice wedge melt out, there is ongoing settlement resulting from thaw of massive ice bodies in many of the borrow sources.

The Tote Road was constructed from natural granular material scraped from the active layer in each of the borrow sources. Material below the active layer was too ice bonded to be excavated in winter.

The field assessment of the Tote Road was carried out on September 10, 2023, and consisted of driving along the Tote Road and visually observing and assessing areas of instability or potential instability. The visual assessment was coupled with examination of aerial photos and imagery. The 2023 work was follow-up work based on the 2009, 2014, and 2019 inspections, targeting and identifying changes and upgrades made to the road.

Baffinland provided Tetra Tech with a list of areas of concern identified by the Qikiqitani Inuit Association, Nunavut Impact Review Board, and Crown-Indigenous Relations and Northern Affairs Canada prior to the 2019 Inspection. The areas of concern included ponding water, road raises, turbid water upstream of the road, cracking along the road embankment, sediment transport through culverts near borrow locations, sinkholes, and slope stability issues. These areas were inspected during the 2019 inspection, revisited during the 2023 inspection, and recommendations for improvements provided.

In line with the methodology applied in 2009, 2014, and 2019, problem sites were grouped into five broad categories based on remediation criteria and stability of the road embankment:

- Priority A++++ pits (6.4%): Where there is the potential for failure of the road embankment posing risk to vehicle and operator safety;
- Priority A+ pits (4.5%): Where thaw settlement initiated by pit excavation is actively affecting the road integrity, and there is a risk of failure;
- Priority A pits (5.5%): Where thaw settlement initiated by pit excavation is actively affecting the road integrity and safety, but with lower risk if failure occurs;
- Priority B pits (21.8%): Where active thaw settlement and water accumulation is ongoing in unstable terrain within an abandoned pit, with no currently identified risk to the road integrity and operator safety; and

- Priority C pits (61.8%): Are relatively stable but will need remediation attention to improve site aesthetics and ensure long-term stability.

The number of sites for each priority category is summarized in Table 4-1. The percentage of each priority category was calculated and listed in Table 4-2.

There are seven (7) Priority A++++ areas as opposed to the ten (10) identified in 2019 because realignment and widening of the road, as well as previous grading and remediation activities has removed some of the areas with stability concerns. Priority A++++ areas are those where significant safety hazards are felt to exist and frequent monitoring and timely remediation actions are strongly recommended. Thawing of ice-rich soils is common in these areas and observed at locations where the road surface is unstable and settlement extends under the road, and where cracking and slumping of side slopes occurs at borrow pits that are adjacent to the edge of the road embankment.

Baffinland has continued to make upgrades to portions of the Tote Road since the 2019 site visit including realignments, grade improvements, widenings, and repairs. Table 1 and Table 2 in the Appendix summarize observations and recommendations for sites that need further remediation actions and sites that no further remediations are required respectively. It is recommended that remediation actions be focused on restoring stability by replacing cover material removed during excavation, developing, and promoting drainage, caring for natural runoff from the borrow sites, and improving the topography to encourage natural revegetation. With high traffic volumes and heavy loaded vehicles, Priority A+ and A++++ sites should be addressed with remediation options first, frequent monitoring and timely action as required. Material sourced for use as protection against permafrost degradation should be harvested from a location where it would not cause further permafrost degradation.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
Baffinland	Baffinland Iron Mines Inc.
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
NIRB	Nunavut Impact Review Board
QIA	Qikiqtani Inuit Association
ROW	Right-of-way
SOW	Scope of Work
Tetra Tech	Tetra Tech Canada Inc.
Tote Road	Milne Inlet Tote Road

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Baffinland Iron Mines Inc. and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Baffinland Iron Mines Inc., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on Use of this Document attached in Appendix A or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) is pleased to submit this report to Baffinland Iron Mines Inc. (Baffinland) regarding the assessment and evaluation of the Milne Inlet Tote Road (Tote Road) and its associated borrow sources. This work is a follow up to a site visit in 2009 and reports by EBA Engineering Consultants Ltd. (EBA 2009), a site visit and reports by Tetra Tech EBA Inc. in 2014 (Tetra Tech EBA 2015), and a site visit and report by Tetra Tech Canada Inc. in 2019 (Tetra Tech 2019).

The scope of work (SOW) for this assessment was outlined in Tetra Tech's proposal to Baffinland dated October 2, 2023.

2.0 PROJECT BACKGROUND

2.1 Project Description

An access road (today referred to as the Tote Road) was constructed from August 2007 to October 2008 to connect the Mary River Mine/Camp to Milne Inlet on Baffin Island. The original purpose of the road was to provide a route for trucks to haul a bulk sample of iron ore from the Mary River deposit to a port site at Milne Inlet (about 100 km long). Initial construction plans were to use three permitted quarries and borrow sites, but the haul distances were considered impractical and construction materials were supplemented by numerous sources within the 30 m road alignment right-of-way (ROW). This resulted in over 90 borrow sources along the road alignment, of which those with concerns were documented and evaluated in 2009 (EBA 2009) and revisited again in 2014 and 2019 (Tetra Tech EBA 2015 and Tetra Tech 2019).

The Tote Road roughly follows an overland cat-train access route established in the 1960s. The road design and construction are described in a comprehensive as-built report by Knight Piésold Consulting, entitled "Milne Inlet Tote Road Construction Summary," dated February 5, 2009.

For the most part, the initial Tote Road embankment was constructed during the winter from natural granular materials that were scraped from within the active layer (seasonal freeze/thaw layer) in each of the borrow sources. The materials from below the active layer were typically too ice bonded to be excavated during the winter.

Baffinland has continued upgrading some portions of the Tote Road since the 2019 site visit; this includes some realignment, grade improvements, widening, and repairs.

The first production loads of iron ore were being transported to the Milne Port at the time of the 2014 site inspection and has continued to date with ore being hauled at quantities of more than 5 million tonnes per year. The crushed ore is hauled in purpose-built B-train trucks, each capable of hauling a total of 150 tonnes of ore.

2.2 Communities and Agencies Concerns

Several areas of concern along the Tote Road alignment have been identified by the Qikiqitani Inuit Association (QIA), Nunavut Impact Review Board (NIRB), and Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC). Several of these locations had also been identified by Tetra Tech as areas of concern following the 2009, 2014, and 2019 site inspections. A re-examination of the previously identified areas of concern was a focus of the 2023 site inspection.

The areas of concern identified by the above groups were as follows:

Qikiqtani Inuit Association (QIA)

- Tote Road km 89.8 (QIA-02), km 49.6 (QIA-06), km 49 (QIA-07), km 29.1 (QIA-09), km 21.9 (QIA-10), and km 7.2 (QIA-11): Water accumulation in historic borrow areas along the road and possibly impacting the long-term stability of the road.
- Tote Road km 7.2 (QIA-11): Borrow area partially filled with granular material but the road grade appears to be near the original ground with water ponding encroaching on the road, possibly due to degradation of permafrost.
- Tote Road km 52.2 (QIA-05): It appears that the road was raised at this location but the reason for raising the road was not able to be confirmed with the maintenance department.
- Tote Road km 92 (QIA-01): Stranded turbid water observed upstream of the road.
- Tote Road km 73.1 (QIA-03): Observed cracking on both sides of the road, possibly due to permafrost degradation.
- Tote Road km 72.4 (QIA-04): Borrow sources on both sides of the road. On the uphill side, the borrow source appears to be the source of sediment transport through the culvert to the downhill side of the road.
- Tote Road km 33 (QIA-08): Sinkhole developed, likely due to culvert failure.

Nunavut Impact Review Board (NIRB)

- Tote Road km 29 to 32: Noticed areas with slope stability issues.

Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)

- Sediment noticed below the bridges. The abutments of the bridges at km 80 (Bridge 3) and 97 (Bridge 4) appear to have shifted.

The above listed areas of concern were inspected by Tetra Tech during the 2023 site inspection. Discussions and evaluations for these areas are provided in this report with a summary of the classifications and remediation actions presented in Table 1 and Table 2 in the Tables Appendix. Table 1 summarizes sites that need further remediation actions, while Table 2 lists sites that need no further remediations.

3.0 SCOPE OF WORK

The SOW included inspection and assessment of the road and associated borrow sources conditions, to observe any changes from previous inspections and assess the most recent improvements and construction. Observations, closure recommendations, remediation objectives, criteria, and the conceptual work plans presented in the 2009, 2014, and 2019 inspection reports were also reviewed and updated based on the current site conditions.

Prior to the preparation of the current SOW, Mohamad Hijazi of Tetra Tech, accompanied/escorted by Kofi Sakyi, Todd Swenson, and Steve Chuard of Baffinland, completed a one-day field inspection of the Tote Road and its associated Borrow Sources on September 10, 2023. The inspection mostly consisted of driving along the Tote Road and visually observing and assessing areas of instability or potential instability. The 2023 inspection focused on assessing the actions taken following the recommendations from the 2009, 2014, and 2019 inspections, and the identification of notable changes in the ground conditions and upgrades made to the road after the 2019 inspection.

The current SOW is summarized as follows:

1. Review of related available information and previous inspection reports.

2. Rating and evaluation of the areas of instability or potential instability.

3. Review and commenting on the applicability of previously developed remediation objectives and criteria.

4. Preparation of this report and updating the previously developed action tables.

Figures 1 to 13 show the Tote Road alignment, inspected borrow pits, and approximate locations where the road has been realigned based on this year's reconnaissance photos and the 2018 satellite imagery that was provided. To be consistent with previous reports, the centre line chainage remains the same on these figures (may not always agree with KM post markers).

4.0 SITE CONDITIONS

4.1 Permafrost

The Mary River Mine and the Tote Road are located on North Central Baffin Island. The closest community is Pond Inlet, on the coast about 150 km north of the mine. The normal mean annual air temperature reported for Pond Inlet is -13.7°C (1991-2020 Canadian Climate Normals). The cold climate sustains continuous permafrost throughout Northern Baffin Island with ground temperatures anticipated to be -8°C to -10°C along the Tote Road routing. For the most part, the Tote Road routing follows glacial valleys that have been infilled with granular material that varies in texture from silty sand to sandy gravel with cobbles and some boulders. Most of the deposits are either post-glacial river terraces or proglacial lacustrine basins. The lake basin segments are table-top flat with finer grained silt and fine sand prevalent. The terrace-like features are poorly sorted (dirty) gravels. The active layer is expected to be thin in the lake sediments (less than 0.5 m) whereas the higher, well-drained terraces probably support an active layer of 1.5 m or more.

Ground ice occurs throughout the region in the upper permafrost soils as predominantly:

- Wedge ice (vertical crevasses of ice)
- Segregated ice (horizontal lenses); or
- Massive ice (tabular bodies).

The wedge ice is the most striking feature in the region of naturally well-drained granular uplands. These show up in aerial photos as polygonal patterned ground comprising a series of orthogonal cracks that are the surface expression of ice wedges that occur to depths up to 3 m or more into the permafrost. Wedge ice that is exposed at the surface within the borrow pits after the ice-poor active layer soils were removed begins to thaw from the top down, resulting in a linear depression. The thaw-depression will typically trap water that sometimes becomes mobile, running along the top of the ice. These features often extend under the road embankment. The thaw initiating within the adjacent pit can feed water into the ice wedge under the side slope of the road embankment resulting in thermal erosion that frequently leaves a transverse void below the side slope. When this happens in a road that is in service, the expanding void can precipitate a failure of the slope of the embankment and occasionally a failure under the travelling surface as well. This is a safety concern for operations over the road in these types of areas. This mechanism of wedge ice thaw, feeding water into cavities that extend under the road is the cause of many significant settlements on side slopes, shoulders, and under the travelling surface of the road observed during the inspection.

Segregated ice occurs as thin lenses in all the finer grained silty soils. It is most prominent in soils of glaciolacustrine origin. The ground ice distribution is erratic, but it is commonly found with greater concentrations in naturally wet

basins. When these soils are exposed within the pit bottom, the consequences are sinkhole depressions that soon become water-filled, interrupting any natural surface drainage.

Examination of the thaw settlements throughout the route in 2014, 2019, and 2023 indicate that in addition to ice wedge melt out, there is ongoing settlement resulting from thaw of massive ice bodies in many of the other borrow sources as well.

4.2 Borrow Summary and Grouping

The 2009 work was carried out to guide possible progressive remediation activities for the numerous borrow pits. Some remediation activities have been conducted over the years from the first inspection to date. Ongoing road upgrades include minor changes to the alignment, minimizing grades, and increasing embankment widths to improve safety and compliance with applicable Mine Safety Regulations. Cut and fill construction methodologies have been used to source and obtain materials adjacent to the road alignment to support this work. In most locations, the current condition of some of the pits can be directly compared to the conditions observed in 2009, 2014, and 2019. A summary of the 2009, 2014, and 2019 conditions noted at each of the sites examined is included in Table 1 as are the observations from the 2023 inspection.

The sites have been grouped into five broad categories that reflect the remediation criteria and stability of the road embankment as follows:

- Priority A++++ pits (6.4%): These are areas where there is the potential for failure of the road embankment posing risk to vehicle and operator safety. This was included in the ranking system after the 2014 and 2019 inspections mainly because of the increased level of road utilization. Areas with this type of potential failure were a particular focus of the 2023 evaluation where thaw settlement, melting permafrost, and water pooling initiated by pit excavation is actively affecting the road integrity, and there is a higher risk of failure.
- Priority A+ pits (4.5%): These are areas where thaw settlement initiated by pit excavation is actively affecting the road integrity, and there is a risk of failure.
- Priority A pits (5.5%): These are areas where active ground ice thaw and/or deep-water pooling is affecting both the borrow source and the adjacent road. These constitute a potential safety hazard for continued use of the road, but with lower risk if failure occurs.
- Priority B pits (21.8%): These are areas where active thaw settlement and water accumulation is ongoing in unstable terrain within an abandoned pit, and those where active thaw and sinkhole formation is ongoing. These are not currently affecting the road but are trapping surface runoff which exacerbates thaw; and leads to settlement, with no currently identified risk to the road integrity and operator safety.
- Priority C pits (61.8%): These are pits where the terrain has been judged to be relatively stable. They will require some site grading and surface dressing to improve site aesthetics and ensure long-term stability, but the timing is not as significant.

Table 4-1 summarizes the number of sites and percentage for each priority category from the different site inspections. Compared to the 2019 evaluation, the percentage of Priority A+ and A++++ sites have decreased from 12% to 11% in the 2023 evaluation. The sites that require remediation are summarized in Table 1 in the Appendix. The priority has been downgraded in a few locations because the pits seem to have self-stabilized, or have been regraded, filled, or realignment has moved the road away from some areas previously identified as being a safety concern. The sites that need no further remediations are listed in Table 2 in the Appendix.

Table 4-1: Number of Sites and Percentage for Each Priority Category

Category	2009 Inspection		2014 Inspection		2019 Inspection		2023 Inspection	
	Number	%	Number	%	Number	%	Number	%
A++++	0	0.0	0	0.0	10	10.0	7	6.4
A+	0	0.0	7	6.9	2	2.0	5	4.5
A	8	9.9	11	10.9	5	5.0	6	5.5
B	25	30.9	26	25.7	25	25.0	24	21.8
C	48	59.2	57	56.5	58	58.0	68	61.8
Total	81	100.0	101	100.0	100	100	110 Note 1	100.0

Note 1: New areas were identified during the 2023 inspection (i.e., 12A, 12B, 16.1, 21A, 35A, 61A, 79.1, 79A and 82B)

A detailed photographic record from the 2023 Tote Road reconnaissance was prepared and is provided with this report. The photo locations are shown by photo number on the route maps in the figures section.

5.0 BORROW PITS REMEDIATION METHODS

Table 1 includes brief descriptions of the conditions of each site at the time of the inspection, followed by recommendations for the monitoring and potential remediation actions for the 2009, 2014, 2019, and 2023 inspections.

Ongoing upgrades (realignment and widening) to the road have resulted in improved stability and consequently a reduction in the number of locations previously identified as having stability concerns. Recommendations provided in 2019 are still valid for most of the locations. As noted in the 2009, 2014, and 2019 reports, the remediation process should be structured around the basic principles of:

- Restoring stability to actively thawing ground ice by replacing some of the cover material removed during excavation;
- Developing drainage that will limit standing water that can exacerbate thaw within the pit;
- Caring for natural runoff from the pits in a manner that will reduce the risk of erosion and sedimentation over undisturbed tundra; and
- Improving site topography to encourage natural revegetation and enhance site aesthetics.

The sites identified as Priority C are the least sensitive and could generally be remediated by site grading and dressing of the slopes. The Priority A and B sites are judged as not currently stable and therefore will require attention and monitoring directed to the ongoing thaw of permafrost and surface water management. The following discussion provides guidance for planning remediation that will address these objectives. The Priority A++++ sites require frequent monitoring and timely remediation actions because of the higher potential for the road surface to fail given the significant amount of haul traffic that is now using the road. Attention should be focused on Priority A+ sites after the Priority A++++ sites have been restored to an extend that the potential for road failure is eliminated.

5.1 Restoring Surface Stability

The Priority A++++, A+, and A pits are experiencing ground ice melt out that is affecting the adjacent road embankment. Experience from other locations has shown that the consequences can be a serious safety hazard.

It is recommended that the road embankment be frequently monitored, and timely remediation and stabilization actions be undertaken on severity and priority basis. The upgrading will require strategic placement of granular cover over the thawing soil with the ultimate purpose of drawing the permafrost back up into the fill. The steps for remediation should include the following:

- Construction of side berms a minimum of 3 m wide on the road shoulders where active cracking and settlement is observed. The berms should be a minimum of 1.5 m thick and to an elevation above where there is a possibility of being overtopped by ponded water in the future. It is also preferable for them to be at an elevation of 1 m to 1.5 m below the final top of road fill at the location.
- Add material to raise the embankment height, where the pooled water level is close to the roadway surface, or there is a possibility of the roadway surface being encroached by ponded water in the future. The height increase should be to achieve a minimum embankment height of 1 m above the water level.
- Improve drainage such that water does not pond at the toe of the embankment. In some cases, this may require filling sinkholes and ice wedge melt out features with imported gravel, placing new culverts, replacing/relocating the existing culverts, and/or fixing the grade to properly divert the water.

An alternative to berm construction for sites where the thaw has not yet progressed under the road embankment but is affecting the side slopes is to widen the grade and flatten the side slopes. The current road shoulder should be widened 0.5 m to 1 m and the slope flattened to 3H:1V. Table 1 provides guidance on those sites where slope flattening is an option. Where slope flattening is applied, consideration should be given to the extent that water can continue to pond at the toe of the slope. One of the primary benefits to be gained from slope flattening is to push any ponded water further from the embankment slope.

Some Priority A sites have developed substantial sinkholes within their pit bottoms. Where these have been observed, regrading the surface to fill the sinkholes has been recommended. In some cases, this may require importing fill from another nearby site that is still active and can confidently produce material without exposing new wedge ice.

Further discussion of road instability locations that present a significant safety hazard (A++++) are presented in the following sections.

5.2 Drainage Improvements and Erosion Protection

Ponded water within the borrow pits retards winter freeze-back of the active layer and will result in retrogressive thickening of the active layer. Once this process starts, it is difficult to reverse. Shallow ponding (less than 0.5 m deep) that is short-lived following freshet is not a concern. Those ponds that are retained throughout the summer and continue to deepen with time will be counter-productive to the remediation efforts.

Table 1 identifies several options for improving site drainage at specific pits. In most cases, there is an obvious routing for trapped surface water from the pit to a nearby stream or onto the tundra. Some pits are identified in the table where additional field work will be required to determine the drainage improvement options for those sites. This will probably involve site surveys to establish the natural topographic grades or if there are options that involve minor ditching.

Substantial ditch excavation into undisturbed active layer soils should be avoided wherever practical. Where new ditching is the only practical option, care should be taken to determine the nature of soils and ground ice that will remain exposed following excavation.

In cases where surface water will be directed to undisturbed tundra, it must be dissipated rather than channelled to avoid local erosion. Dissipation can be achieved by strategic use of cobbles and boulders to dissipate energy just before the water exits the pit area.

5.3 Surface Grading

All the pits will require surface grading that will range from filling sinkholes in the Priority A and B pits to simply dressing the current surface in most Priority C pits. Obvious ridges that can impede surface drainage should be removed and final surface contour developed to ensure drainage. The surface should not be left completely smooth. It is common practice at the end of surface grading to track the surface with tractor grouser bar ruts. These will trap fines and dissipate energy from runoff. The shallow grooves left in this manner will also improve the possibility for long-term natural revegetation by providing seed traps.

The backslopes in most pits are remarkably stable. Those steep slopes greater than 2 m in height should be graded to a final slope of 3H:1V. It is preferable to flatten the slopes by mounding new fill at the toe rather than cutting further into undisturbed tundra. The steeper pit slopes observed were generally of a height less than 2 m and were not visibly active. These shallow cut slopes that are currently stable are better left to seek their own long-term condition rather than risk further disturbance to the underlying permafrost.

6.0 TOTE ROAD SAFETY HAZARDS

As noted in Section 5, some of the borrow pits are adversely affecting the stability of the road due to thaw of ice-rich materials at the edge of the road or toe of the road embankment, or due to inadequate or dysfunctional water management. In many cases the road surface is unstable; deterioration of the embankment corps and/or settlements are extending under the road, indicating thaw of ice-rich soils. In other locations, thaw in the adjacent borrow pit has led to the formation of deep holes immediately at the edge of the embankment filled by pooled water of up to 5 m or 6 m deep. Cracking and slumping of the side slopes are occurring in many of these locations.

The areas where more significant safety hazards are felt to exist on the Tote Road are identified in Table 1 as Priority A++++. Specific locations are discussed below:

1. km 3.5R (Point 85): See Photos 55 and 56. A failure was observed along the right edge of the road, and this failure led to significant damages to the traffic safety berm and the Tote Road surface (portion of the safety berm fell in the dip and significant cracks were noticed on the roadway surface). The failure was classified as a slope failure and may have resulted from poor/dysfunctional water management and triggered by excessive erosion of the soils at the slope's toe. The slope failure appeared to be circular in shape. Conditions may deteriorate rapidly due to the heavy traffic loading on the Tote Road and any additional surface water flow from future precipitation events. Tetra Tech recommended that the dip be filled and the slope stabilized immediately to prevent further deterioration through an email sent to Kofi Sakyi, Dale Tulloch, and Baruck Wile on September 11, 2023. Baffinland reported via email to Tetra Tech on February 4, 2024 that remediation action for the area was taken by Baffinland following Tetra Tech's visit. Photos of the completed work were provided in the email and indicated that the failure appears to have been addressed and the safety and water management issues resolved. This area will be reevaluated by Tetra Tech during the next site inspection to determine if additional work is required.

2. km 12.8 (Point 79): See Photo 49. Water pooling in several large pits. The pooled water may have resulted from poor water management and/or the continuous thawing of the exposed ice-rich ground. The water level was observed to be close to the roadway surface (in many places) and might affect the embankment stability

and undermine the roadway structure. To guard against road failure, the water must be drained from these pits, imported fill material must be placed to fill these areas, and the surface must be graded and dressed properly to improve the drainage and divert the surface water. If the filling of the entire areas is impractical, a minimum of 2.0 m or so berm should be placed along the embankment slopes to provide additional stability and to push ponded water away from the slope.

3. km 20.7 (Point 71): See Photo 44. Continued thaw of wedge ice is increasing settlement depth and there continues to be evidence that the ice wedge ground that the road is constructed on is thawing. Remediation actions should be taken to stabilize the embankment side slopes and lessen the potential for thaw of the wedges below the embankment.

4. km 21.9 (Point 68, QIA-10): See Photo 41. Thaw of ice-rich ground leading to deep ponding, an over-steepened side slope, and embankment instability. Remediation actions should be taken to enhance stability and retard further thaw.

5. km 29.1 (Point 61B, QIA-09): See Photo 34. Thaw continues in this pit leading to steep side slopes and instability. The central portion of the pit had been backfilled (prior to 2019 inspection) and this has significantly improved stability. The north and south ends of the pit should be similarly remediated to improve stability and retard further thaw along the pit.

6. km 56.7L and 56.9R (Points 32 and 33): See Photo 13. The new road alignment runs through an old pit which had experienced extensive melt out of ice-rich permafrost. The old embankment is now failing quite significantly. Water is ponding on both sides of the new road bringing concern of instability as further thaw is expected. Drainage from the pond on the west of the embankment flows through the new embankment through a culvert into the area between the new and the old road and towards the lake from there. With no maintenance on the old road, there is concern for the continued performance of the culvert on the old road. If it was to fail or become blocked, water levels beside the new road would rise significantly, perhaps leading to more thaw along the new road. Breaching of the old road would remove reliance on the old culvert and help mitigate water management risk. In the short-term, it is recommended that wider safety berms be provided along the length of the new section of road prior to remediation of this area.

7. km 89.8 (Point 14): See Photo 7. This is a very deep pond resulting from thaw of a massive ice body initiated because the protective active layer material was removed. Thaw is continuing and appears to be occurring under the side slopes of the road which appear very steep. Timely remediation actions are required to slow or arrest the thaw and provide additional stability to the road embankment.

With the high traffic volumes and heavy loaded vehicles on the Tote Road, it is strongly recommended that adequate monitoring and timely remediation actions be undertaken to reduce and potentially eliminate safety hazards in the areas observed to be of significant instability.

7.0 CONCLUSION

The focus of this project has been to compare the general stability observations and evaluations made during the 2019 inspection of the state of the borrow pits used for the construction of the Tote Road with the conditions observed during the September 10, 2023, inspection. The 2009 evaluation identified general guidelines for developing a practical and acceptable plan for the remediation of the borrow pits. The 2009, 2014, 2019, and 2023 site observations have established that there are clear links between some borrow pit locations adjacent to the road and the thaw settlement observed on the road embankment which increases stability risks at these locations.

Roadside borrow pits were utilized during the initial construction of the Tote Road, but Baffinland apparently no longer extracts material from roadside borrow pits. This would eliminate the potential for thaw induced settlements impacting the stability of the road surface. Also, visual examination of permafrost terrain features evident on the surface of a borrow prospect can identify in advance those deposits that may be potentially prone to thaw settlements and instability if disturbed.

The photo library and documentation in this report and the 2009, 2014, and 2019 reports have provided a basis for monitoring changes and adapting the remediation process in a stepwise manner as outlined in the Multi-Year Remediation Plan and Schedule (Tetra Tech 2024).

8.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully Submitted,
Tetra Tech Canada Inc.

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Reviewed by:
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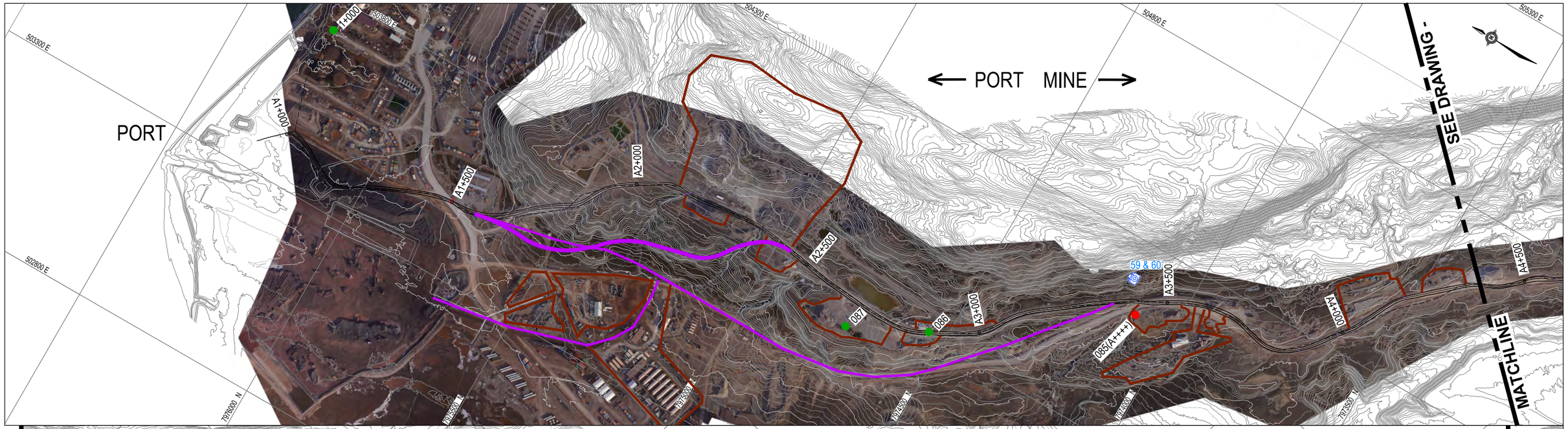
FIGURES



LEGEND:

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NIRB - NUNAVUT IMPACT REVIEW BOARD CONCERNS

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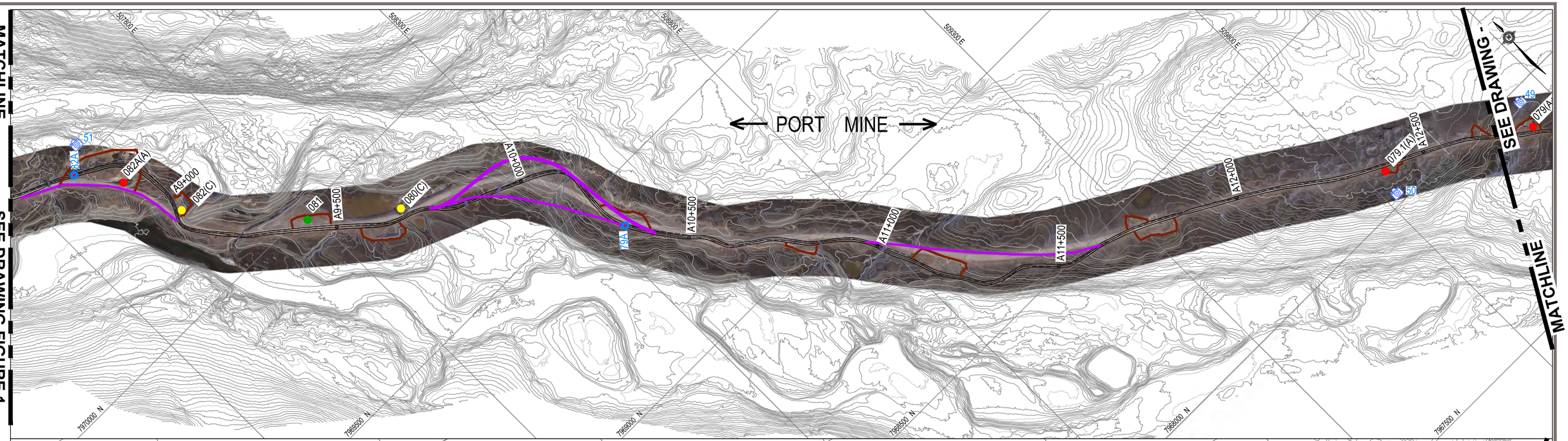
Figure 1



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PROJECT NO.	DWN	CKD	REV
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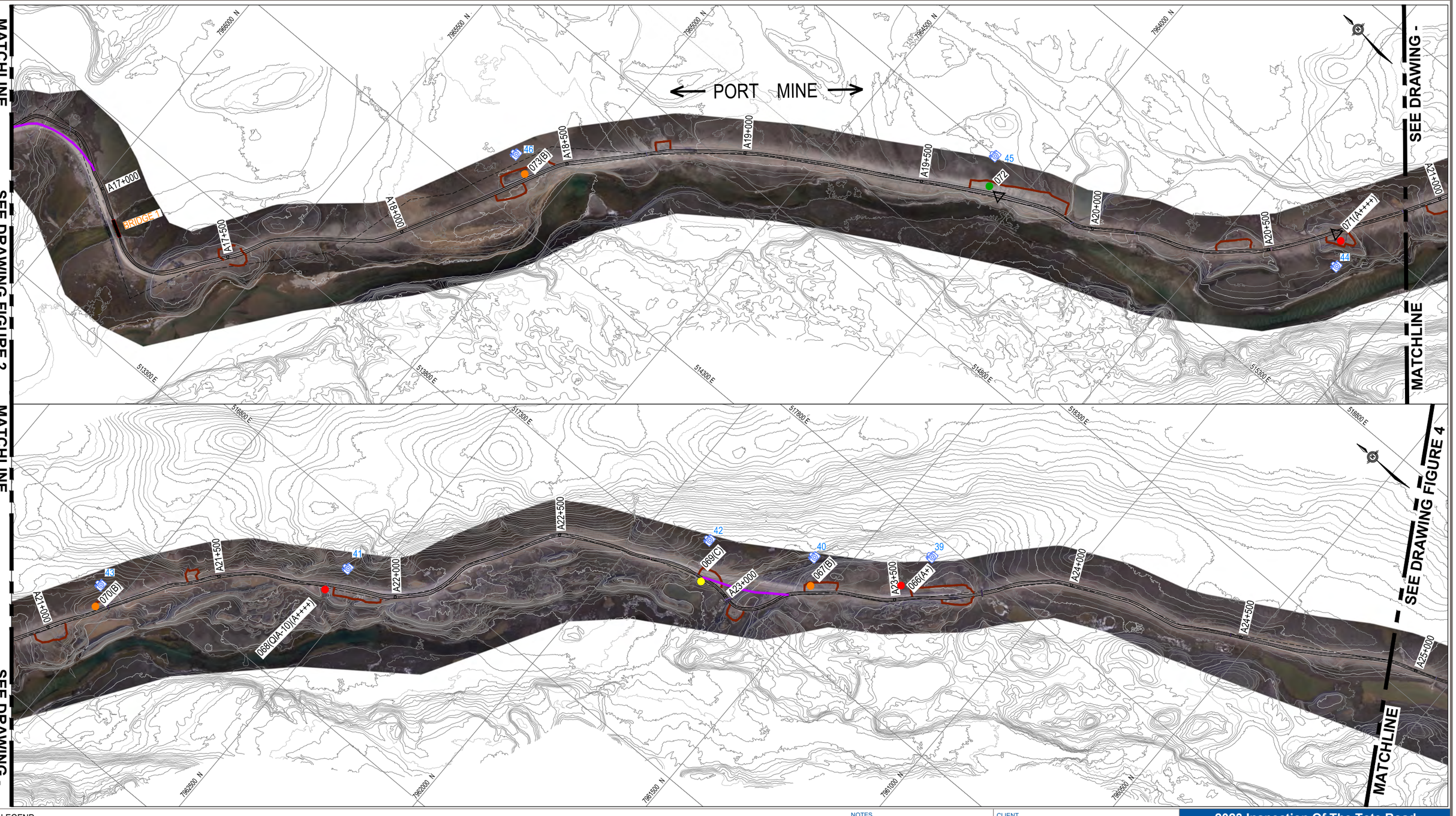
Figure 2

C:\Users\DEVON.SOSNIUK\Documents\Mary River\Mary River Tote Road\12\704-ENG.EARC03209-12-Figures-IFR.dwg [FIGURE 2] July 17, 2024 - 9:58:44 am (BY: SOSNIUK, DEVON)



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AREA OF CONCERN LOCATIONS SHEET 3 OF 13

PROJECT NO.	DWN	CKD	REV
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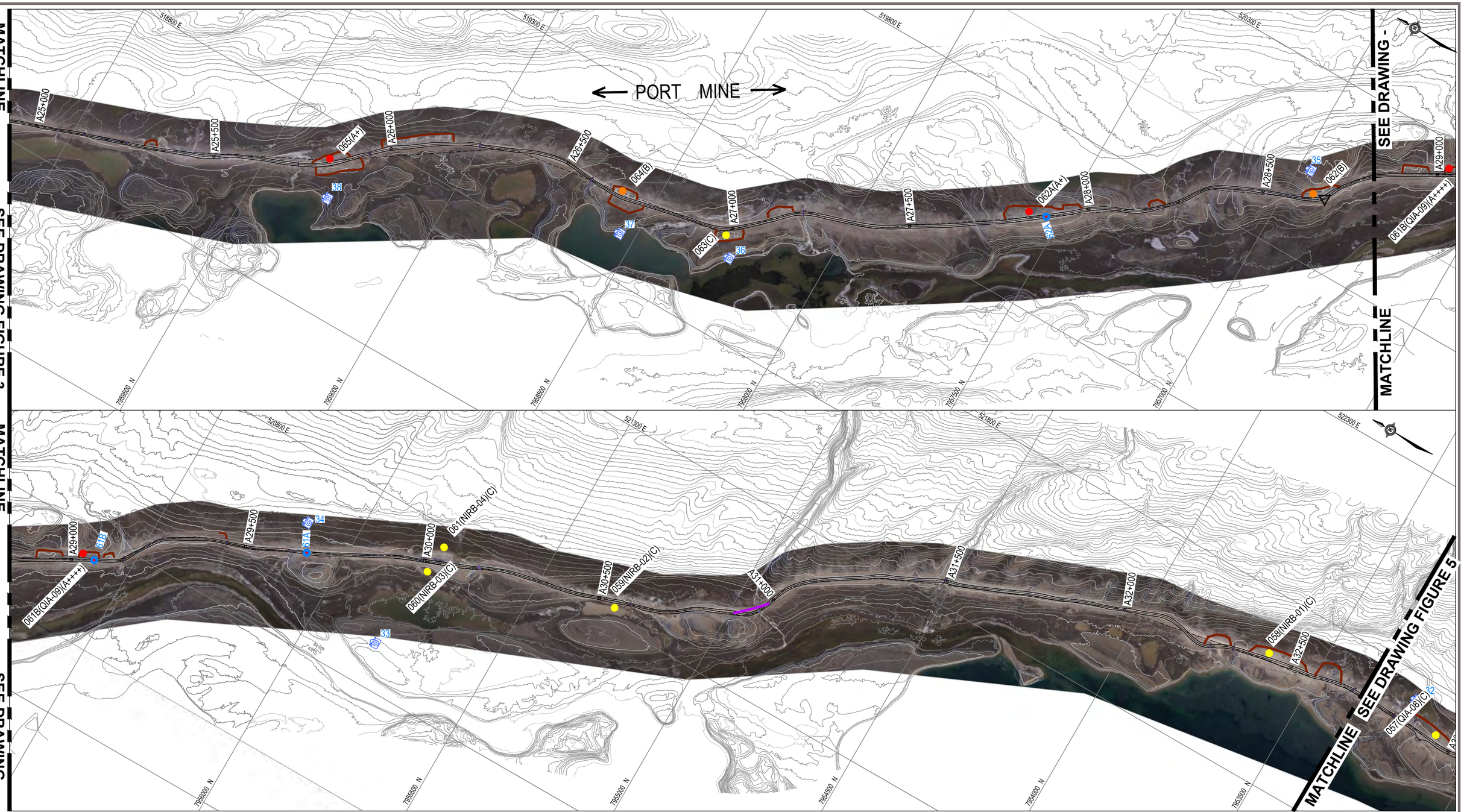
Figure 3



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AREA OF CONCERN LOCATIONS SHEET 4 OF 13

PROJECT NO.	DWN	CKD	REV
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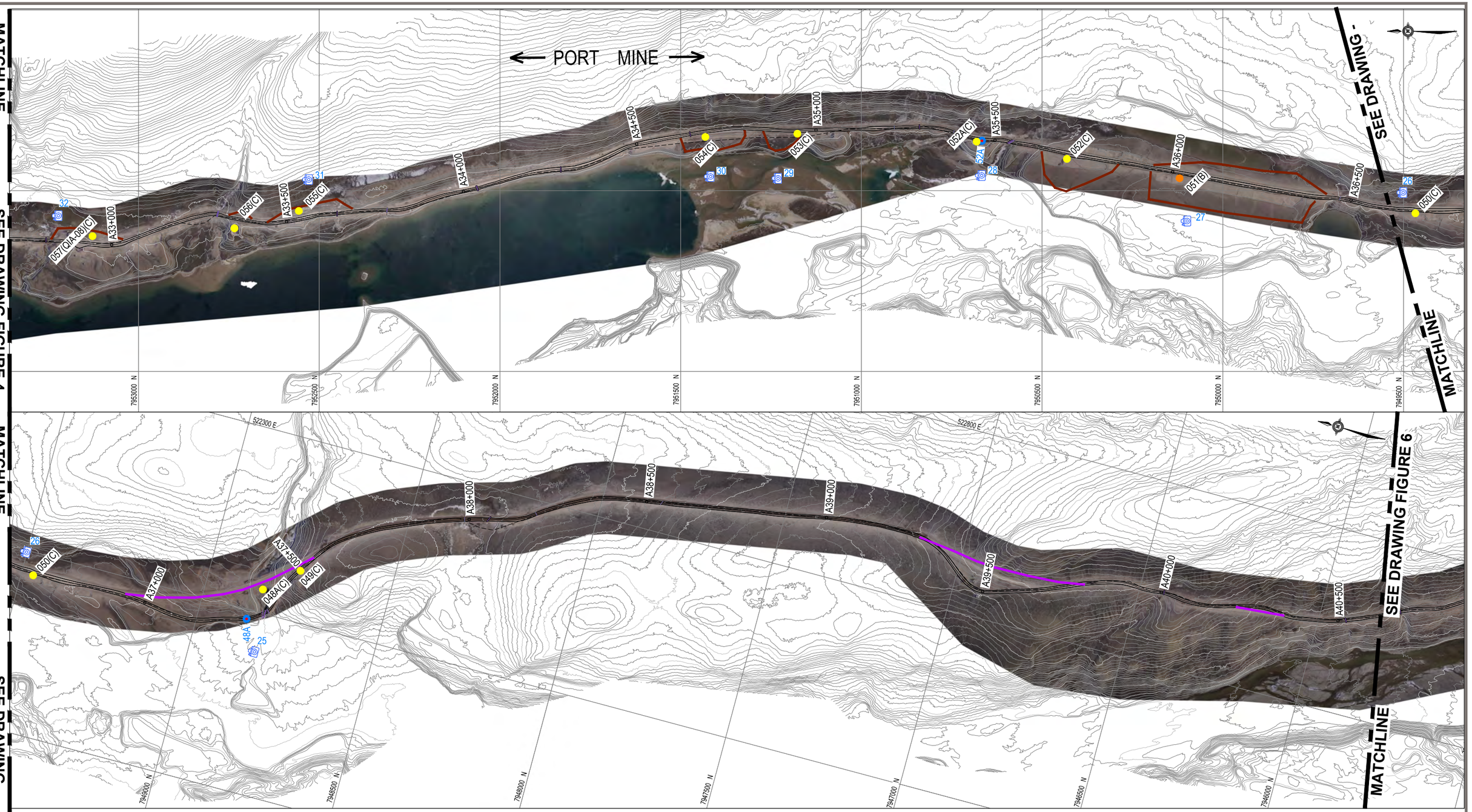
Figure 4



C:\Users\DEVON.SOSNIUK\Documents\Mary River\Mary River Tote Road\127704-ENG.EARC03209-12-Figures-IFR.dwg [FIGURE 5] July 17, 2024 - 10:12:53 am (BY: SOSNIUK, DEVON)

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AREA OF CONCERN LOCATIONS SHEET 5 OF 13

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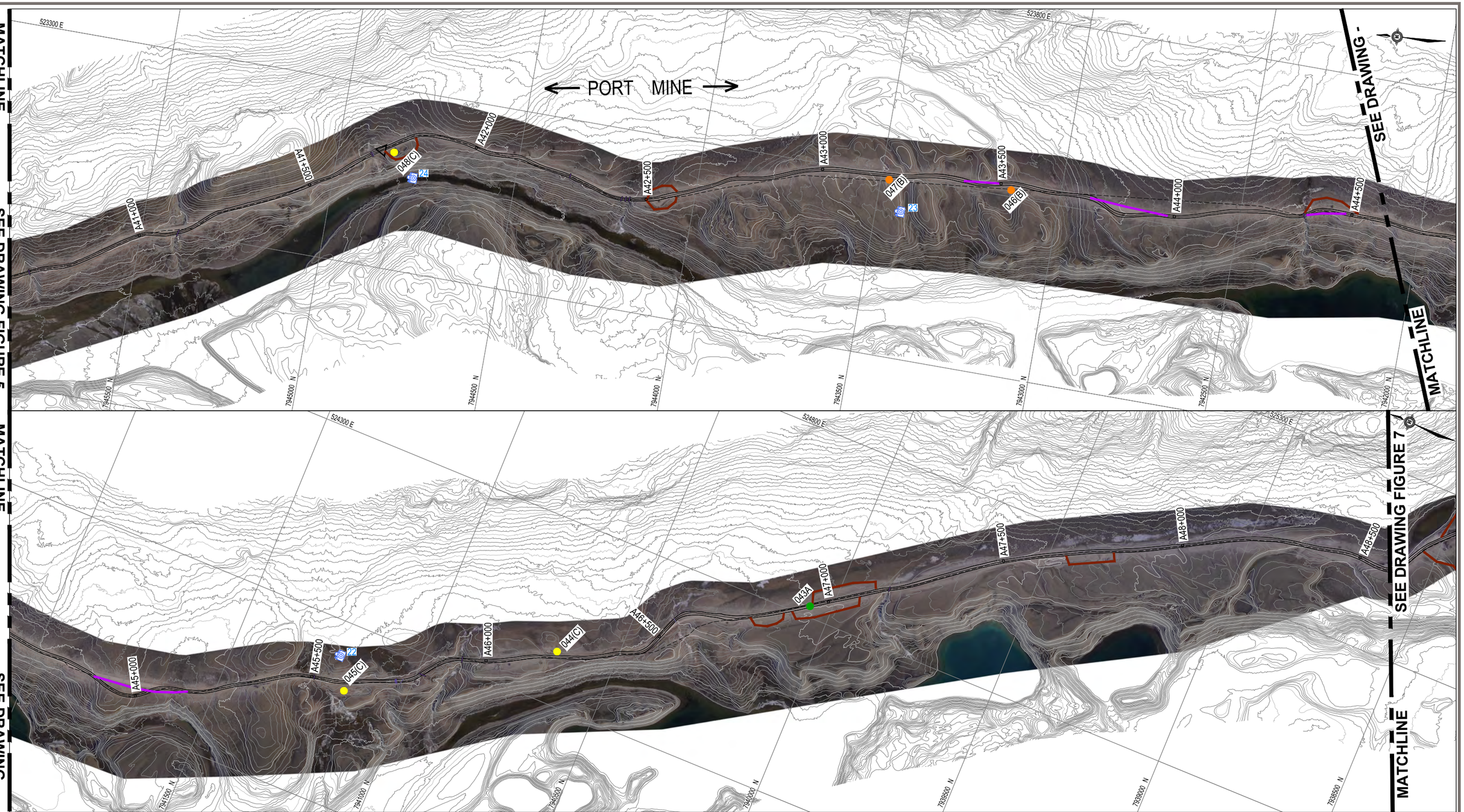
Figure 5



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PROJECT NO.	DWN	CKD	REV
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DATE: June 2024

Figure 6

MATCHLINE SEE DRAWING FIGURE 6 MATCHLINE

SEE DRAWING - MATCHLINE SEE DRAWING FIGURE 8

PORT MINE

525800 E
526300 E
526800 E
527300 E
527800 E

7938000 N
7937500 N
7937000 N
7936500 N
7936000 N
7935500 N
7935000 N
7934500 N
7934000 N
7933500 N
7933000 N
7932500 N
7932000 N
7931500 N

A49+500
A50+000
A50+500
51+000
A51+000
A51+500
A52+000
A52+500
A53+000
A53+500
A54+000
A54+500
A55+000
A55+500
A56+000
A56+500
A57+000

QIA-07(A+)
A0 - YKC
043(QIA-06)(C)
042(QIA-06)(C)
041(A)
040
039(C)
038(C)
037(QIA-05)(C)
036A
036A(B)
036(B)
035A(B)
035(B)
034(C)
033(A++++)
032(A++++)

16
15
14
13
21
20
19
18
17

C:\Users\DEVON.SOSNIUK\Documents\Mary River\Mary River Tote Road\12704-ENG.EARC03209-12-Figures-IFR.dwg [FIGURE 7], July 17, 2024 - 10:15:33 am [BY: SOSNIUK, DEVON]

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AREA OF CONCERN LOCATIONS SHEET 7 OF 13

PROJECT NO.	DWN	CKD	REV
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Figure 7

MATCHLINE

SEE DRAWING FIGURE 7

527800 E
528300 E
528800 E

PORT MINE

A57+500
A58+000
A58+500
A59+000
A59+500
A60+000
A60+500
A61+000

7931000 N
7930500 N
7930000 N
7929500 N
7929000 N
7928500 N
7928000 N
7927500 N

SEE DRAWING - MATCHLINE

SEE DRAWING FIGURE 9

529300 E
529800 E
530300 E
530800 E
531300 E

A61+000
A61+500
A62+000
BRIDGE 2
A62+500
A63+000
A63+500
A64+000
A64+500
A65+000

031
030(C)
030A(C)
029(B)
028(C)
027(C)
026(C)

11
12

7927000 N
7926500 N
7926000 N
7925500 N
7925000 N
7924500 N

SEE DRAWING - MATCHLINE

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AREA OF CONCERN LOCATIONS SHEET 8 OF 13

PROJECT NO.	DWN	CKD	REV
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Figure 8

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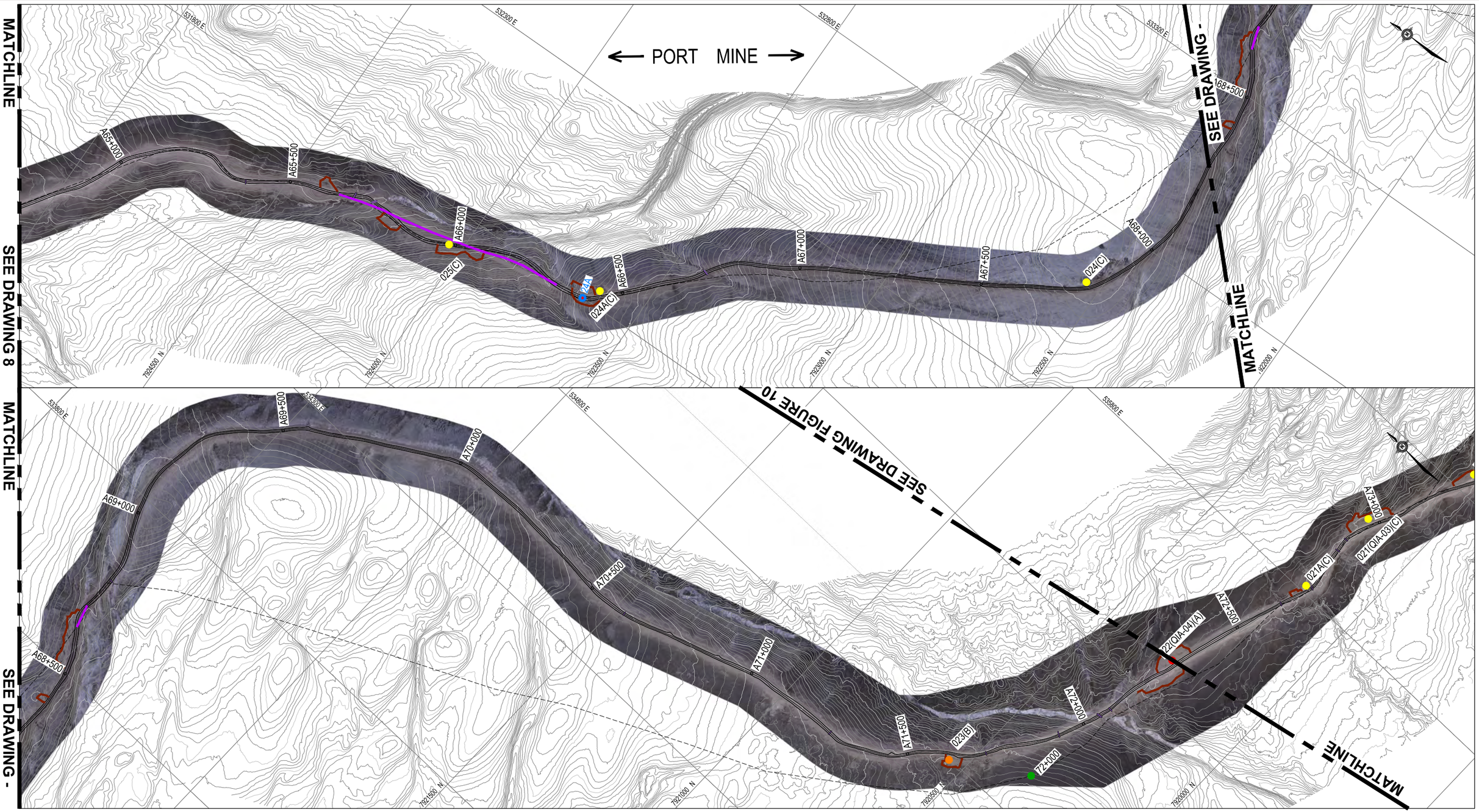

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AREA OF CONCERN LOCATIONS SHEET 9 OF 13

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EDM	June 2024

Figure 9

C:\Users\DEVON.SOSNIUK\Documents\Mary River\Mary River Tote Road\12\704-ENG.EARC03209-12-Figures-IFR.dwg [FIGURE 9] July 17, 2024 - 10:24:04 am (BY: SOSNIUK, DEVON)

MATCHLINE

SEE DRAWING 9

MATCHLINE

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SEE DRAWING FIGURE 11

MATCHLINE

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LEGEND:

- REMEDIATION LOCATIONS FOR SITES A++++, A+ AND A
- REMEDIATION LOCATIONS FOR SITES B
- REMEDIATION LOCATIONS FOR SITES C
- PREVIOUSLY REMEDIATED SITE (NO ACTION REQUIRED)
- QUARRY LOCATIONS
- APPROXIMATE EXTENT OF BORROW AND LAYDOWN LOCATIONS
- APPROXIMATE ROAD REALIGNMENT
- HISTORIC ORIGINAL ALIGNMENTS NOT USED

1 - 2023 GROUND PHOTOGRAPH LOCATION WITH REPORT PHOTO NUMBER(S)

QIA - QIKIQTANI INUIT ASSOCIATION CONCERNS

NIRB - NUNAVUT IMPACT REVIEW BOARD CONCERNS

NOTES

BASED ON DRAWING DATA PROVIDED BY BAFFINLAND IRON MINES CORPORATION

BASE DATA: 1:10 000

ISSUED FOR REVIEW

0 500m

Scale: 1:10,000 @ 11"x17"

CLIENT

Baffinland Iron Mines Corporation

TETRA TECH

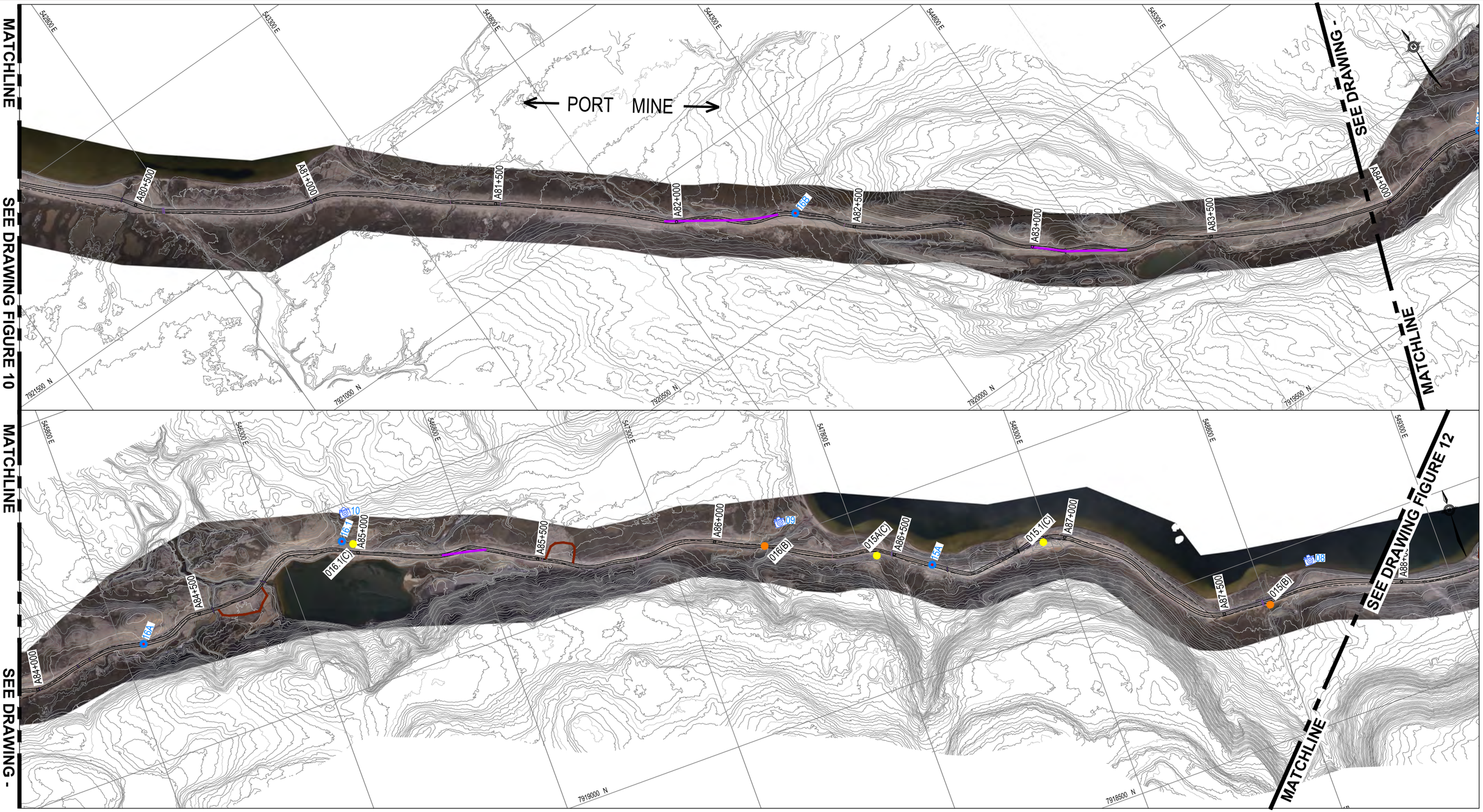
2023 Inspection Of The Tote Road Mary River, Baffin Island

AREA OF CONCERN LOCATIONS SHEET 10 OF 13

PROJECT NO.	DWN	CKD	REV
ENG.EARC03209-12	RC	MH	0

OFFICE	DATE
EDM	June 2024

Figure 10



LEGEND:

- REMEDIATION LOCATIONS FOR SITES A++++, A+ AND A
- REMEDIATION LOCATIONS FOR SITES B
- REMEDIATION LOCATIONS FOR SITES C
- PREVIOUSLY REMEDIATED SITE (NO ACTION REQUIRED)
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- APPROXIMATE ROAD REALIGNMENT
- HISTORIC ORIGINAL ALIGNMENTS NOT USED

1 - 2023 GROUND PHOTOGRAPH LOCATION WITH REPORT PHOTO NUMBER(S)
QIA - QIKIQITANI INUIT ASSOCIATION CONCERNS
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TETRA TECH

2023 Inspection Of The Tote Road Mary River, Baffin Island

AREA OF CONCERN LOCATIONS SHEET 11 OF 13

PROJECT NO.	DWN	CKD	REV
ENG.EARC03209-12	RC	MH	0
OFFICE: EDM	DATE: June 2024		

Figure 11

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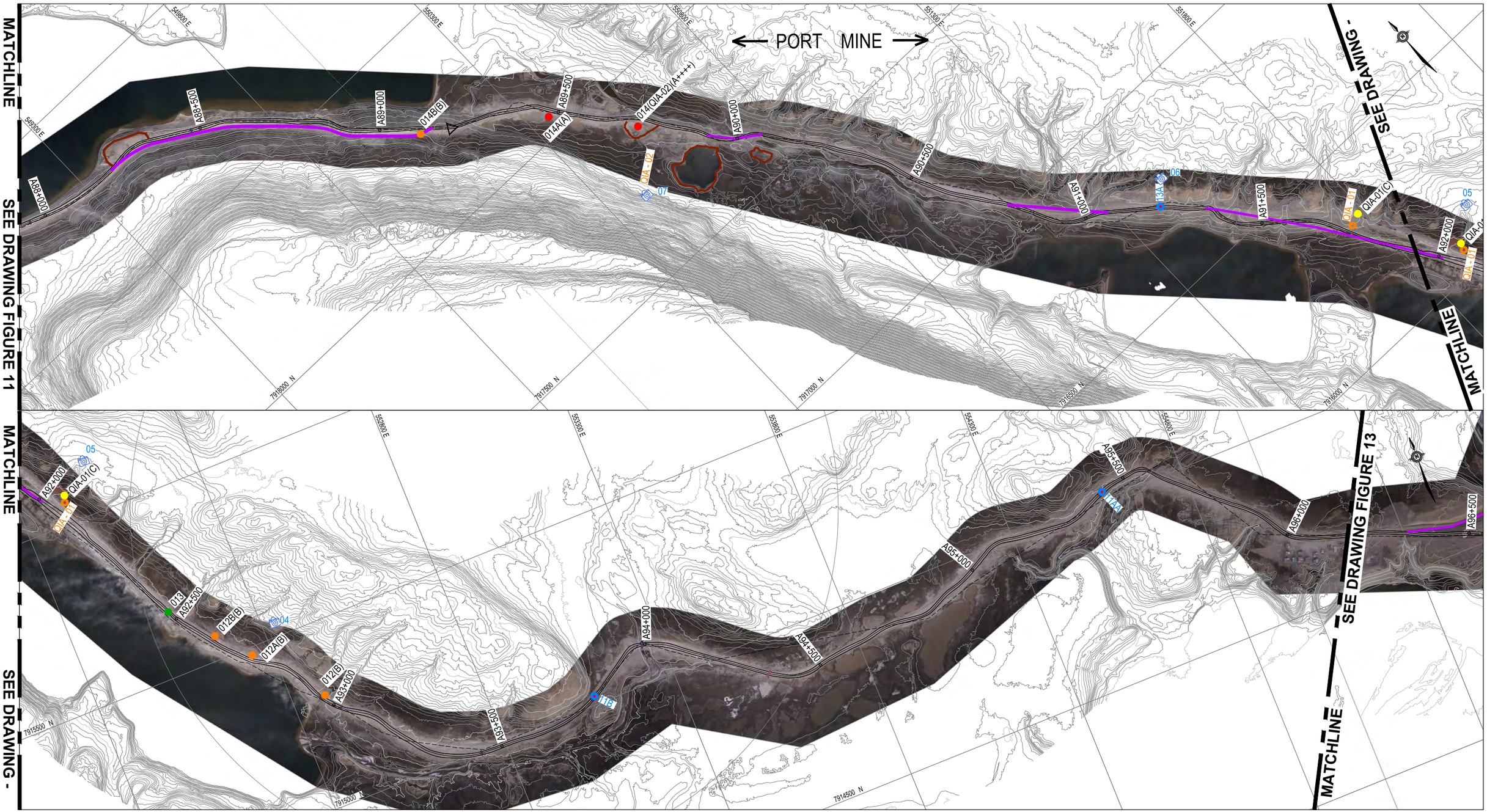

LEGEND:

- REMEDIATION LOCATIONS FOR SITES A++++, A+ AND A
- REMEDIATION LOCATIONS FOR SITES B
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- PREVIOUSLY REMEDIATED SITE (NO ACTION REQUIRED)
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- HISTORIC ORIGINAL ALIGNMENTS NOT USED

1 - 2023 GROUND PHOTOGRAPH LOCATION WITH REPORT PHOTO NUMBER(S)
QIA - QIKIQTANI INUIT ASSOCIATION CONCERNS
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NOTES
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BASE DATA: 1:10 000

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TETRA TECH

2023 Inspection Of The Tote Road Mary River, Baffin Island

AREA OF CONCERN LOCATIONS SHEET 12 OF 13

PROJECT NO.	DWN	CKD	REV
ENG.EARC03209-12	RC	MH	0

OFFICE: EDM

DATE: June 2024

Figure 12

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MATCHLINE

SEE DRAWING FIGURE 12 MATCHLINE

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LEGEND:

- REMEDIATION LOCATIONS FOR SITES A++++, A+ AND A
- REMEDIATION LOCATIONS FOR SITES B
- REMEDIATION LOCATIONS FOR SITES C
- PREVIOUSLY REMEDIATED SITE (NO ACTION REQUIRED)
- QUARRY LOCATIONS
- APPROXIMATE EXTENT OF BORROW AND LAYDOWN LOCATIONS
- APPROXIMATE ROAD REALIGNMENT
- HISTORIC ORIGINAL ALIGNMENTS NOT USED

1 - 2023 GROUND PHOTOGRAPH LOCATION WITH REPORT PHOTO NUMBER(S)

QIA - QIKIQTANI INUIT ASSOCIATION CONCERNS

NIRB - NUNAVUT IMPACT REVIEW BOARD CONCERNS

NOTES

BASED ON DRAWING DATA PROVIDED BY BAFFINLAND IRON MINES CORPORATION

BASE DATA: 1:10 000

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0 500m

Scale: 1:10,000 @ 11"x17"

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TETRA TECH

2023 Inspection Of The Tote Road Mary River, Baffin Island

AREA OF CONCERN LOCATIONS SHEET 13 OF 13

PROJECT NO.	DWN	CKD	REV
ENG.EARC03209-12	RC	MH	0

OFFICE	DATE
EDM	June 2024

Figure 13

C:\Users\DEVON.SOSNIUK\Documents\Mary River\Mary River Tote Road\127704-ENG.EARC03209-12-Figures-IFR.dwg [FIGURE 13] July 17, 2024 - 10:34:27 am (by: SOSNIUK, DEVON)

TABLES

TABLE 1: SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS FOR SITES NEEDING FURTHER REMEDIATIONS

		2009 Inspection (DWH)								2014 Inspection (KWJ)		2019 Inspection (KWJ)		2023 Inspection (MH)		
Site WP No. 2009	**Km Post**	**General Location**	**Pit Water 2009**	**Erosion Potential**	**Ground Ice Features**	**Active Layer Stability**	**Reclamation Focus**	**Priority**	**2009 Comments**	**Priority**	**2014 Comments**	**Priority**	**2019 Comments**	**Priority**	**Ground Photos**	**2023 Comments**
9	97.9	Off ROW permitted	Minor ponding	-	Extensive Wedge Ice	Fair	Regrading Surface and Slope	**B**	This pit within permit area should be reclaimed. Pad and flatten south slope of road to limit further thaw of wedges and erosion. Improve drainage without further impact on natural tundra wedge ice lying to the south of disturbed area.	**B**	Some regrading has been carried out which has improved drainage and pit remains stable.	**B**	No Change	**B**	Photo 01	Ponded water and further permafrost degradation.
10	97.5	Off ROW permitted	Major ponding	Low	Massive ice	Unstable, extensive thaw occurring	Pump out ponds, berm road side slope on south side such that no water can pond at toe. Regrade pit bottom.	**B**	Pit is still within quarry permit area but should be reclaimed soon. Extensive thaw settlement is occurring. Future materials should be taken from source 11.	**B**	Thaw settlement is continuing and pit should be reclaimed as noted in 2009.	**B**	Thaw settlement is continuing and pit should be reclaimed as noted in 2009 and 2014.	**B**	Photo 02	Thaw settlement is continuing and excessive water ponding. Pit should be reclaimed as noted in 2009, 2014, and 2019 Reports. Drainage should be improved (clogged culverts).
11	97.3	Off ROW permitted	Major ponding	Low	Wedge ice	Moderately stable	Improve natural drainage and develop a plan for an ongoing pit at this location.	**C**	This is currently the best source of gravel in the vicinity of Mary River Camp. It is permitted for development off the ROW, and the material is relatively well-graded alluvial gravel. This pit has ongoing value for the development. A pit development plan should be prepared that will allow efficient stockpiling of the material in a manner that deals with surface water and thaw generated water. The plan should include site reclamation.	**B**	Separate memo issued by Tetra Tech to comment on the Hatch 2013 reclamation plan for this pit. In general there has been a considerable amount of thaw and associated settlement since 2009. Plan calls for regrading, filling low areas, and making provision for draining collected pit water.	**B**	The north end of the borrow pit was being backfilled and graded while on site. The regrading activities are being carried out appropriately. The majority of the pit is unchanged since the 2014 inspection. The outflow location into the lake to the south indicate that there has been no outflow in this direction since the 2014 inspection. Water is now directed to the south from the south end of the pit and simply flows out onto flat marshy tundra thereby reducing the potential for erosion.	**B**	Photo 03	Further permafrost degradation, excessive water ponding, and inadequate water management.
11A	96.5	-	-	-	-	-	-	-	-	**C**	Active borrow pit on left side, some evidence of thaw subsidence, will require regrading.	**C**	No change	**C**	-	No Change from 2019
12	93.2	-	Runoff impounded	Severe	Unknown	Unknown	Culvert needed	**A**	The road crosses a natural valley at this site, and water is trapped against the upstream road embankment. The pond must be drained by culvert installation to prevent thaw and collapse of the embankment and risk of significant downstream erosion. The disturbance from scavenging active layer material on ROW is minor at this site.	**B**	Water continues to pond at this location but is now released through a culvert. Water is quite turbid in the pond. The road has been regraded and widened at this location and now appears to be stable.	**B**	Water continues to be turbid but road is stable.	**B**	-	No Change from 2019
12A	93.0	-	-	-	-	-	-	-	-	-	-	-	-	**B**	Photo 04	Water ponding adjacent to the road north edge. Improve drainage conditions.
12B	92.9	-	-	-	-	-	-	-	-	-	-	-	-	**B**	-	Water ponding near to the road north embankment toe. Improve drainage conditions.
QIA-01	92.0	-	-	-	-	-	-	-	-	-	-	-	Turbid water was noted in several small ponds along the left (north) side of the road. Discussion with the environment department indicated that they had inspected the small drainages that lead down to the road and did not see any erosion at all. The reason for the turbid water has not been able to be determined. Tt suggests analysis of the water to see if the colour is a result of a chemical/mineral (natural iron?) impact or is the turbidity a results of sediment in the water. If sediment is determined to be the cause of the water colour it would be most feasible to connect the several small ponds together with a ditch and then discharge it through a culvert to the downhill side of the road into a settling basin before it flows into the nearby lake.	-	Photo 05	Water ponded at several locations near the northern edge of the road. Environmental specialist should be consulted before draining these locations.
14 (QIA-02)	89.8	-	Substantial	Moderate	Unknown	Unstable	Pit directly adjacent to south toe of road embankment. Ponding threatens to undermine road.	**B**	The active layer was pushed up to form the embankment at this site. Substantial ponding is present in disturbed area. Site needs to be regraded and drainage established to the south where a new culvert can be installed that will lead to a natural drainage course.	**A**	Thaw settlement and ponding is continuing to worsen and pit reclamation should be considered very soon to avoid potential road embankment instability.	**A++++**	Noted road stability issues. Instability is very evident, water is very deep and the embankment side slope on the right side of the road is very steep and shows cracking on the shoulder and side slope. Stabilization should be undertaken as soon as possible.	**A++++**	Photo 07	Instability is evident, water is very deep and the embankment side slope on the right side of the road is very steep and shows cracking on the shoulder and side slope. Stabilization should be undertaken as soon as possible.
14A	89.3	-	-	-	-	-	-	-	-	**A**	Realignment of road with a cut on the west side of road exposed massive ground ice in the ditch, extensive thaw settlement is expected unless this exposed ice is covered by 1.5 m or more of fill to re-establish an active layer.	**A**	-	**A**	-	Additional degradation and water ponding along the western edge of the road.
14B	89.0	-	-	-	-	-	-	-	-	**B**	Realignment of road is in a cut section, cut has exposed frozen soils in the west side ditch, with the removal of the active layer it is expected that thaw settlement will occur perhaps leading to loss of support for the toe of the embankment.	**B**	-	**B**	-	No Change from 2019
15	87.8	-	Moderate	Moderate	Substantial segregated ice throughout silty material	Unstable	Improve drainage along the south embankment side slope convey ponded water to the existing culverts.	**B**	Material exposed at this site is predominantly silt. Thaw-subsidence will continue. The strategy for reclamation must be to improve drainage using existing culverts and continue to regrade the surface until the active layer stabilizes. Keep ponded water from accumulating against the toe of the embankment. The exposed silt at this site is very mobile; thus, erosion protection measures may be required when improving site grading.	**B**	Thaw subsidence has continued, road has been recent regraded and raised but water is still ponding at the toes of the very steep side slops of the embankment at this location. There is concern for embankment stability and the side slopes should be flattened to enhance stability	**B**	-	**B**	Photo 08	Water ponding at the toe of the embankment (south edge, culverts appeared to be clogged). Excessive erosion and degradation near the embankment toe (northern edge, culverts outlets). Culverts should be cleared and the drainage should be improved, in addition erosion control measures should be taken into considerations.
15.1	87.0	-	-	-	-	-	-	-	-	**C**	Not a borrow pit but water is being impounded on the upslope side of the embankment and appears to be leading to some thaw settlement. A culvert should be installed at this location to remove the ponding issue.	**C**	Drainage has been improved	**C**	-	Requires minor drainage improvement.
15A	86.5	-	-	-	-	-	-	-	-	**C**	Material was actively being removed from this location, it is a silty sandy gravel material and there is potential for sediments to be released form this pit which is simply cut into the hillside beside the road, Pit should be monitored to evaluate thaw and sediment generation.	**C**	Ponding is now noted, no change in recommendations from 2014	**C**	-	Water ponding (culvert clogged). Requires culvert clearing and drainage amelioration.
16	86.2	-	Moderate	Severe	Minor	Stable	Long-term drainage improvements	**B**	This is a deep pit pond that has established on the south side of the road. Soils in this area are controlled by a weak carbonate sandstone that readily decomposes into fine uniform sand. The pond is currently functioning as an effective sedimentation pond. Water is clear and the pond seems to be stable in a region of minor thaw-subsidence. It is recommended that the pond remain and that a new and higher culvert be placed through the road to allow the surface water to drain into the creek and subsequently the lake. The road embankment should be raised a minimum of 1.5 m at this location to protect the permafrost and provide cover for the new culvert.	**B**	Recommendations for raising the road embankment should be followed but in general the area displays little change since 2009.	**B**	-	**B**	Photo 09	Water ponding at the south edge of the embankment. Inlet culvert head appeared to be damaged and the culvert has become dysfunctional.
16.1	84.8	-	-	-	-	-	-	-	-	-	-	-	-	**C**	Photo 10	Water ponding, culverts appeared to not be functioning properly.
17	75.0	-	Not practical	Low	Not apparent	Stable	Surface dressing and erosion protection	**C**	This is a long section where the active layer soils have been pushed up from both sides to form the embankment. North (left) side is dry and stable — surface dressing only required. The south (right) side has a deep pond. The surrounding terrain is flat thus little opportunity for natural drainage. The ponds are not affecting the embankment, and ground ice seems minimal. The ponds can be left following site grading with some armour placed on the adjacent side slope to prevent erosion and dusting.	**C**	Pond on south side of the road looks the same as it did in 2009. Overall there is very little change in the borrow pit.	**C**	No change from 2014	**C**	-	Minor concern. Need drainage improvement only. No evidence of soil instability.
19	73.8	-	Uncertain	Moderate	Substantial wedge ice	Unstable	Protection of road side slope	**B**	This site is locally very ice rich. Water ponded along road shoulder is a threat to the road. Drainage improvement options are not obvious and should be reviewed further in the field. If ponds cannot be drained, construct a berm to an elevation above water level that will push water back 3 m from embankment slope.	**C**	Site seems to have stabilized naturally, there is less ponded water and there is no current concern for the stability of the road embankment so berms may not be required.	**C**	No change from 2014	**C**	-	No stability concern, some earthworks and drainage improvement.
20	73.4	-	No	Low	Not apparent	Stable	Dress pit floor	**C**	Small active layer pit. Dry and stable. Dress the surface.	**C**	No change	**C**	No change from 2014	**C**	-	No Change from 2019

TABLE 1: SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS FOR SITES NEEDING FURTHER REMEDIATIONS

		2009 Inspection (DWH)								2014 Inspection (KWJ)		2019 Inspection (KWJ)		2023 Inspection (MH)		
Site WP No. 2009	**Km Post**	**General Location**	**Pit Water 2009**	**Erosion Potential**	**Ground Ice Features**	**Active Layer Stability**	**Reclamation Focus**	**Priority**	**2009 Comments**	**Priority**	**2014 Comments**	**Priority**	**2019 Comments**	**Priority**	**Ground Photos**	**2023 Comments**
21 (QIA-03)	73.1	-	No	Low	Not apparent	Stable	Potential future use	**C**	Top of hill, small quarry in rock. Could be a source of materials for road repair and dressing or filling sink holes in nearby pits. Can be easily reclaimed by surface grading.	**C**	No change	**C**	QIA indicated that there were cracks on sides of road at km 73 which is anticipated to be associated with this pit. No cracking noted at the time of the 2019 inspection but borrow pit remains in a similar state.	**C**	-	No stability concern on the roadway embankment. No Change from 2019.
21A	72.7	-	-	-	-	-	-	-	-	-	-	-	-	**C**	-	Water pooling along the north edge of the road (due to poor water management). Improve drainage and place culvert to divert the water away from the embankment.
22 (QIA-04)	72.4	-	Drain and fill all ponds within 3 m of the toe of embankment	Moderate	Wedge ice, possibly massive ice	Active sinkhole formation	Road embankment safety	**A**	The pit on the north (left) side has become a large sink hole that is actively undermining the side slope and crest of the embankment. Wedge ice appears to extend under the road, and there is a potential for water to flow through any wedge cavities. Active cracking is occurring well into the driving lane. This is a priority site for repairs. Substantial risk of a road surface collapse exists. The sinkhole pond should be either drained or pumped and the road grade raised. A berm 3 m wide should be constructed in areas of active embankment sloughing. The site should be frequently observed when the road is used for haul traffic.	**A++++**	Sinkholes have continue to increase in size with water being impounded immediately at the toe of the embankment in many locations. The road grade has been raised here which will help to protect the permafrost underlying the embankment. However, the extensive ponded water and large settlements point to the need to fill in the pits or at a minimum create toe berms along both sides of the embankment where water is currently ponding. This remains a particular priority pit as there is potential for catastrophic failure of the road embankment.	**A++++**	QIA - noted issues at km 72.3 and the uphill (left) borrow pit appears to be a source of sediment. Continued settlement and slope instability, and road maintenance noted that the left side of the road collapsed into the pond on left side earlier this year. Further work is needed as soon as possible to curtail further thawing and potential road collapse. Filling in the pits will lessen the potential for sediment release if some check dams and armouring (rip rap) is also applied to the left of the road below the borrow pit.	**A**	-	Earthworks and filling activities were completed prior to the 2023 site inspection and the roadway embankment appeared to be fairly stable. However, additional earthworks and drainage improvement will be required (both sides of the embankment).
23	71.8	-	Regrade and fill.	Low	Extensive, distributed	Sinkholes active in pit floor	Regrade and fill	**B**	This site has active sinkholes below surrounding terrain. Some water trapped. May require imported fill from other sources to regrade the pit floor.	**B**	No change	**B**	No change from 2014	**B**	-	No change from 2019
24	68.5	Communication Tower	-	Low	Not apparent	Stable	Flatten embankment slope by filling out into pond displacing water.	**C**	Small water-filled pothole left following material excavation. No obvious natural drainage potential. Complete reclamation would require infilling. Nearby material sources are not obvious.	**C**	No change	**C**	No change from 2014	**C**	-	No change from 2019
24A	66.4	-	-	-	-	-	-	-	-	**C**	Pit is stable and requires no reclamation other than simple regrading.	**C**	No change from 2014	**C**	-	No change from 2019
25	66.0	-	Clean ditch along toe of slope	Low	Not apparent	Stable	Regrade surface	**C**	Colluvial soils scavenged from hillside above road for embankment. Site is stable requires cleanup and dressing with improvements to drainage along toe of slope.	**C**	No change	**C**	No change from 2014	**C**	-	No change from 2019
26	65.2	Active Pit	Well drained	Low	Not apparent	Stable	Regrade surface	**C**	This pit remains active with reasonable construction material. Drainage is currently good, but further excavation within ROW will probably initiate ponding. Should material continue to be removed, a pit development and reclamation plan should be prepared.	**C**	No change	**C**	No change from 2014	**C**	-	No change from 2019
27	64.7	-	Poorly drained	Low	Not apparent	Moderate	Fill and regrade	**C**	This is a small pothole filled with water. Site should be regraded and fill added to improve drainage.	**C**	No change	**C**	No change from 2014	**C**	-	No change from 2019
28	63.9	Active Pit	Dry	Low	Not apparent	Stable	Dress surface	**C**	Both sides of road. Naturally well-drained silty gravel. No sinkholes. Grade surface at closure.	**C**	No change	**C**	No change from 2014	**C**	-	No change from 2019
29	63.7	-	-	Severe	Massive ground once observed in pit. Wedge ice under road.	Unstable, extensive thaw	Rebuild road grade	**A**	This is the most ice rich site noted. Remnants of massive ice were found in large thaw depression on south side of road. Ice wedges are actively melting under road side slope Cracks and depressions extend to the shoulder. To reduce risk of road collapse, the grade should be raised at least 1 m through this area and berms a minimum 3 m wide constructed on the south side slope. Final reclamation of this site will require further assessment of the best method for ensuring drainage from the sink hole without risking siltation of the creek valley immediately to the south.	**A++++**	Extremely ice rich material exist on both sides of the road. Thaw settlements have been significant since 2009. Many areas of settlement exist immediately beside the road embankment and there is evidence of settlement of the road itself. There is a significant risk of catastrophic road collapse in several locations. Settlement areas beside the road should be backfilled as soon as possible to arrest further thaw settlements form impacting the stability of the road. Increasing the road surface elevation by 0.5 m would also help in changing the thermal regime in the embankment itself.	**A++++**	This series of pits has gotten worse, recommendations from 2014 remain appropriate. See Section 4.0 in the report for additional details.	**B**	Photo-11	Partially filled after 2019 inspection. The un-filled portion needs to be filled and graded.
30	63.1	-	Dry	Low	Not apparent	Stable	Regrade	**C**	River terrace. Active layer gravel removed over a large area. Site is dry and naturally well drained. Regrade surface for reclamation.	**B**	Recent removal of material from the active layer has initiated thaw and instability in this kame type deposit. It is anticipated that there is considerable ground ice in this deposit. It is suggested that further material should not be removed from this deposit. The stability of the deposit should be monitored closely because of its proximity to the river.	**B**	No change from 2014	**C**	-	No change from 2019
30A	62.3	-	-	-	-	-	-	-	-	**B**	New alignment is visible. Considerable material was recently removed from the active layer on the east side of the old alignment over a very large area. Ice wedge melt out was already being noted in this area. There is potential for some slope instability and sediment transport towards from this area. This should be monitored to see if some form of sediment capture system might be required downslope form the pit development area.	**B**	No change from 2014	**C**	Photo 12	No change from 2019
32	56.9 R	-	Moderate	High	Substantial wedge ice	Unstable	Improve site drainage	**B**	Pit excavated in ice-rich sandy gravel. Active thermokarst and ponding. Regrading to fill ponds required. Develop drainage to the east along north side of road. Construct a coarse boulder apron at outfall onto tundra.	**A**	Thaw and settlement has continued and there is now considerably more ponded water. Discussion with the construction crew indicated that the road might be realigned at this location but the new road would likely go through the large ponds. The pond should be filled to reduce the potential for further thaw settlement and the loss of support for the road embankment.	**A++++**	There has been significant road realignment at this location. Water is ponding along portions of the new road and cracking is noted on the shoulders and side slopes of the new road. The old road is now very unstable and side slopes are failing in many locations. Water must be pushed back from the edge by placing additional fill on the side slopes of the new road embankment to enhance stability. Of significant concern is the fact that the water currently ponding along the new road is only drained away by a culvert in the old road near the sharp corner. With no maintenance on the old road, Tt has concerns that the culvert will become inoperable/blocked and water levels in the pond will rise significantly leading to more thaw and further threaten stability on the new road. Suggest removal of the culvert and breaching the old road embankment to lower water levels. See Section 4.0 for further discussion.	**A++++**	Photo 13	Water ponding and continuing ground settlement due to permafrost degradation. Installed culverts are dysfunctional due to the changing ground conditions. Remediation actions should start as soon as possible to prevent further permafrost degradation, and to reduce the risk of the roadway embankment failure. Pooled water must be drained out or pushed back from the edge by placing additional fill on the side slopes of the road embankment to enhance stability. The water management system must be improved to let the water flow away from the embankment and to prevent further permafrost degradation.
33	56.7 L	-	Severe	Moderate	Not visible	Unknown	Drainage enhancement	**B**	Pit water is intended to drain to a small culvert under road at west end of pit. Continued settlement has left invert of culvert too high. Consider draining along north (left) toe of road grade to natural draw about 100 m south and placing a new culvert through road at that location.							
34	55.8	-	Minor	Low	Not apparent	Unknown	Grading	**C**	Regrade and improve drainage.	**C**	No change	**C**	No change	**C**	Photo 14	No change from 2019

TABLE 1: SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS FOR SITES NEEDING FURTHER REMEDIATIONS

		2009 Inspection (DWH)								2014 Inspection (KWJ)		2019 Inspection (KWJ)		2023 Inspection (MH)		
Site WP No. 2009	**Km Post**	**General Location**	**Pit Water 2009**	**Erosion Potential**	**Ground Ice Features**	**Active Layer Stability**	**Reclamation Focus**	**Priority**	**2009 Comments**	**Priority**	**2014 Comments**	**Priority**	**2019 Comments**	**Priority**	**Ground Photos**	**2023 Comments**
35	55.4	Risk of road collapse	None	Low	Wedge ice	Unstable	Protecting road embankment	**A**	A small excavation on the upslope side of the embankment has allowed water to penetrate into Wedge Ice initiating thermal erosion. The road grade was actively collapsing into thaw depressions at the time of the visit. There is a high safety risk of total collapse. The road must be bermed on both sides for a distance of 3 m to 4 m and the embankment raised to accommodate settlements that have occurred. The side slopes should be dressed along with disturbed areas. The site should be monitored during periods of high road use until stability of the permafrost is assured.	**B**	Stability has improved with some berming of the embankment and the embankment does not seem to be at risk of failure now but should be monitored once the road sees increased traffic.	**B**	No change	**B**	Photo 15	No change from 2019 (Embankment appeared to be stable)
35A	53.8	-	-	-	-	-	-	-	-	-	-	-	-	**B**	Photo 16	Replace damaged culvert. Grading and drainage improvement (upstream), fix damaged embankment, and place erosion protection material (downstream, culvert outlet).
36	53.1	-	Minor	Low	Not apparent	Stable	Protecting road embankment	**C**	Small pothole pit beside road. Material stockpile. The shoulders of the road should be dressed and slopes flattened.	**C**	No change since 2009	**C**	No change since 2014	**B**	Photo 17	Poor water management and presence of ponded water in depressed areas (due to permafrost degradation). Improve drainage, fill the depression, and grade the ground surface to properly divert surface water away from the embankment toe.
36A	52.9	-	-	-	-	-	-	-	-	**C**	Some material removed from the edge of this kame type deposit. There is obviously massive ground ice in the deposit as evidenced by the settlement in the portions of the deposit where material was removed from the active layer. Stability should be monitored as there may be potential for sediment release. At present there is no impact on the stability of the road.	-	-	**B**	-	Poor water management and presence of ponded water in depressed areas (due to permafrost degradation). Improve drainage, fill the depression, and grade the ground surface to properly divert surface water away from the embankment toe.
37 (QIA-05)	52.2	Road collapse	Dry	Low	Wedge	Unstable	Protecting road embankment	**A**	Active sinkhole on immediate north side of embankment has extended under the road resulting in grade collapse about 1/2 m. Selective excavation of the road fill and underlying ice at this site is recommended followed by rebuilding grade with compacted material. Raise the final grade 1 m or more above current elevation and flatten side slopes.	**A++++**	Settlement continues and the road embankment is now very steep on the north side, recent extraction of material has removed more of the active layer and thaw is ongoing. The embankment side slope is very unstable and this is a safety issue as there is a risk of catastrophic failure. The large sinkhole should be backfilled as soon as possible.	**A**	QIA noted that the road appeared to have been raised at this location. Actually the road was significantly realigned to improve grades and is now located at a lower elevation and borrow pit 37 is now well away from the new road. Therefore the stability of the old road is not of significant concern. The thaw degradation that was noted to be ongoing is still happening in the pit and there is the potential for sediment laden water to be released from the old pit. The priority has been downgraded to reflect the lessened safety issue but is still rated A because of the potential sediment issue. Regrade pit surface, assess potential water release locations and armour outflow, and install check dams as required to control sediment release.	**C**	Photo 18	Site grading and filling activities were completed prior to the site inspection visit. This area requires minor grading and leveling works only. (New alignment embankment appeared to be stable)
38	51.9	-	Dry	Low	Not apparent	Stable	Grading	**C**	Dress the slopes and bottom.	**C**	No change	**C**	No change since 2014	**C**	-	Site grading and filling activities were completed prior to the site inspection visit. This area requires minor grading and leveling works only.
39	51.7	-	-	Low	Wedge ice extending under road	Unstable	Stabilize road surface, dress side slopes and fill sinkholes	**B**	Sinkhole under road at north end, cracking onto road surface. Build road grade up, dress disturbed area, and flatten embankment side slopes.	**B**	Continued settlement away from the road, some recent regrading has improved the stability of the road but this area should be closely monitored to see if the sinkhole redevelops.	**B**	No change since 2015	**C**	Photo 19	Most of this area had been filled prior to the site inspection visit but some spots need more filling and surface grading.
41	50.6 L	-	Minor	Low	Localized wedge ice	Moderately stable	Regrading	**C**	Regrade and improve drainage from sinkholes.	**C**	No change	**C**	No change since 2014	**A**	Photo 21	Evidence of ground settlement, deep water pooling (due to permafrost degradation) and excessive erosion. This area needs to be graded (pushing pooled water, filling holes), in addition to improving the erosion protection system at the existing culvert outlet.
42 (QIA-06)	49.7 L	-	Mostly dry	Low	Ice wedges, south end	Sinkholes south end	Regrading	**C**	Regrade to fill and cover sinkholes at south end.	**C**	No change	**C**	QIA - noted water accumulation and potential for instability at km 49.9 Do not see evidence of ponding in the pits at this location and road seems to be stable.	**C**	-	Appeared to be dry and no evidence of embankment instability at these locations.
43 (QIA-06)	49.6 R	-	Dry	Low	Not apparent	Stable	Dress surfaces	**C**	Long pit where active layer soils have been pushed up to make embankment.	**C**	No change	**C**		**C**		
QIA-07	49.0	-	-	-	-	-	-	-	-	-	-	**A+**	QIA - noted ponding and road instability. There is a cut that was made to improve grade and a communications tower is situated on the top of the terrace on the west side of the road. There is ponding on the east side of the road. An ice wedge can be seen to be degrading on the terrace and is very evident on the cut slope on the west side of he road (Photos 2698 and 2699). Material should be placed over the degrading ice wedge both on the terrace and on the cut slope. The ditch (Photo 2700) to the south of the wedge is unstable as is the side of the road, suggest some regrading and slope flattening to help improve stability. Close monitoring of the road should be undertaken and if any dips are noted at the ice wedge locations further remediation may be required.	**A+**	-	No change from 2019 inspection. Embankment slope should be flattened, as such earthwork and filling activities will be required to push the pooled water away from the steep embankment toe.
44	46.7 L	-	Minor	Low	Not apparent	Stable	Dress surfaces	**C**	Pothole pit, some water. Dress slopes and improve drainage.	**C**	No change	**C**	No change since 2014	**C**	-	No change since 2019 (Minor water ponding).
45	46.1	-	Dry	Low	Not apparent	Stable	Dress slopes	**C**	This is a confined but deep pit, currently dry. The backslopes are steep and may require minor cleanup and dressing.	**C**	No change	**C**	No change since 2014	**C**	Photo 22	No change since 2019 (Minor water ponding).
46	44.0	-	Dry	Low	Not visible	Moderately stable	Repair grade	**A**	This road cut exposed ground ice that is actively thawing. The road grade should be built up at this location about 1/2 m.	**B**	Road stability has improved at this location but should be monitored closely with increased traffic.	**B**	Minor realignment has improved stability.	**B**	-	No change since 2019 (Minor water ponding).
47	42.2 R	-	Partial	Low	Not visible	Moderate	Regrade	**C**	Small pit with one large sinkhole. Regrade and fill sinkhole (not affecting road).	**C**	Sinkhole has increased in size but has not yet affected the road, should regrade and fill in the hole.	**C**	May have been some material removed since 2014 but pit is stable.	**B**	Photo 23	Sinkhole has increased in size but is not yet affecting the road. Sinkhole should be filled and the ground surface graded.
48	41.8 R	-	Dry	Low	Not visible	Stable	Regrade	**C**	Dry pit on ridge. Regrade to dress surfaces.	**C**	No change	**C**	No change since 2014	**C**	Photo 24	No change since 2019.
48A	37.2	new pit	-	-	-	-	-	**C**	New borrow pit	**C**	Active layer has been scraped off, some limited settlement near the road but no water ponding was observed.	**C**	No change since 2014	**C**	Photo 25	No change since 2019.
49	37.5 R	-	Dry	Low	Not visible	Stable	Dress surface	**C**	Linear pit from push up. Well drained. Dress the surface.	**C**	No change	**C**	No change since 2014	**C**	-	No change since 2019.

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		2009 Inspection (DWH)								2014 Inspection (KWJ)		2019 Inspection (KWJ)		2023 Inspection (MH)		
Site WP No. 2009	**Km Post**	**General Location**	**Pit Water 2009**	**Erosion Potential**	**Ground Ice Features**	**Active Layer Stability**	**Reclamation Focus**	**Priority**	**2009 Comments**	**Priority**	**2014 Comments**	**Priority**	**2019 Comments**	**Priority**	**Ground Photos**	**2023 Comments**
50	36.7 R	-	Dry	Low	Not visible	Stable	Dress surface	**C**	Similar to 49.	**C**	No change	**C**	No change since 2014	**C**	Photo 26	No change since 2019.
51	36.5 L&R	-	Ponding on left	Low	Wedge Ice	Moderate	Improve drainage and regrade	**B**	Active layer removed along road on both sides. Well developed ice wedge cracks evident across pits and continuing under embankment. Beginning to affect road at north end. Stockpiles remain in left pit. Further removal of surface soils at this location not recommended without a pit development plan. Reclamation should grade pit surface, infill ice wedge cracks and flatten embankment side slopes in regions showing distress. Improve drainage.	**C**	Drainage seems to have improved and this may have lead to improved road stability, still do not recommend additional material removal without a pit plan. Reclamation recommendations remain the same.	**B**	Pits look similar, ice wedge melt out is evident in the pits and upon close inspection the wedges can be traced under the road, appearing slightly darker. When driving slight dips are evident in the roads where the ice wedges are under the road. This indicates that some thaw is continuing. This calls for close monitoring to warn of potential collapse. It is very important to keep the pits dry.	**B**	Photo 27	Left and Right pits appeared to be generally stable and dry, except a little portion of the left pit (near the road edge) that contained ponded water (water appeared to be shallow and may have resulted from melted ground ice/degraded permafrost).
52	35.7 R	-	Dry	Low	Not apparent	Stable	Regrade	**C**	A relatively large pit but dry and stable bottom. Dress slopes and bottom.	**C**	No change	**B**	Pits look similar, ice wedge melt out is evident in the pits and upon close inspection the wedges can be traced under the road, appearing slightly darker. When driving slight dips are evident in the roads where the ice wedges are under the road. This indicates that some thaw is continuing. This calls for close monitoring to warn of potential collapse. It is very important to keep the pits dry.	**C**	-	The pit appeared to be stable and dry.
52A	35.5	-	-	-	-	-	-	-	-	-	-	**C**	Pit stable no issues	**C**	Photo 28	The pit appeared to be stable and dry.
53	34.9	-	Dry	Low	Not visible	Moderately stable	Regrade and fill sinkholes	**C**	Long, linear pit with a few sinkholes. Regrade and fill sinkholes. Material removed recently	**C**	No change	**C**	-	**C**	Photo 29	The pit appeared to be deep, but it was stable and dry.
54	34.7	-	Dry	Low	Not apparent	Stable	Regrade	**C**	Dress all surfaces.	**C**	No change	**C**	-	**C**	Photo 30	The pit appeared to be stable and dry.
55	33.5	-	Minor ponding	Low	Minor wedge ice	Stable	Regrade	**C**	Regrade to fill wedge cracks and dress surface.	**C**	No change	**C**	No change	**C**	Photo 31	Minor ponding but stable.
56	33.4 L	-	Dry	Low	Not apparent	Stable	Regrade	**C**	Small square pit. Dress all surfaces.	**C**	No change	**C**	No change	**C**	-	Stable and dry.
57 (QIA-08)	33.0 L	-	Partial	Low	Not apparent	Moderate	Partial infill and regrade	**C**	Three small pits, two dry and one with water. Regrade or import fill to flatten or berm embankment side slope beside water-filled pit. Grade surface.	**C**	No change	**C**	QIA noted that a sinkhole was evident on the road and suggested that it was a result of a culvert failure. At the time of the 2019 inspection there was no evidence remaining and therefore it was assumed that the problem had been repaired.	**C**	Photo 32	Deep pit appeared to be dry and stable.
58 (NIRB-01)	32.4 L	-	Partial	Low	Not apparent	Moderate	Regrade	**C**	Push up pit. Rough bottom. Grade surface, improve drainage. Defined pit on left about 300 m further south is dry and needs no work.	**C**	No change	**C**	No change	**C**	-	This area appeared to be dry and stable.
59 (NIRB-02)	30.6 R	-	Dry	Low	Not apparent	Stable	Dress surfaces	**C**	High, well-drained side borrow site. Dress bottom and slopes.	**C**	No change	**C**	No change	**C**	-	No change since 2019.
60 (NIRB-03)	30.1 R	-	Dry	Low	Not apparent	Stable	Dress surfaces	**C**	Similar to Site 59.	**C**	No change	**C**	No change	**C**	Photo 33	Borrow pit appeared to be generally stable and dry, but the drainage should be improved and erosion protection system should be installed at the existing culvert outlet.
61 (NIRB-04)	30.1 L	-	Dry	Low	Not apparent	Stable	Dress surfaces	**C**	Similar to Sites 59 and 60.	**C**	No change	**C**	No change	**C**	-	This area appeared to be dry and stable.
61B (QIA-09)	29.1	-	-	-	-	-	-	-	-	**A++++**	Site not reported on in 2009. Recent construction has removed considerable material form this location, extensive settlement is occurring (5 m to 6 m) and is undermining the road embankment on the east side. Settlement and ice wedge melt out is also occurring on the west side. There is a significant risk of catastrophic failure of the embankment at this location. Material should be imported to fill in all of the settlement areas and improve the potential to arrest these extensive thaw settlements.	**A++++**	QIA noted water accumulation and stability issues at km 29.4 but the pit with issues is located at 29.1 on the Figure (assumed to be the area of concern). As noted in 2014 this entire pit should be backfilled with imported material after removing as much water as possible. See Section 4.0 for further information.	**A++++**	Photo 34	Steep and high roadway embankment. Presence of pooled water at the embankment toes. The pooled water may have resulted from poor surface water management and/or permafrost degradation. No signs of slope movement/instability, but the excavation should be filled with imported fill to improve embankment stability and to prevent any slope failure.
62	28.7	-	Minor ponding	Low	Not apparent	-	Regrade	**C**	Near vertical slope on sidehill pit. Slope pit back at 3H:1V and add some shoulder to road. Improve drainage.	**C**	No change	**C**	No change	**B**	Photo 35	Steep roadway embankment and pooled water at the embankment toes.
62A	27.8	-	-	-	-	-	-	-	-	**B**	Not reported on in 2009, appears that more material has been recently removed, thaw of ice wedges and ground ice is leading to ponding but it is away from the toe of the slope, road embankment seems stable for now. Pit could be regraded to reduce ponding and resulting thaw settlements.	**B**	Extensive ponding remains in the pit, recommendations from 2014 still apply.	**A+**	Photo 36	Extensive water ponding and evidence of permafrost degradation. No signs of slope movement/instability, but the excavation should be filled with imported fill to improve embankment stability and to prevent any slope failure.
63	27.0R	-	Minor ponding	Low	Not apparent	Stable	Regrade vertical slope	**C**	Pit has a near vertical slope 2 m to 3 m high. Slope back to 3H:1V and dress pit bottom to improve drainage away from road embankment.	**C**	No change, currently stable	**C**	Some ponding on the left side of the road, perhaps in an area were material was removed after 2014.	**C**	-	The pit appeared to be stable and dry.
64	26.7 L&R	-	Major ponding	Low	Not apparent	Stable	Regrade backslope, develop drainage plan	**B**	Deep pits on both road shoulders, both flooded. Slope sides to 3H:1V and develop a drainage plan. It may be practical to ditch to the creek about 100 m to the north.	**B**	Water continues to pond on the east side of the road but road embankment continues to appear stable at this time.	**B**	Ponding remains similar to 2014, embankment remains stable.	**B**	Photo 37	Bottom of both pits appeared to be wet, but no presence of standing water within the pits. The walls appeared to be stable and no evidence of soil movement.
65	25.8 L&R	-	Minor	Low	Not apparent	Stable	Dress surfaces	**C**	Push up pits on both sides. Well drained. Dress slopes and ensure future drainage.	**B**	Water continues to pond on the east side of the road but road embankment continues to appear stable at this time.	**B**	Ponding remains similar to 2014, embankment remains stable.	**A+**	Photo 38	Right borrow area appeared to be dry and stable. The left borrow areas (2 pits) were full of ponded water, and showed evidence of continuing permafrost degradation. Pooled water in the left borrow areas appeared to be deep, but the excavation walls were stable (at the time of the inspection).
66	23.6 L&R	-	Minor	Low	Not apparent	Stable	Dress surfaces	**C**	Push up pits both sides. Currently self-draining to tundra. Not obvious erosion or sinkholes. Grade side slope into pond lying to the left side.	**C**	More water is now ponding in the NW corner of the pit and due to settlement is no longer free draining to the tundra.	**C**	Conditions similar to 2014	**A+**	Photo 39	Right borrow area appeared to be dry and stable. The left borrow was full of ponded water, and showed evidence of continuing permafrost degradation. Pooled water in the left borrow appeared to be deep and may affect the roadway embankment stability.
67	23.3 L	-	Dry	Low	Not apparent	Stable	Dress surfaces	**C**	Well drained pit on top of natural rise. Dress bottom and slopes.	**C**	-	**C**	Limited ponding in the north end of the pit	**B**	Photo 40	Southern portion of the pit appeared to be shallow, dry, and stable. Deep pooled water was observed towards the northern end of the pit (potential sinkhole due to continuing permafrost degradation).

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Site WP No. 2009	**Km Post**	**General Location**	**Pit Water 2009**	**Erosion Potential**	**Ground Ice Features**	**Active Layer Stability**	**Reclamation Focus**	**Priority**	**2009 Comments**	**Priority**	**2014 Comments**	**Priority**	**2019 Comments**	**Priority**	**Ground Photos**	**2023 Comments**
68 (QIA-10)	21.9 R	-	Minor ponding	Low	Massive ice	Unstable	Fill and Cover Sinkholes	**B**	Melt out of massive ice actively developing sinkholes at toe of embankment side slope. A berm should be built on side slope and sinkholes infilled at 2 locations. Regrade to improve drainage to the northwest.	**A**	Thaw continues and is threatening embankment stability on the west side of the road. This pit should be regraded and backfilled with material to improve embankment stability.	**A++++**	QIA noted water accumulation and road instability at this location. Pits should be backfilled and graded as noted in 2014 to cause the permafrost to aggrade and enhance the stability of the embankment side slopes. See Section 4.0 for more information.	**A++++**	Photo 41	Deep water pooling and evidence of continuing permafrost degradation. The existing culvert appeared to be dysfunctional (no proper drainage). No signs of slope movement or instability at this moment (2023 inspection).
69	22.9	(Out of sequence)	Minor ponding	Moderate	Segregated ice	Unstable	Control drainage and limit sediment transport	**C**	Pit cut into side of knob. Thaw of icy soils is producing meltwater and sediment. Selective use of a boulder riprap blanket is recommended. Use riprap to control and filter drainage that is being dispersed onto tundra.	**C**	Drainage seems to have ceased and pit seems stable, may not need to consider the rip rap blanket now.	**C**	No change since 2014	**C**	Photo 42	Drainage must be improved and the existing culverts must be cleared. Large water pond was observed near the southern edge of the embankment (southwest the connection of the new and the old alignment). No signs of instability or deterioration were observed in the road embankment at this location.
70	21.2 L	-	Water-filled pothole pit beside road	Low	Unknown	Unstable	Water-filled pit	**C**	Pothole immediately beside embankment side slope. Drain and install culvert under road. May require widening shoulder and partial infilling to maintain long-term drainage.	**C**	No change	**C**	No change since 2014	**B**	Photo 43	Borrow area bottom appeared to be wet and soft, in addition this location showed evidence of continuing permafrost degration and creation of a water pooled dip.
71	20.7 R	-	Water-filled wedge cracks	Moderate	Substantial wedge ice	Unstable	Prevent further ice wedge thaw	**B**	Active layer removed from top of hill, exposing substantial wedge ice. Substantial melt out and continued activity. Water collecting in wedge cracks. Develop drainage and fill expanding wedge cracks. Berm the side slope to prevent further thaw under road embankment.	**A++++**	Wedge ice has substantially degraded since 2009 thaw settlement is now undermining the road and road settlement is obvious. There is potential for catastrophic collapse of the road surface at this location. Reclamation should occur as soon as possible. This must involve complete filling of all the settlement areas to eliminate ponded water and arrest continuing thaw settlements.	**A++++**	Pit remains similar to 2014 and settlement and instability of the road side slope is evident. Filling of the pit as soon as possible is still recommended to improve safety. See Section 4.0 for further detail.	**A++++**	Photo 44	Steep high roadway embankment. Presence of pooled water at the embankment toes. The pooled water may have resulted from poor surface water management and/or permafrost degradation. No signs of slope movement/instability.
73	18.3 L&R	-	Large water-filled pit	Moderate	Not apparent	Moderate	Develop pit drainage	**B**	Large pit pond immediately adjacent to road. Appears to be deep water. Currently no drainage. Can be drained by installing a culvert under the road. Flatten side slopes into pit to push water further from road shoulder.	**B**	Water in pit is much less than in 2009 and it appears that some additional material may have been recently removed.	**B**	More water is ponding in the left side (east) pit than noticed in 2014 but road appears stable.	**B**	Photo 46	The bottom of both borrow areas (left and right) were wet and soft (with no standing water observed). Roadway embankment appeared to be stable.
75	15.0 L&R	-	Some water	Low	Not apparent	Stable	Dress surfaces	**C**	Long pit, some water, no active subsidence, dress surfaces.	**C**	No change	**A**	More ponded water and there is a short section at the south end of the pit where there is a very steep side slope and considerable drop from the edge of the road down into the water. Pond should be drained and the area where water is ponding should be backfilled.	**A**	Photo 48	The right side (heading north) borrow area was graded and filled before the 2023 site inspection, and no further action is required for this side. The left side (heading north) borrow area had ponded water and there is a short section at the south end of the pit where there is a very steep side slope and a considerable drop from the edge of the road down into the water. Ponded water must be drained, the area backfilled, and the surface dressed properly to improve drainage.
76	14.2 L	-	Dry	Low	Not apparent	Stable	Dress surfaces	**C**	Dry, well-drained pit floor. Stockpile of sandy gravel present. Dress surfaces.	**C**	No change	**C**	No change since 2014	**C**	-	No change since 2019
77	13.4L	-	Pond	Low	Not apparent	Moderate	Pothole pit	**C**	Some refilling may be required in pothole pit beside road.	**C**	No change	**C**	No change since 2014	**C**	-	No change since 2019.
78	13.2L	-	One pond to north	Low	Not apparent	Moderate	Large area to dress	**C**	Shallow pit on top of rise. Pond in north end that can be drained to the north. Grade and dress surfaces.	**C**	Pond size is increasing and water is getting deeper, may start to impact road stability.	**C**	No change since 2014	**C**	-	No change since 2019.
79	12.8 L&R	-	Wet bottom	Low	Segregated ice	Unstable	Large surface area	**B**	Pit in silty sand, abundant ground ice. Active thaw in pit floor. Surface will need to be regraded to cover exposed icy sediments. Several visits may be necessary to stabilize the new active layer.	**B**	No change	**B**	No change since 2014	**A+**	Photo 49	Large water pooling. Pooled water may have resulted from poor surface water management and/or permafrost degradation. The water level appeared to be close to the roadway surface and might affect the embankment stability and undermine the roadway structure.
79.1	12.3 R	-	-	-	-	-	-	-	-	-	-	-	-	**A**	Photo 50	Large sinkhole filled by water near the right toe of the roadway embankment. The water in the sinkhole indicate the presence of continuing permafrost degradation. This sinkhole should be filled to prevent further expansion that may undermine the roadway embankment stability.
80	9.7 R	-	Water-filled wedge cracks	Low	Wedge ice	Unstable	Active sinkholes in wedge cracks	**B**	Extensive melt out of ice wedges resulting in water-filled troughs. Need to drain and fill sinkholes. Material should be imported as the entire pit is underlain by wedge ice and further removal of active layer material will exacerbate reclamation.	**A**	Water continues to pond and thaw settlement continues, need to undertake reclamation as suggested in 2009.	**A**	See 2014 recommendations for stabilization. Also consider adding a toe berm to the left side of the road or at a minimum flatten the side slope near the natural pond to stabilize embankment on that side (east side).	**C**	-	Historical borrow pit was graded and filled in 2021, and no further action required for this area (right side of the road). Also, consider adding a toe berm to the left side of the road or at a minimum flatten the side slope near the natural pond to stabilize embankment on that side (as recommended in 2019).
82	9.1 L	-	Dry	Low	Segregated ice	Unstable	Sinkholes	**C**	Sidehill cut into bank beside road. Backfill and regrade with riprap quality material. Allow future drainage from cover.	**C**	No change	**C**	No change	**C**	-	This borrow pit was partially filled. Need some dressing and surface grading.
82A	8.8 L	-	-	-	-	-	-	-	-	**C**	New borrow pit, relatively stable and well drained, some limited settlement but currently is well away from the road.	**C**	No change since 2014	**A**	Photo 51	Deep excavation full of water (high embankment). Granular fill placed over the embankment edge to flatten the steep slope, but this area needs to be drained from standing water, filling/grading, and dressing the surface to properly drain water.
82B	8.3 L	-	-	-	-	-	-	-	-	-	-	-	-	**C**	-	Dry and stable (partially filled).
83A (QIA-11)	7.2	-	-	-	-	-	-	-	-	**A**	Realignment with pits on both sides of the embankment, extensive thaw settlement and potential road instability. The pits on both sides of the road should be immediately regraded and material added at the toe on both sides to lessen thaw settlement and improve embankment stability.	**A++++**	QIA noted that the road was surrounded by water at nearly the elevation of the road and noted that there appeared to be degradation of permafrost. Indeed, ongoing permafrost degradation is ongoing in the pit. The road appears much less stable in 2019 and the water levels have risen in the pits, leading to road instability due to thaw. This pit needs to be filled on both sides of the road after removing as much water as possible. Filling the pits a regrading will hopefully lead to aggradation of permafrost and enhance the stability of the road much worse. See Section 4.0 for further discussion.	**B**	Photos 53 and 54	Right borrow area was graded and filled in 2021, and no further action is required for this side (right borrow). The left side was partially filled, but this area needs more filling, grading, and water management.
85	3.5 R	Milne Inlet permitted pit	Dry	Low	Minor wedge ice	Stable	Silty sand susceptible to dusting	**B**	This is the main permitted pit for development at Milne Inlet. The site is a dry and naturally well-drained river terrace. The material is fine grained (silty) and may be susceptible to generating dust. Small dune-like features evident on surface. If the site is retained for future use, a pit plan should be prepared. In order to control dust, it may be necessary to provide ridges of coarse material at closure that will trap wind-blown sand.	**B**	With the creation of the Milne inlet quarry there is likely no need to consider further material withdrawal from this pit and it could be reclaimed in the manner suggested in 2009	**B**	Pit is being reclaimed using overburden from the main quarry (pit 87) at the port. A granular fill berm was constructed downslope to act as a filter for any thaw water released form the frozen overburden. Thaw and settlement was still ongoing below (to the north) of the already stabilized area and it is recommended that this areas should also be covered with suitable overburden material retained by a downhill berm if additional material is available. This was discussed with Dominic Ritgen and he noted that was the plan.	**A++++**	Photos 55 and 56	Failure was observed along the right edge of the road. This failure was classified as a major slope failure, and may have been caused by poor water management which lead to excessive erosion of the slope soils. Email was sent to Kofi Sakyi, Dale Tulloch, and Baruck Wile about this issue on September 11, 2023.

Legend:

- Qikiqitani Inuit Association (QIA) Concerns
- Nunavut Impact Review Board (NIRB) Concerns

Priorities:

- Major Concern
- Moderate Concern
- Least Concern

Actions:

- **A++++** Not stable, require monitoring and timely actions
- **A & B** Not stable, require attention and monitoring
- **C** Stable, require normal grading and dressing

TABLE 2: SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS FOR SITES NOT REQUIRING FURTHER ACTION

		2009 Inspection (DWH)								2014 Inspection (KWJ)		2019 Inspection (KWJ)		2023 Inspection (MH)		
Site WP No. 2009	**Km Post**	**General Location**	**Pit Water 2009**	**Erosion Potential**	**Ground Ice Features**	**Active Layer Stability**	**Reclamation Focus**	**Priority**	**2009 Comments**	**Priority**	**2014 Comments**	**Priority**	**2014 Comments**	**Priority**	**Ground Photos**	**2023 Comments**
8	98.3	Off ROW permitted	Minor ponding	Low	Abundant Wedge Ice	Fair	Drainage Improvements	**C**	This pit is within off ROW permitted and should be regraded and closed with future material taken from Area 1.1	**C**	No change	**C**	No change	**-**	-	Regraded, Tote Road Alignment pass through the historical pit.
11AA	95.4	-	-	-	-	-	-	-	-	**-**	-	**C**	Stable pit	**C**	-	No Change from 2019
11B	93.8	-	-	-	-	-	-	-	-	**C**	Reclaimed borrow area that has recently been used as a source of material. Pit/Quarry is in very stable condition, no further work required.	**C**	No change	**C**	-	No Change from 2019
13	92.7	-	Runoff impounded	Moderate	Unknown	Unknown	Culvert replacement/ repairs	**A**	This site has a drainage interruption issue that needs attention. Not a soil borrow site.	**C**	The drainage issue has been addressed at this location with the installation of a culvert that is operable.	**C**	No change	**C**	-	No Change from 2019
13A	91.0	-	-	-	-	-	-	-	-	**C**	Realignment to improve grade. It appears that material has been obtained from roadside pits both north and south of this location. So far these pits appear to be stable.	**C**	No change	**C**	Photo-06	No Change from 2019
16A	84.3	-	-	-	-	-	-	-	-	**C**	New pit on right, appears very stable.	**C**	-	**C**	-	No Change from 2019
16B	82.3	-	-	-	-	-	-	-	-	**C**	New pit on left appears very stable.	**C**	-	**C**	-	No Change from 2019
16C	80.0	-	-	-	-	-	-	-	-	**C**	Assumed new pit near south abutment of new bridge. Materials assumed to have been used for bridge approach fill construction, pit appears stable, requiring no reclamation effort.	**C**	No change from 2014	**C**	-	No change from 2019
18	74.7	-	-	High	Not apparent	Stable	Protect outlet at north end from erosion	**B**	Sandy active layer soils have been removed on ROW for embankment construction. Minor thaw subsidence or ponding within pit floor. Outlet for water at north end flows downhill into a creek. Substantial risk of erosion on that sandy slope during freshet. Recommend armouring the outlet with coarse materials and cross berm for erosion protection. Dress pit floor.	**C**	There does not seem to be evidence of sediment movement downslope to the creek so armouring may not be necessary.	**C**	No change from 2014	**C**	-	No Change from 2019
31	61.7	Midway Pit, Off ROW permitted	Minor ponding	Low	Wedge ice on south-facing slope	Stable	Regrade	**C**	The active layer has been stripped over a substantial surface area. Gravel is well graded and free draining. The site can potentially produce more gravel by progressive stripping as it thaws or by drill and blast. A pit development plan including reclamation planning should be developed if borrow material harvesting is continued at this location.	**B**	Extensive thaw settlement is occurring in the a large area where the active layer soils were removed. This is indicative of massive ice in this deposit. Material is of good quality and lots of additional material could be obtained from this pit. Care must be exercised to control runoff from the area during development. Photo 1530 does show some instability due to thaw settlement near the road. this area should be stabilized by regrading combined with placement of fill at the toe of the slope to arrest thaw.	**B**	Road has been realigned to the west to improve grade. It does not appear that the pit has been used since 2014 other than as a laydown area. Continued thaw of massive ice on the south side of the pit has increased settlement. With road realignment there is no longer concern of stability on the road.	**C**	-	No change from 2019
40	51.2	Hole in Road	-	Low	Wedge ice extending under road	Unstable	Ensure safety of road	**A**	Wedge Ice that extends under the road has thawed resulting in collapse. Road grade dropped about 1 m. Sinkholes in pit allow standing water adjacent to side slope. Raise the road grade about 1 m at this location, and construct side berms to protect permafrost and push any free water 3 m minimum away from toe of slope. Regrade the abandoned pit and upgrade the site drainage.	**A**	Pit and road in similar state although ponded water seems to have decreased. Recent road grading may have obscured any recent settlements	**A+**	Thaw is ongoing and pit is deepening, steepening the side slope. Drainage out of the pit flows to the south towards the lake (Photo 2702). There is some thermal degradation happening in the natural drainage probably due to increased water flow in the spring. Ideally this pit would benefit from being backfilled as this would arrest thaw, improve embankment stability and reduce spring flows.	**C**	Photo-20	This area has been filled with granular materials (minus 150 mm).
43A	46.8	-	-	-	-	-	-	-	-	**-**	-	**C**	No change since 2014	**C**	-	No change since 2019
61A	29.7	-	-	-	-	-	-	**-**	**-**	**A+**	New pit? If not a new pit it is a pit that was not reported in 2009. Extensive thaw settlement from melt out of massive ice immediately beside the road on the east side leading to very steep unstable side slopes. There is a risk of collapse of the road. The settlement areas should be filled in and at a minimum a 3 to 4 m wide toe berm should be constructed.	**-**	-	**C**	This area appeared to be dry and stable.
72	19.8 L	-	Water-filled pit	Moderate	Unknown	Moderate	Develop pit drainage	**B**	A 2 m deep pit with water. No obvious opportunities to develop drainage. Survey and determine options to drain while minimizing further cuts. May require berming along road to prevent thaw from undercutting embankment side slopes.	**A++++**	Extensive settlement is ongoing on the east side of the road and is now estimated to be upwards of 6 deep, cracking is evident on the west side and settlement is evident in several location in the road. This area needs to be reclaimed immediately to reduce the potential for catastrophic failure of the road.	**A++++**	Photos 2541 and 2542 show instability on the side slopes and observed conditions and suggested stabilization measures remain as indicated in 2014. See Section 4.0 for further information.	**C**	Photo-45	This area was graded and filled in 2021 and 2022. During the 2023 inspection, this area appeared to be stable and dry, as such no further action will be required.
74	16.9 L&R	-	Linear pits both sides with water	Moderate	Not apparent	Moderate	Develop pit drainage	**B**	Long, linear pits both sides. Left side has larger pond. No thaw features apparent. Assess drainage options. Flatten embankment side slopes where water is at the toe of slope.	**B**	Little change, although there is now more ponding on right side. Should flatten embankment slopes as noted in 2009. Limited settlement of road surface above ice wedges can be seen and may be indicative of the start of thaw of the ice wedges.	**A**	More water is ponding in the pits than noticed in 2014 and there is concern that rate of thaw will increase potentially leading to embanknt instability but road currently appears stable. Determine if it is feasible to drain water from pit to reduce potential for increased thaw. Otherwise monitor closely to evaluate road stability.	**C**	Photo-47	This area was filled and graded in 2021 and 2022. During the 2023 inspection, the area appeared to be stable and dry, as such no further action will be required.
79A	10.4 L	-	-	-	-	-	-	-	-	**-**	-	**-**	-	**C**	-	Old borrow area. Some surface disturbance but no real concern.
81	9.4 L	-	Extensive pond	Moderate	Wedge ice	Unstable	Wedge cracks flooded in pit	**B**	Flat bottom pit with no drainage. Develop drainage and fill wedge cracks evident below water level. Dress and grade surfaces.	**B**	No change	**B**	No change	**C**	-	This borrow pit was graded and filled in 2021, and no further action required for this area.
83	7.7 L&R	-	Left pit flooded, right pit wet	Moderate	Wedge ice	Unstable	Road shoulder unstable, develop drainage	**B**	Deep pits (about 3 m) no drainage. Ice wedge cracks and sinkholes. Backfill sinkholes and regrade steep slopes. Rebuild and flatten road side slopes. Regrade base and improve drainage.	**A**	Extensive settlement continues near the edge of the road embankment, threatening road stability. The recommendations from 2009 should be carried as soon as possible to reduce the chance of catastrophic failure of the road.	**A++++**	Thaw has continued and instability is more prominent on the sides of the road. The priority has therefore been increased to A++++ and therefore reclamation as per the 2009 recommendation should commence as soon as possible. See Section 4.0 for further details.	**C**	Photo-52	This borrow pit was graded and filled in 2021, and no further action required for this area.
84	6.9 R	-	Flooded	Moderate	Wedge ice	Moderate	Develop drainage	**C**	Broad flooded pit. Develop drainage. Grade and dress pond edges and road side slopes.	**C**	No change	**C**	No change since 2014	**C**	-	This borrow pit was graded and filled in 2021, and no further action required for this area.
86	3.1 R&L	Milne Inlet permitted pit	Minor pond on left, right is dry	Low	Not apparent	Stable	Regrade to protect from dusting	**B**	Small pits, silty sand poor construction material. Grade and work cover to provide a coarser cap.	**B**	No change	**B**	No change	**C**	-	This borrow pit was graded and filled in 2021, and no further action required for this area.
87	2.9R	Within permit	Localized ponding	Low	Not apparent	Stable	Regrade to protect from dusting	**B**	Large exposed pit; silty sand may need a coarser cover to protect from dusting.	**B**	No change	**B**	No change	**C**	-	This borrow pit was graded and filled in 2021, and no further action required for this area.

APPENDIX A

TETRA TECH'S LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

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1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.

APPENDIX B

PHOTOGRAPHS TAKEN DURING THE SITE INSPECTION VISIT

Photo 1 (Point 9-Priority B)	Ponded water and continuing permafrost degradation
Photo 2 (Point 10-Priority B)	Thaw settlement, excessive water pooling and dysfunctional drainage system
Photo 3 (Point 11-Priority B)	Excessive water pooling and dysfunctional drainage system
Photo 4 (Point 12A-Priority B)	Water pooling adjacent to the north edge of the road
Photo 5 (Point-QAI-01)	Water pooling at several locations along the north edge of the road
Photo 6 (Point 13A-Priority C)	General view of Area 13A
Photo 7 (Point 14 (QAI-02)-Priority A++++)	Steep embankment, deep water pooling, and evidence of instability
Photo 8 (Point 15-Priority B)	Dysfunctional drainage system and water pooling at the toe of the embankment
Photo 9 (Point 16-Priority B)	Dysfunctional drainage system and water pooling at the toe of the embankment
Photo 10 (Point 16.1-Priority C)	Dysfunctional drainage system and water pooling at the toe of the embankment
Photo 11 (Point 29-Priority B)	Partially filled, need more filling, grading, and dressing
Photo 12 (Point 30A-Priority C)	General view of Area 30A
Photo 13 (Point 33-Priority A++++)	Water pooling, ground settlement, dysfunctional drainage system
Photo 14 (Point 34-Priority C)	General view of Area 34
Photo 15 (Point 35-Priority B)	General view of Area 35
Photo 16 (Point 35A-Priority B)	Dysfunctional drainage system and poor erosion protection measures
Photo 17 (Point 36-Priority A)	Poor water management, ground settlement, and continuous permafrost degradation
Photo 18 (Point 37 (QAI-05)-Priority C)	Completed grading and filling activities
Photo 19 (Point 39-Priority C)	Completed grading and filling activities
Photo 20 (Point 40-Priority C)	Completed filling activities (filled with 150 mm minus material)
Photo 21 (Point 41-Priority A+)	Evidence of ground settlement and water pooling due to permafrost degradation
Photo 22 (Point 45-Priority C)	Minimal water ponding
Photo 23 (Point 47-Priority B)	Sinkhole (natural) has increased in size but is not yet affecting the road
Photo 24 (Point 48-Priority C)	Dry and stable borrow area
Photo 25 (Point 48A-Priority C)	Dry and stable borrow area
Photo 26 (Point 50-Priority C)	Dry and stable borrow area

Photo 27 (Point 51-Priority B)	Dry and stable right (heading north) borrow, stable with minimal water ponding for the left (heading north) borrow
Photo 28 (Point 52A-Priority C)	Dry and stable borrow area
Photo 29 (Point 53-Priority C)	Dry and stable borrow area
Photo 30 (Point 54-Priority C)	Dry and stable borrow area
Photo 31 (Point 55-Priority C)	Minor water ponding but stable borrow area
Photo 32 (Point 57(QAI-08)-Priority C)	Deep pit, appeared to be dry and stable
Photo 33 (Point 60(NIRB-03)-Priority C)	Stable, but drainage should be improved
Photo 34 (Point 61B(QAI-09)-Priority A++++)	Steep and high embankment, presence of water at the toe of the slope
Photo 35 (Point 62-Priority B)	Steep embankment and pooled water at the embankment toe.
Photo 36 (Point 63-Priority A+)	Water pooling and evidence of permafrost degradation
Photo 37 (Point 64-Priority B)	Pit bottom appeared to be wet, but no presence of standing water
Photo 38 (Point 65-Priority A+)	Pooled water and evidence of continuing permafrost degradation (left pit heading north)
Photo 39 (Point 66-Priority A+)	Pooled water and evidence of continuing permafrost degradation (left pit heading north)
Photo 40 (Point 67-Priority B)	Deep water and evidence of continuing permafrost degradation (north end of the pit)
Photo 41 (Point 68 (QAI-10)-Priority A++++)	Deep water pooling, evidence of continuing permafrost degradation, and the drainage system appeared to be dysfunctional
Photo 42 (Point 69-Priority C)	Large water pooling and dysfunctional drainage system
Photo 43 (Point 70-Priority B)	Wet bottom, settlement, and evidence of continuing permafrost degradation
Photo 44 (Point 71-Priority A++++)	Steep slope, deep water, and evidence of continuing permafrost degradation
Photo 45 (Point 72-Priority C)	Graded and filled in 2021 and 2022
Photo 46 (Point 73-Priority B)	Soft and wet pits bottom (left and right pits), but no presence of standing water
Photo 47 (Point 74-Priority C)	Graded and filled in 2021 and 2022
Photo 48 (Point 75-Priority A)	Right (heading north) pit filled and graded. Deep pooled water in the left (heading north) pit
Photo 49 (Point 79-Priority A+)	Large water pooling near the edge of the road
Photo 50 (Point 79.1-Priority A)	Large sinkhole filled by water near the right (heading north) toe of the roadway embankment
Photo 51 (Point 82A-Priority A)	Old borrow area with deep standing water near the left edge of the embankment
Photo 52 (Point 83-Priority C)	Graded and filled in 2021
Photo 53 (Point 83A(QAI-11)-Priority B)	Right borrow area was graded and filled in 2021

Photo 54 (Point 83A(QAI-11)-Priority B)	Left borrow area was partially filled in 2021, needs more grading
Photo 55 (Point 85-Priority A++++)	Slope failure along the right (heading north) edge of the Tote Road
Photo 56 (Point 85-Priority A++++)	Slope failure along the right (heading north) edge of the Tote Road

Photo 1 (Point 9-Priority B): Ponded water and continuing permafrost degradation

Photo 2 (Point 10-Prioirity B): Thaw settlement, excessive water pooling and dysfunctional drainage system

Photo 3: (Point 11-Priority B) Excessive water pooling and dysfunctional drainage

Photo 4 (Point 12A-Priority B): Water pooling adjacent to the north edge of the road

Photo 5 (Point-QIA-01): Water pooling at several locations along the north edge of the road

Photo 6 (Point 13A-Priority C): General view of Area 13A

Photo 7 (Point 14 (QIA-02)-Priority A++++): Steep embankment, deep water pooling, and evidence of instability

Photo 8 (Point 15-Priority B): Dysfunctional drainage system and water pooling at the toe of the embankment

Photo 9 (Point 16-Priority B): Dysfunctional drainage system and water pooling at the toe of the embankment

Photo 10 (Point 16.1-Priority C): Dysfunctional drainage system and water pooling at the toe of the embankment

Photo 11 (Point 29-Priority B): Partially filled, need more filling, grading, and dressing

Photo 12 (Point 30A-Priority C): General view of Area 30A

Photo 13 (Point 33- Priority A++++): Water pooling, ground settlement, dysfunctional drainage system

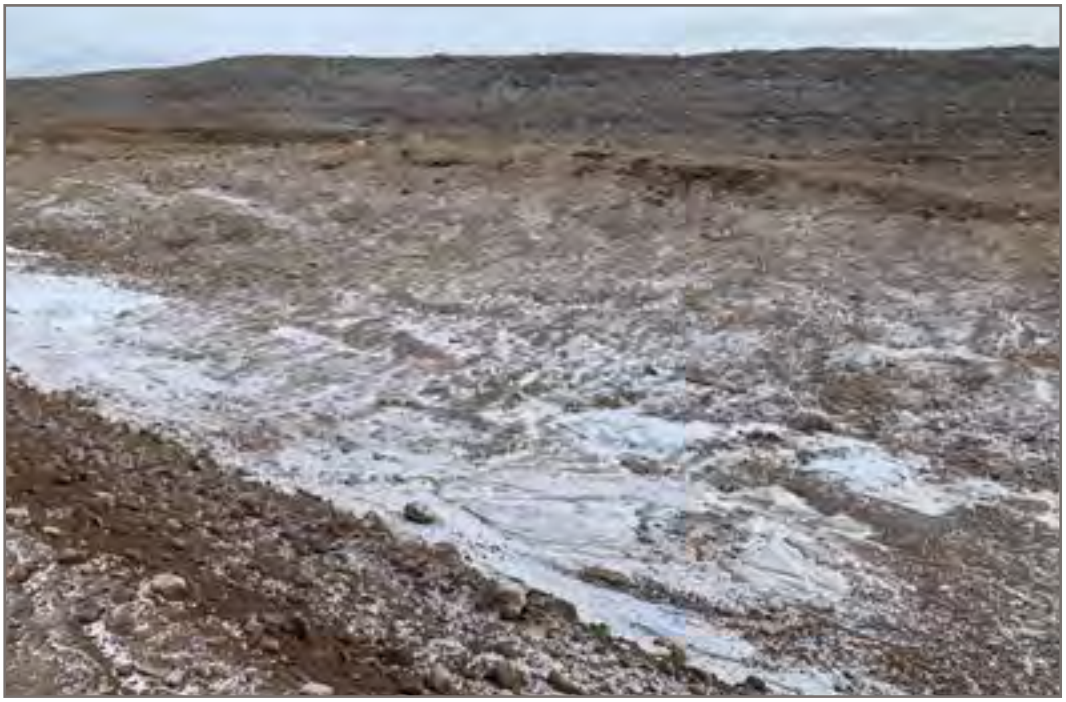

Photo 14 (Point 34-Priority C): General view of Area 34

Photo 15 (Point 35-Priority B): General view of Area 35

Photo 16 (Point 35A-Priority B): Dysfunctional drainage system and poor erosion protection measures

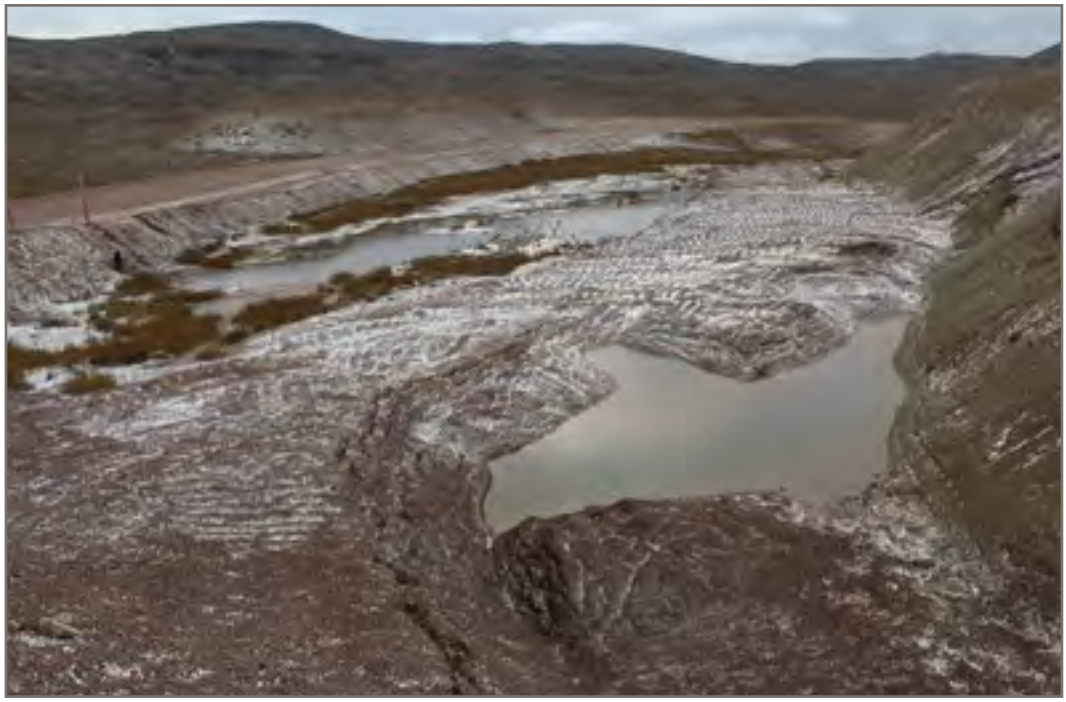

Photo 17 (Point 36-Priority B): Poor water management, ground settlement, and continuous permafrost degradation

Photo 18 (Point 37 (QIA-05)-Priority C): Completed grading and filling activities

Photo 19 (Point 39-Priority C): Completed grading and filling activities

Photo 20 (Point 40-Priority C): Completed filling activities (filled with 150 mm minus material)

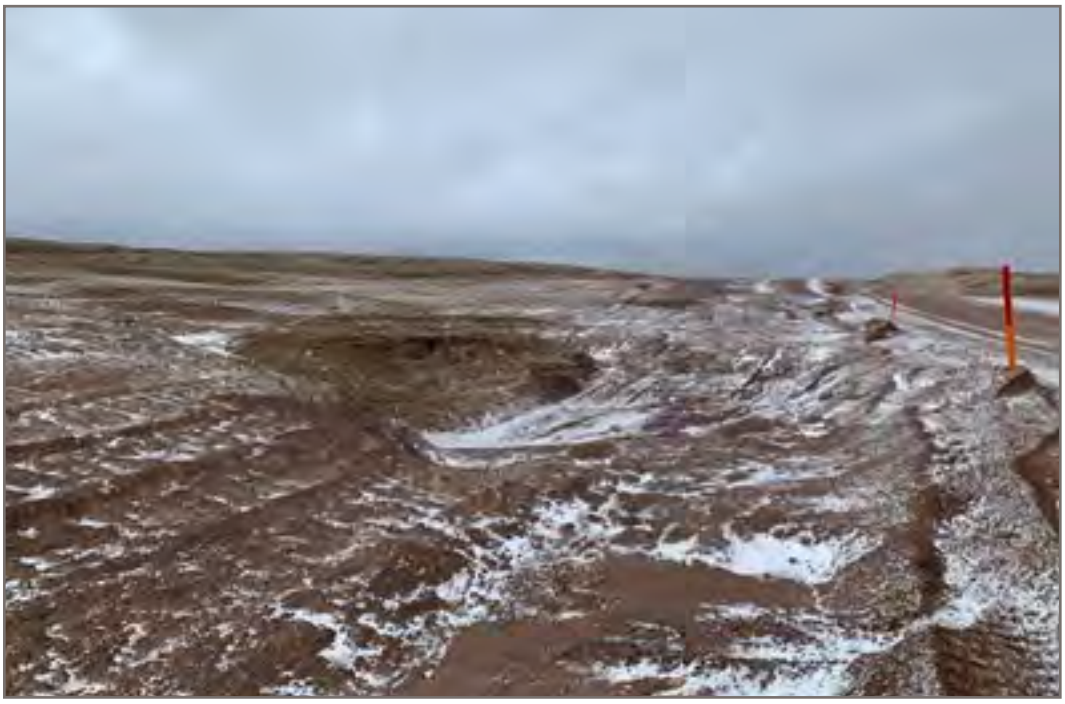

Photo 21 (Point 41-Priority A): Evidence of ground settlement and water pooling due to permafrost degradation

Photo 22 (Point 45-Priority C): Minimal water ponding

Photo 23 (Point 47-Priority B): Sinkhole (natural) has increased in size but is not yet affecting the road

Photo 24 (Point 48-Priority C): Dry and stable borrow area

Photo 25 (Point 48A-Priority C): Dry and stable borrow area

Photo 26 (Point 50-Priority C): Dry and stable borrow area

Photo 27 (Point 51-Priority B): Dry and stable right (heading north) borrow, stable with minimal water ponding for the left (heading north) borrow)

Photo 28 (Point 52A-Priority C): Dry and stable borrow area

Photo 29 (Point 53-Priority C): Dry and stable borrow area

Photo 30 (Point 54-Priority C): Dry and stable borrow area

Photo 31 (Point 55-Priority C): Minor water ponding but stable borrow area

Photo 32 (Point 57 (QIA-08)-Priority C): Deep pit, appeared to be dry and stable

Photo 33 (Point 60 (NIRB-03)-Priority C): Stable, but drainage should be improved

Photo 34 (Point 61B (QIA-09)-Priority A++++): Steep and high embankment, presence of water at the toe of the slope

Photo 35 (Point 62-Priority B): Steep embankment and pooled water at the embankment

Photo 36 (Point 62A-Priority A+): Water pooling and evidence of permafrost degradation

Photo 37 (Point 64-Priority B): Pit bottom appeared to be wet, but no presence of standing water

Photo 38 (Point 65-Priority A+): Pooled water and evidence of permafrost degradation (left pit heading north)

Photo 39 (Point 66-Priority A+): Pooled water and evidence of continuing permafrost degradation (left pit heading north)

Photo 40 (Point 67-Priority B): Deep water and evidence of continuing permafrost degradation (north end of the pit)

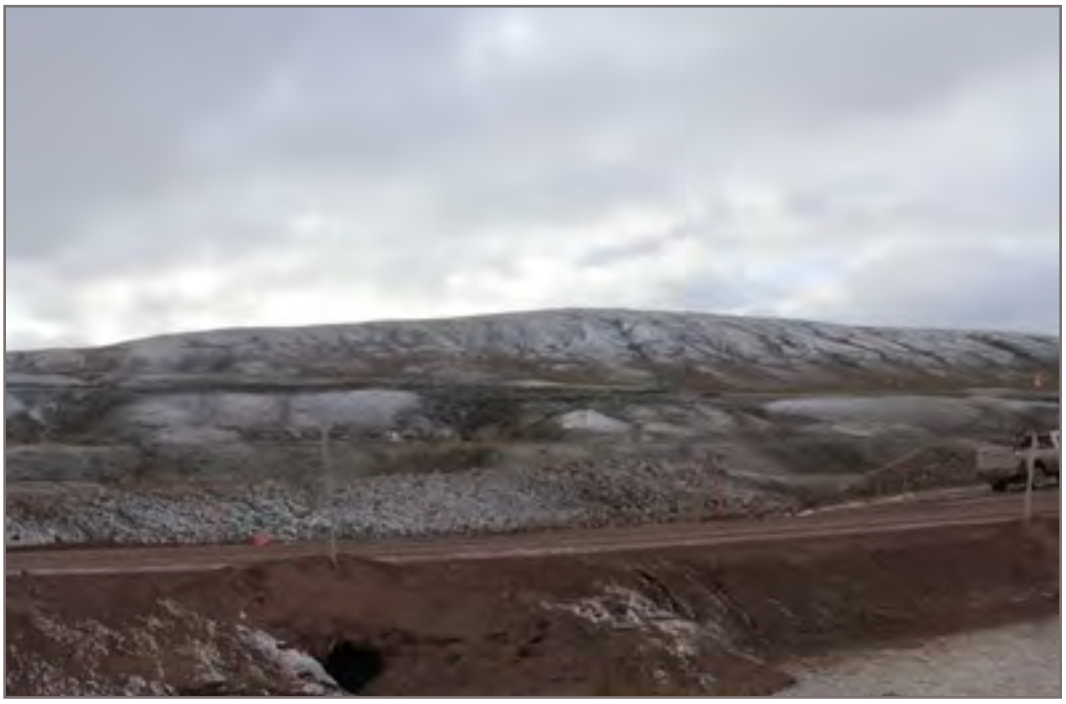

Photo 41 (Point 68 (QIA-10)-Priority A++++): Deep water pooling, evidence of continuing permafrost degradation, and the drainage system appeared to be dysfunctional

Photo 42 (Point 69-Priority C): Large water pooling and dysfunctional drainage system

Photo 43 (Point 70-Priority B): Wet bottom, settlement, and evidence of continuing permafrost degradation

Photo 44 (Point 71-Priority A++++): Steep slope, deep water, and evidence of continuing permafrost degradation

Photo 45 (Point 72-Priority C): Graded and filled in 2021 and 2022

Photo 46 (Point 73-Priority B): Soft and wet pits bottom (left and right pits), but no presence of standing water

Photo 47 (Point 74-Priority C): Graded and filled in 2021 and 2022

Photo 48 (Point 75-Priority A): Right (heading north) pit filled and graded. Deep pooled water in the left (heading north) pit

Photo 49 (Point 79-Priority A+): Large water pooling near the edge of the road

Photo 50 (Point 79.1-Priority A): Large sinkhole filled by water near the right (heading north) toe of the roadway embankment

Photo 51 (Point 82A-Priority A): Old borrow area with deep standing water near the left edge of the embankment

Photo 52 (Point 83-Priority C): Graded and filled in 2021

Photo 53 (Point 83A (QIA-11) Priority B): Right borrow area was graded and filled in 2021

Photo 54 (Point 83A (QIA-11)-Priority B): Left borrow area was partially filled in 2021, needs more grading

Photo 55 (Point 85-Priority A++++): Slope failure along the right (heading north) edge of the Tote Road

Photo 56 (Point 85-Priority A++++): Slope failure along the right (heading north) edge of the Tote Road