Anarraaq and Aktigiruq Exploration Program

Construction Rock Handling Plan

Amended February 2022

Teck

Prepared for:
Alaska Department of Environmental Conservation

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Introduction

TAI American Incorporated (TAI) originally submitted this Plan to ADEC for approval in December 2018 and received Conditional Approval of the Plan on February 1, 2019, with the requirement that final cover designs be approved by ADEC prior to final disposal of any segregated construction rock.

TAI postponed construction of the project through 2022 and currently plans to initiate road construction in early 2023. Minor changes in the proposed road alignment were made since 2018 and the proposed waste rock storage facility has been eliminated from the project altogether. This amended document is being provided to ADEC to reflect these changes. No changes have been made to the procedures and best management practices for managing construction rock. As a result, except for modifications to this Introduction and the figures to reflect changes to the road alignment, and the removal of the waste rock facility, the remainder of this Plan remains unchanged from 2018.

We are submitting this Amended Plan to ADEC for their endorsement. TAI intends to implement this Amended Plan as the primary tool for managing construction rock during the construction of the infrastructure for this explorations project including the roads, material sites and the facility pads.

TAI has proposed constructing an exploration access road between the Red Dog Mine and the Anarraaq and Aktigiruq exploration area located approximately 10 miles north of the mine. The access road and approximately 3 miles of spur roads would provide access to six pads required for camp facilities, portal access, laydown and ventilations raises. The access road would cross state and NANA land; the pads will be on State land. Construction fill material for the roads and pads will be excavated from four material sites; two sites will be on NANA land, two on state land. Construction of the roads, pads and material sites on State land will be authorized by ADNR under a Plan of Operations Approval anticipated in mid-2022. Authorization for construction activities on NANA land is pending. The roads, pads and material sites are illustrated on Figure 1. Road construction is tentatively scheduled to begin in early 2023.

The road construction method will primarily be fill on native ground with minimal cut. But in places where cuts are necessary some bedrock will be exposed and excavated. The underlying geology along the access road and in the AAEP area is quite like the geology at the Red Dog Mine. Based on geologic mapping completed by TAI, we recognized that potentially acid generating (PAG) geologic units, like those known to occur around the mine, exist within the proposed access road corridor and at the pad sites. TAI estimates that it may generate 42,000 m^3 of PAG material, more or less, that will have to be managed during the construction program.

Starting in 2017, TAI worked closely with SRK consulting to: 1) integrate existing geological and geochemical data to identify areas where PAG rock might be exposed during construction, 2) execute field mapping and sampling programs to confirm the geology and geochemistry of the units and refine the understanding of the distribution of PAG rock, 3) develop a method for verifying the PAG character of the rock in the field using a portable XRF, and 4) develop this

Construction Rock Handling Plan (Handling Plan) with best management practices (BMP's) for managing PAG during construction.

The objectives of the Handling Plan are to: 1) provide field procedures that enable ARD classification of "bedrock" exposed in cut sections of the roads, pads and material sites during construction, and 2) ensure that rock that is classified as PAG is properly managed.

This Handling Plan describes the best management practices (BMP) that will allow TAI to proceed with construction activities on a typical construction schedule while identifying and managing any PAG material it encounters in a way that minimizes the potential for release of acid rock drainage.

Certain geologic units in the project area are known to be consistently PAG based on a large number of lab analyses (this project and at Red Dog Mine). Others are consistently non-PAG. This is reflected on the ARD Classification maps in this Handling Plan. But other units are variably PAG or non-PAG. This Handling Plan is more directed at these units with variable geochemistry that require site-specific ARD classification in the field during construction.

TAI is seeking to secure ADEC's approval of this Handling Plan under 18 AAC 60.005(e)(1). 18 AAC 60.005(e) states: If a person treats a waste and demonstrates to the department's satisfaction that the potential for a release of hazardous constituents is eliminated by the treatment and the treated waste will not present a threat to the public health, safety, or welfare or to the environment, the department will allow the treated waste to be managed as an inert waste under 18 AAC 60.460 or an exempt waste under (c) of this section. The operator of the treatment works must

(1) Secure the approval of the department before handling the waste as inert or exempt under this subsection; and
(2) Keep records demonstrating that all waste managed under this subsection was treated in the manner on which the approval was based.

This Handling Plan also contains some discussion of the background study work, including the work that validated the portable XRF instrument as a suitable tool for "real-time" ARD classification of materials in the field. Supporting information is also included as Appendix A.

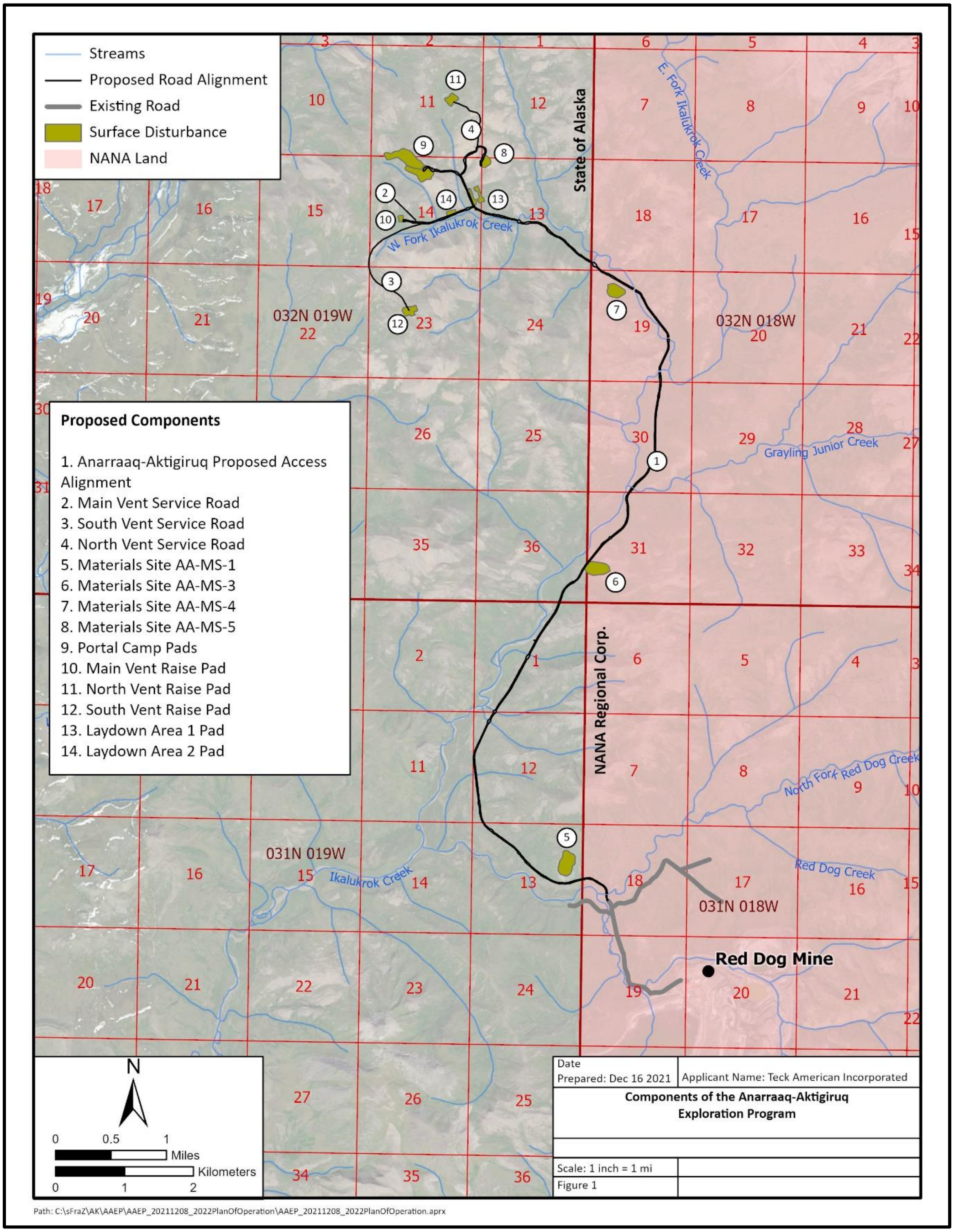

Figure 1. Project Map including Roads, Material Sites and Pads

1.0 CONSTRUCTION ROCK HANDLING PLAN

This Construction Rock Handling Plan will be applied to all road construction, pad construction and material site construction activities for the project. For the purpose of the Handling Plan “bedrock” is defined as rock that is in-place, competent enough to require blasting or ripping to remove, or is less competent (weathered) but retains enough mineralogical and other geologic characteristics that the field geologist can reasonably conclude that it is weathered bedrock, in-place, and not transported material (i.e., not colluvium, till or alluvium). Material not meeting these criteria for “bedrock” is considered overburden and is not subject to this Plan. For the purposes of the Handling Plan, excavated “bedrock” and construction rock are synonymous.

1.1 Best Management Practices for ARD Classification of “bedrock” for All Road, Pad and Material Site Construction Activities

The following field procedures will be implemented by a field geologist whenever “bedrock” is initially exposed at a road or pad cut or in any of the material sites. The field geologist will have enough experience working with the geologic units in the Red Dog area that they are qualified to implement the BMP’s.

- In advance of the start of any excavation that is anticipated to expose “bedrock”, the field geologist will refer to the ARD Classification maps (Figures 3-7) to confirm which geologic unit is expected in the excavation. These ARD Classification maps include geologic information and ARD classification information.
- The geologist will refer to the same maps to determine if that geologic unit has been pre-determined as PAG, non-PAG or as Uncertain ARD classification.
- Once “bedrock” is exposed in the excavation the geologist will examine the “bedrock” and assign it one of the recognized geologic units (typically should agree with map). If the geologist determines the “bedrock” is not part of the geologic unit assigned to it on the ARD Classification map then the ARD classification will continue with the steps in this section and then perform the additional BMP’s in Section 1.3 for Uncertain category rocks.
- The geologist will examine hand samples of the “bedrock” exposure and visually estimate the sulfide types and abundance (%) of each.
- The geologist will collect portable XRF (pXRF) readings for Sulfur as Fe-sulfide and Acid Potential (AP) from at least five fresh “bedrock” surfaces within the excavation within a $25m^2$ area. The pXRF will be pre-programmed for these readings and the calculation process is automated.
- The geologist will use dilute (10%) HCl to perform fizz tests on the same “bedrock” surfaces for the presence of carbonate and describe the effervescence as 1) none, 2)

weak (few bubbles, slight and/or delayed reaction), 3) moderate (near immediate reaction, many bubbles), or 4) strong (immediate reaction, audible ‘fizz’).

- The geologist will record the gps coordinates, a geologic description (geologic unit, color, mineralogy, lithology, grain size, sulfide types and concentrations), the pXRF Acid Potential (AP) readings, results of the HCl fizz test and the assigned ARD classification as PAG or non-PAG (see Sections 1.2 and 1.3) in a field notebook, or electronically, to comply with requirements of 18 AAC 60.005(e)(2).
- These procedures will be repeated in any cut where the cut crosses a contact between two geologic map units identified on the ARD Classification map, or there is a change in the predetermined ARD classification on the map for that cut.

1.2 Additional Best Management Practices for ARD Classification of “Bedrock” in Areas Predetermined as PAG or non-PAG on ARD Classification Maps

- If the cut area has a predetermined ARD classification on the maps, then after completing all steps in Section 1.1, the geologist will instruct operations to manage the material as PAG or non-PAG based <u>on the predetermined ARD classification on the ARD Classification maps (Figures 3-7)</u>, NOT the results of the pXRF and fizz-test. In all cases, exposures identified as PAG on the ARD Classification maps should be managed as PAG, and non-PAG should be managed as non-PAG, unless it was determined that the geologic unit in the cut is not the one that is assigned on the ARD Classification maps. This is because these predeterminations are based on lab data.
- On road cuts, the geologist will instruct operations to haul all PAG cut material to the designated stockpile area at AA MS-1.
- On pads the geologist will give operations the option of hauling the material to the stockpile at AA MS-1 or using it as internal fill in the same pad but operations is responsible for making sure the PAG fill is placed more than 100 ft. inside the design edge of the pad and is covered with clean fill as part of the pad construction.
- Material sites have been designed to avoid known PAG units but any PAG that is identified in material sites should be left in these material sites and any further excavation of that material should be avoided.

1.3 Additional Best Management Practices for ARD Classification of “bedrock” In Areas Designated as Uncertain on the ARD Classification Maps

- Areas may be classified on the ARD Classification maps (Figures 3-7) as Uncertain if: 1) representative sampling was not possible (lack of outcrops), or 2) samples were collected, and the results fall in the “Uncertain” ARD classification category or that unit has a wide range of ARD classification. It is also possible the geologist on site will determine that the exposed “bedrock” is not consistent with the geologic unit assignment on the ARD Classification Map. So, there may be geologic uncertainty or geochemical uncertainty associated with any “bedrock” exposure.

- After completing all steps in Section 1.1, the geologist will characterize the material as PAG or non-PAG and manage it accordingly, on the basis of the results of the pXRF and fizz-test as follows:
    - Samples with an average pXRF AP value < 3 (kg CaCO3/t) and a trace or less sulfide will be classified and managed as non-PAG, regardless of fizz test results.
    - Samples with an average pXRF AP value of 3 to 31 (kg CaCO3/t), a moderate or strong fizz rating and only a trace of sulfide will be classified and managed as non-PAG.
    - Samples with an average pXRF AP value of > 3 kg CaCO3/t and a weak or absent fizz rating, regardless of sulfide concentration, will be classified and managed as PAG
    - Samples with an average pXRF AP value of > 31 kg CaCO3/t, regardless of fizz test results or sulfide concentration, will be classified and managed as PAG.
- The geologist will instruct operations to handle the material as PAG or non-PAG as follows:
    - On road cuts, the geologist will instruct operations to load and haul all PAG cut material to the designated stockpile area at AA MS-1.
    - On pads the geologist will give operations the option of hauling the material to the stockpile at AA MS-1 or using it as internal fill in the same pad with operations being responsible for insuring that the fill is placed more than 100 ft. inside the designed edge of the pad and will be covered with at least 3 ft. of clean fill as part of the pad construction.
    - In material sites any PAG identified in material sites should be left in these material sites.
    - On road cuts, pads or material sites the geologist will instruct operations that they are free to use all non-PAG material as fill wherever it is needed.

1.4 Allowable Uses for non-PAG and PAG “Bedrock”

1.4.1 Non-PAG Construction Rock

“Bedrock” material excavated from any road cut, pad or material site that is classified by the field geologist as non-PAG using the BMP’s outlined in the Handling Plan may be used as fill anywhere else on the project.

1.4.2 PAG Construction Rock

“Bedrock” material that is classified by the field geologist as PAG using the BMP’s outlined in this Handling Plan must be handled as follows.

- PAG “bedrock” that must be moved (pushed, blasted, ripped, excavated) as part of any cut in any road must be removed and hauled to material site AA MS-1 for stockpiling and storage.
- PAG “bedrock” material that must be moved (pushed, blasted, ripped, excavated) within the footprint of any of the pads can be used as fill within the same pad with the caveat that it is placed as fill at least 100 feet from the exterior edge of the pad and that the PAG material is covered with at least 3 feet of clean (i.e. non-PAG) fill.
- PAG “bedrock” material that must be moved (pushed, blasted, ripped, excavated) within the footprint of any of the material sites cannot be used as fill anywhere else on the roads or pads and should be left in place at that material site.

1.5 Final Disposal of PAG Construction Rock

The field procedures describe that all construction rock that is classified as PAG will be hauled to material site AA-MS-1 where it will be stored, except for PAG that may be used as internal fill in the pads. AA-MS-1 has been chosen as the appropriate storage site because the bedrock geology at AA-MS-1 consists of Kogruk Formation limestone. Its calcareous nature provides excellent buffering capacity for any ARD coming off the PAG stockpile. TAI anticipates leaving this stockpile in place for up to 2 years and may permanently dispose of the PAG at the Red Dog Mine. At the end of the road construction, TAI will evaluate the best option for permanently disposing of the PAG and collaborate with ADEC on the authorizations required for the permanent disposal.

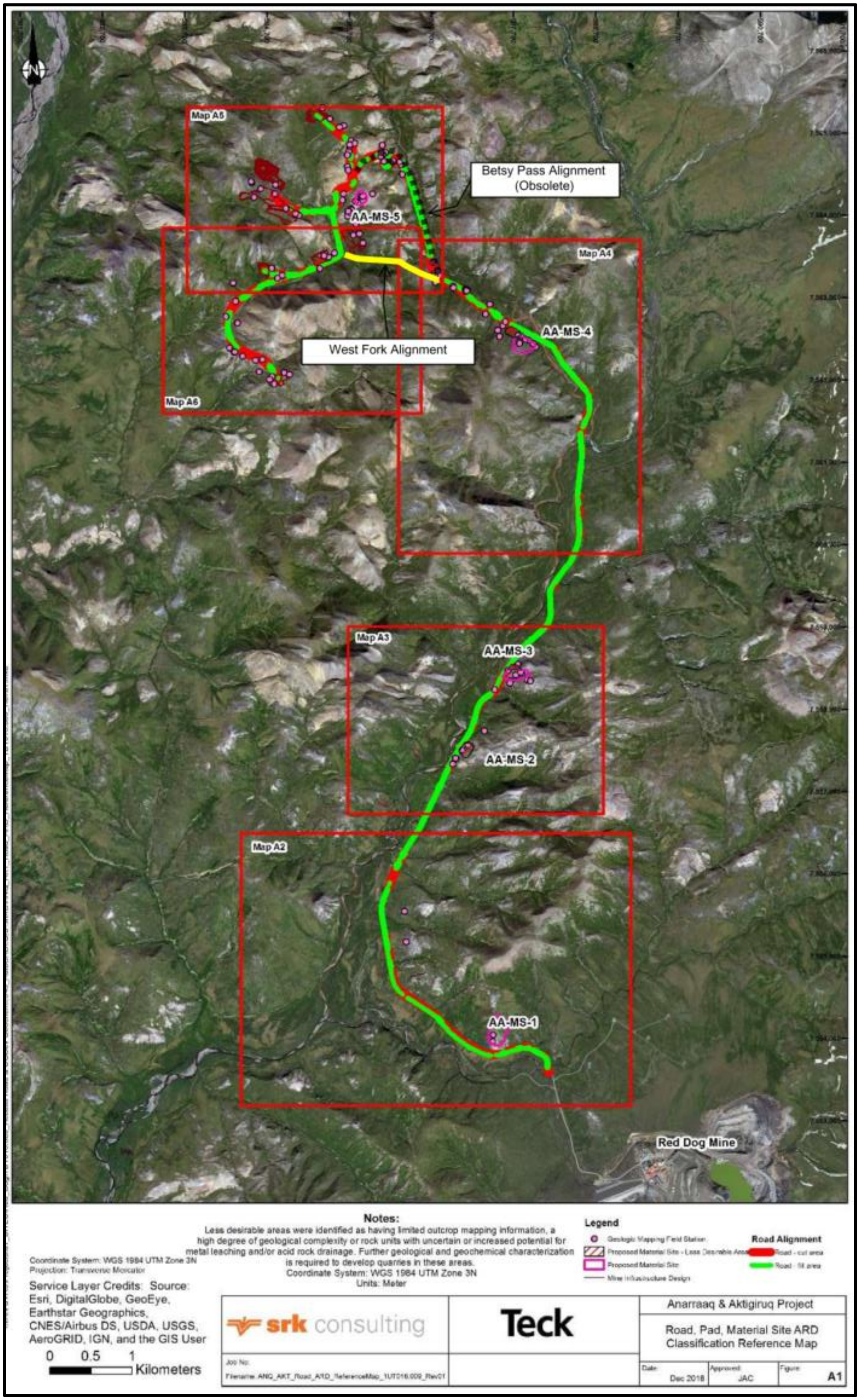

Figure 2. ARD Classification Reference Map

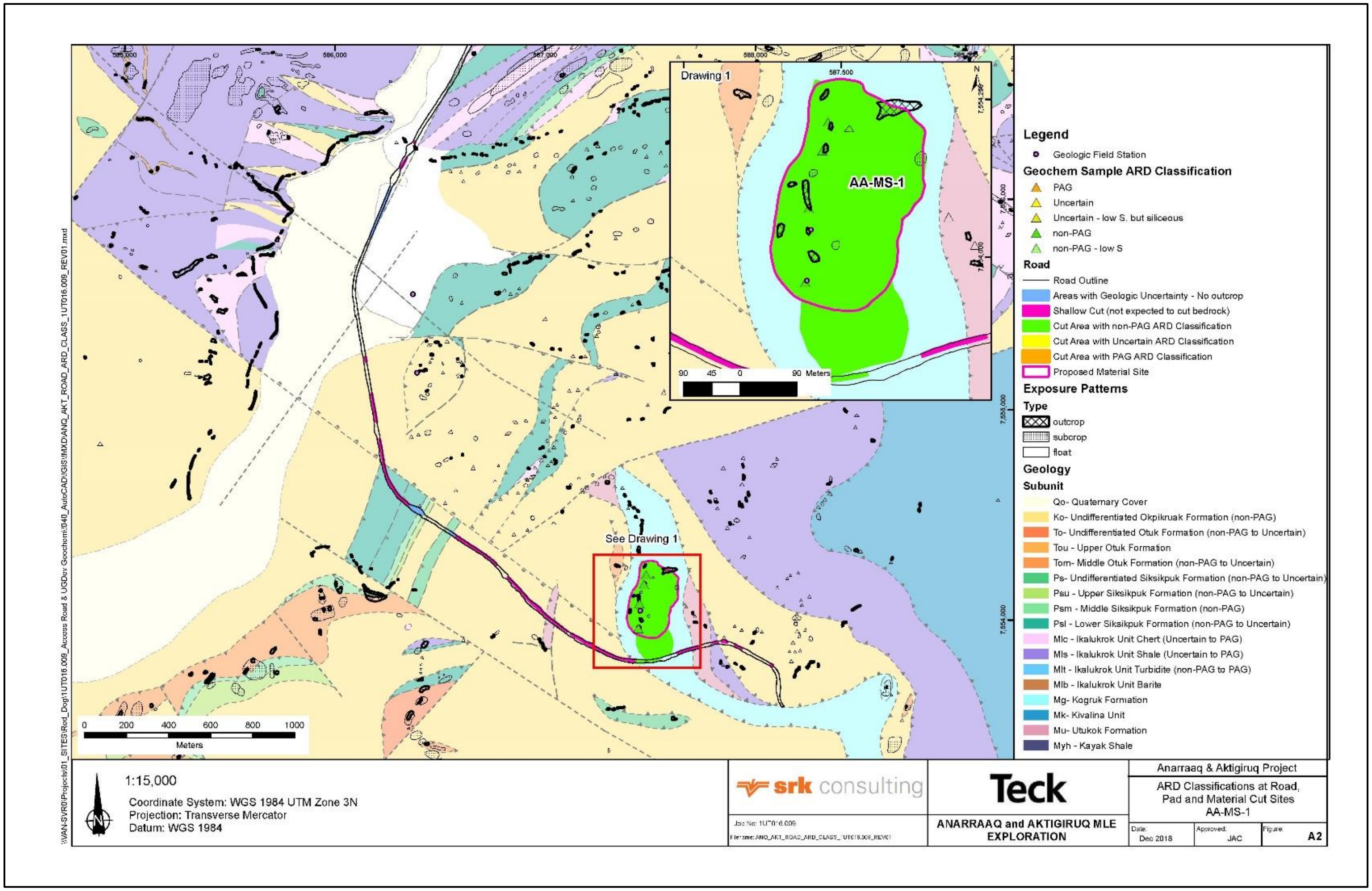

Figure 3. ARD Classification and Geology Reference Map for Road and Material Site AA-MS-1

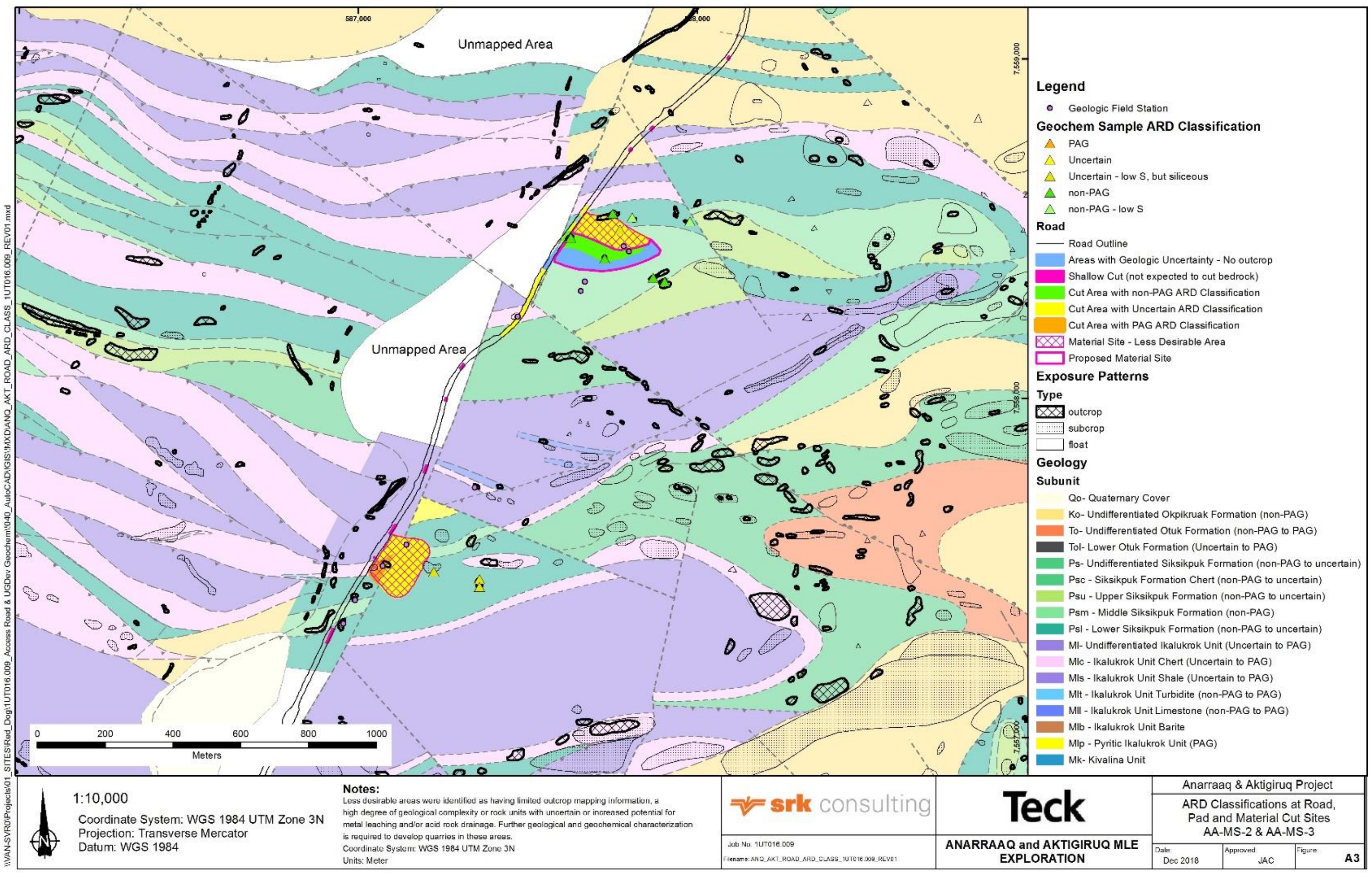

Figure 4. ARD Classification and Geology Reference Map for Road and Material Sites AA-MS-2 and AA MS-3

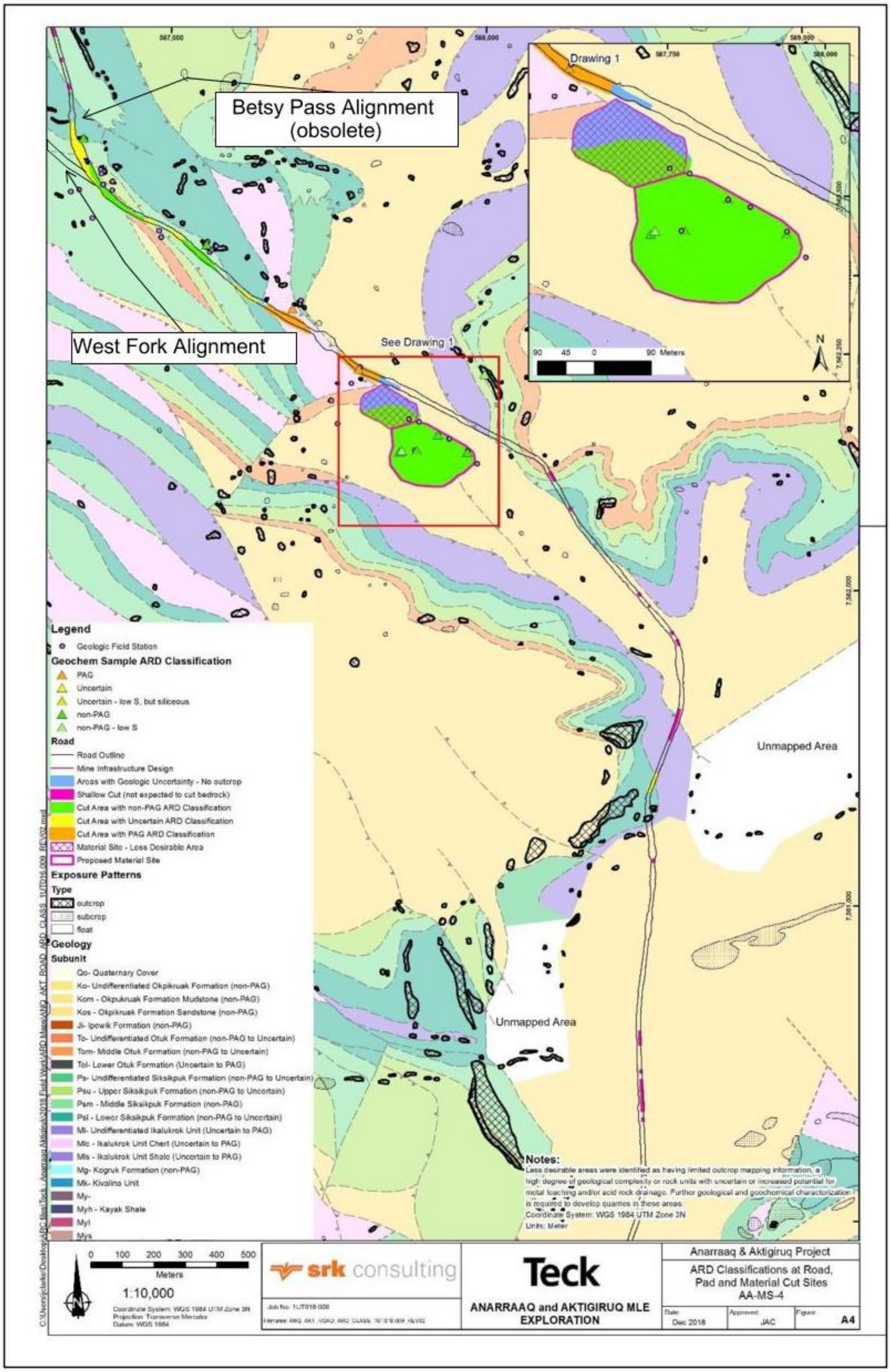

Figure 5. ARD Classification and Geology Reference Map for Road and Material Site AA MS-4

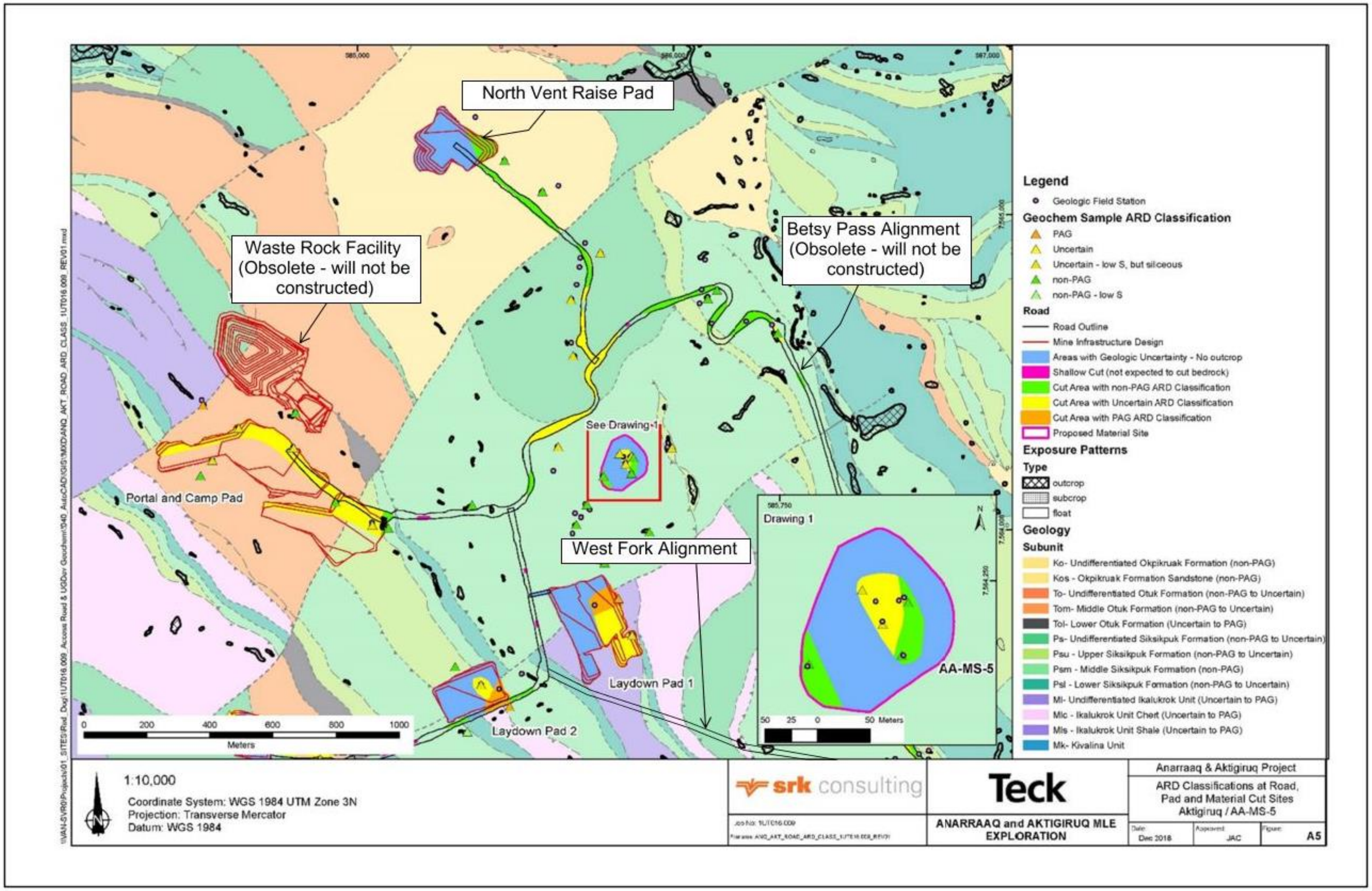

Figure 6. ARD Classification and Geology Reference Map for Road, Pads and Material Site MS AA-5

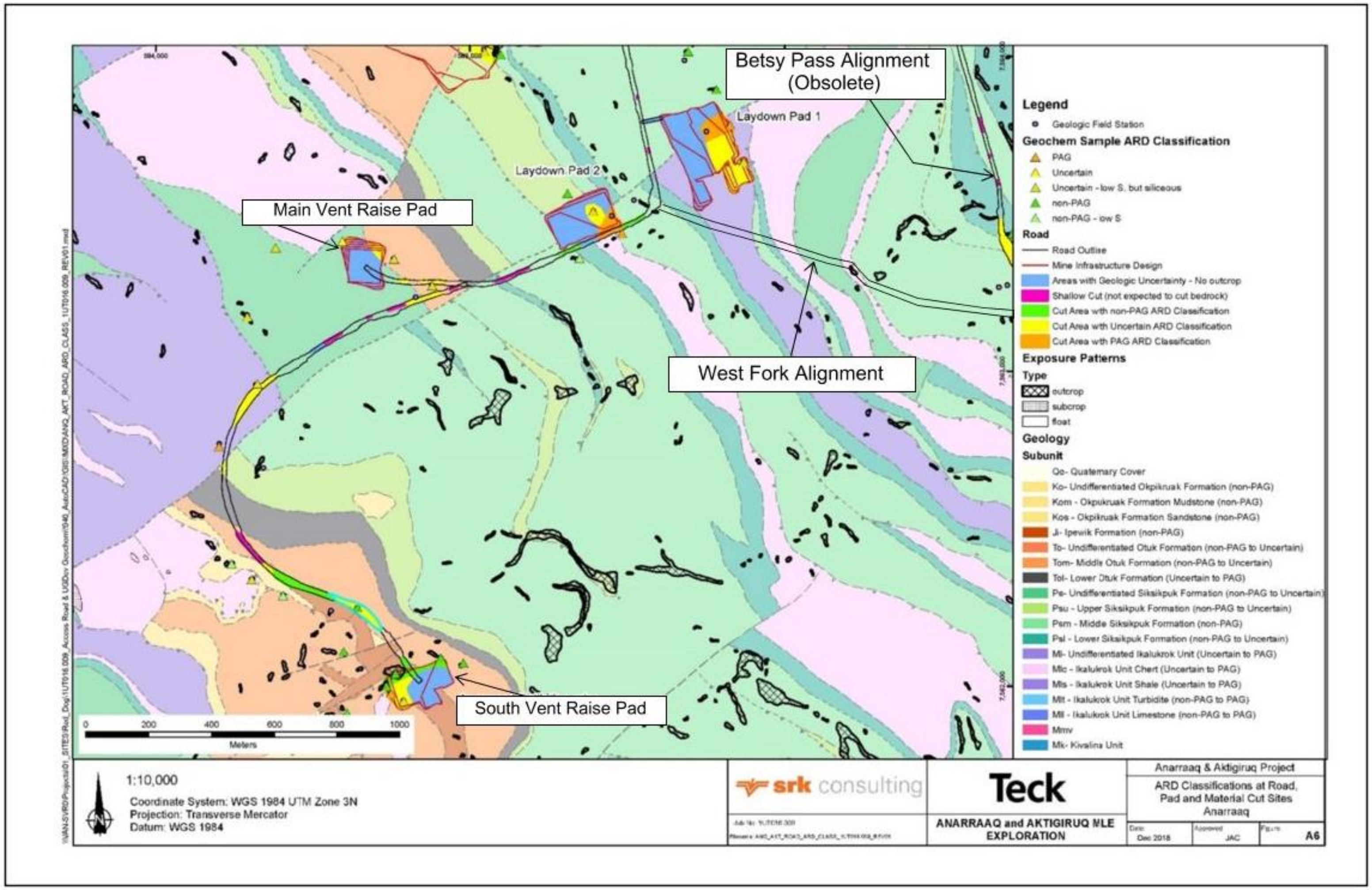

Figure 7. ARD Classification and Geology Reference Map for Roads and Select Pads

2.0 DISCUSSION

In this section background information used to develop this Handling Plan is discussed. Additional Supporting information is included in the Appendix A.

One of the challenges with managing construction material in the field is the ability to classify it as PAG or non-PAG in real-time under a typical daily construction schedule. Under different circumstances, ARD classification of construction or waste material is accomplished by collecting samples and processing them at a commercial laboratory to generate the acid-base-accounting data that allows an assessment of the rock's capacity to generate acid. However, the laboratory analyses can take weeks and is not a practical solution for construction. Some mines have adopted the use of site-based XRF into their waste rock characterization process which allows sample-to-analytical results turnaround time of a few hours. But even this requires a degree of sample preparation (sample drying, splitting, crushing, grinding) which takes several hours and is impractical for construction. Portable XRF's are being increasingly used for simple tasks of mineral identification and in some cases concentrations of silver and gold. The ability to use a handheld XRF in the field for classification of construction rock would be a definite advantage over the other options. The concept was to rely on a hand help XRF during road construction to classify construction rock as either PAG or non-PAG if it could be shown that the handheld XRF could generate the accurate and precise data required for the ARD classification.

For this project TAI and SRK investigated the effectiveness of using a portable XRF instrument (Niton XL3t950 GOLD model) to generate accurate data for the concentrations of S, Ba, Zn and Pb to then calculate the acid potential (AP) of rocks, and then see if AP could be a meaningful cutoff criteria distinguishing PAG from non-PAG for the kinds of rocks known to occur in the Red Dog Mine and Anarraaq and Aktigiruq exploration area.

TAI and SRK used a set of 38 samples consisting of drill core and outcrop grab samples from the Anarraaq and Aktigiruq exploration area to perform the suitability tests on the portable XRF. After collecting XRF measurements from the 38 samples the results were compared to laboratory analyses for the same samples. The 38 samples represent the suite of rock types (lithologies) known to occur in the project area and a range of ARD classifications (strong PAG to strong non-PAG and Uncertain).

The results of the trial study showed that the XRF results had a strong linear correlation with the lab results for Ba, S, Zn and less so for Pb as shown in the following graphs. These are the elements that are critical in establishing the Acid Potential of the rock. As it turned out the Pb concentrations were so low that the poor correlation had no effect on the XRF's usefulness. However, the linear correlation was not 1:1 so a calibration was applied to the XRF which then showed a good 1:1 correlation with the lab data as shown in Figures 8 -10 below.

In Figure 8 total sulfur is compared between the uncalibrated XRF and the calibrated XRF compared to the total sulfur lab results using a Leco furnace.

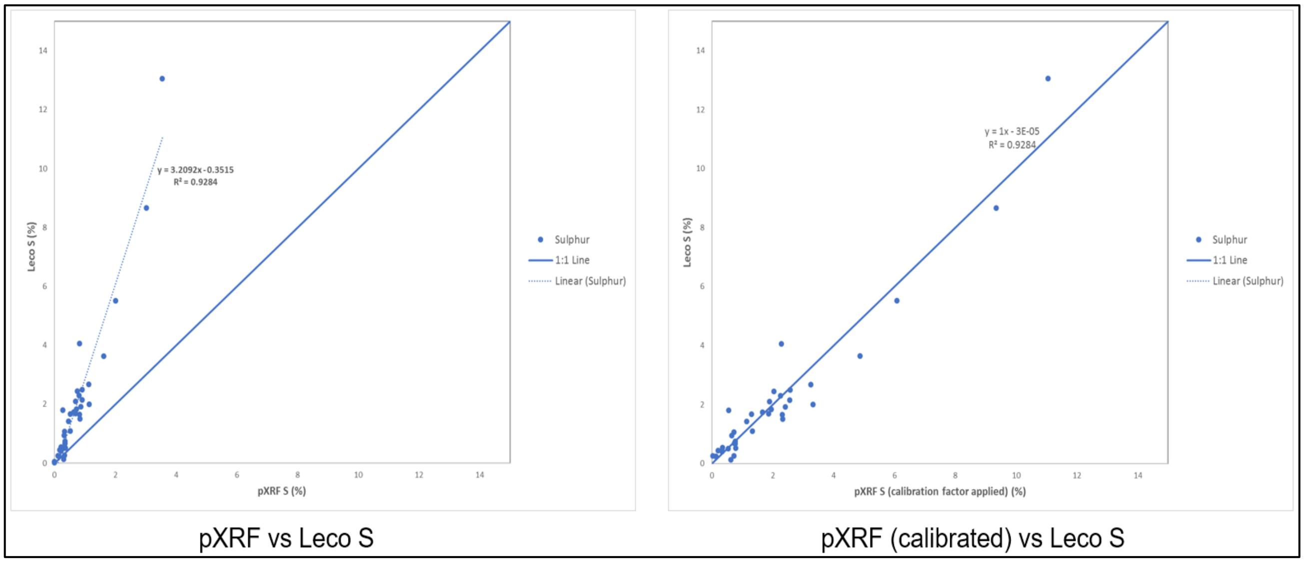

Figure 8. Comparison of XRF and Leco Furnace Results for Total Sulfur

In Figure 9 uncalibrated and calibrated XRF data for barium are compared to the lab results using lithium borate fusion method.

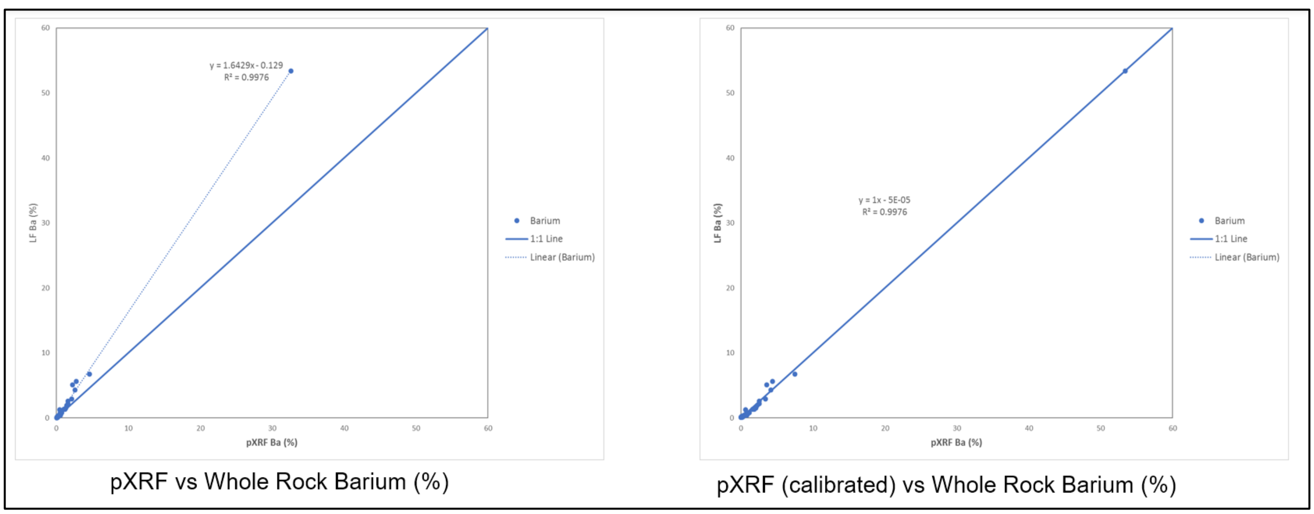

Figure 9. Comparison of XRF and Whole Rock Analyses Results for Barium

In Figure 11 the calibrated XRF data are compared to Zn and Pb lab results. The calibrated Zn correlation is quite good but the Pb is poor. Fortunately, Pb values are quite low and do not affect the outcome of the study.

Arguably the most important plot is Figure 12 which plots S as Fe-sulfide from the calibrated XRF vs that from the lab data. This is the most direct evidence that the portable XRF can generate the Acid Potential of the samples. Acid Potential is calculated using the amount of Fe as Fe-sulfide present in a sample after factoring for S as barite, sphalerite, galena and total sulfur. Pb values are so low that they could be eliminated from the formula with no effect on the calculated S as Fe-sulfide. The next calculation is to factor the S as Fe-sulfide by 31.25 to generate the AP as kg $CaCO^3$/tonne. All of the calculations can be programmed into the XRF, so it is a fairly automated process of generating an AP value for any sample in the field in a matter of minutes. Figure 10 is a photo of the XRF screen.

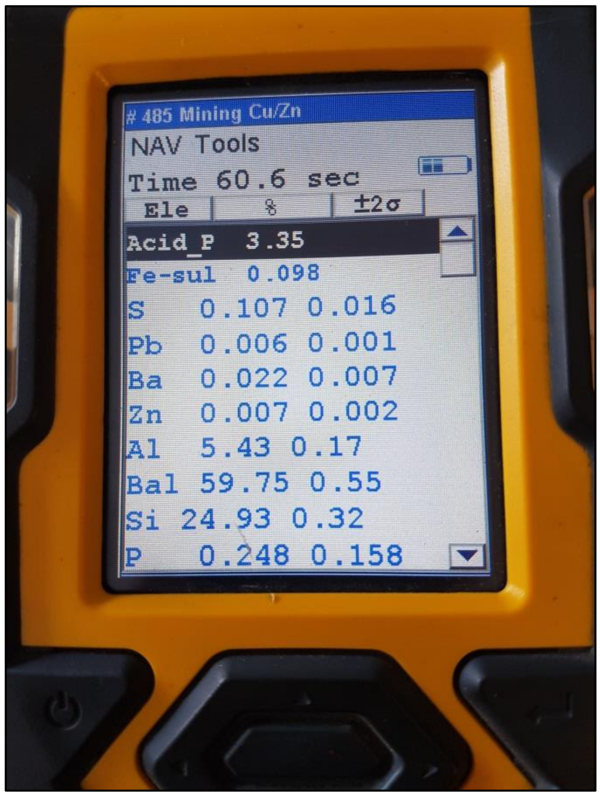

Figure 10. Niton handheld XRF Display Showing Calculated S as Fe-sulfide and Acid Potential (Acid_P) Value and Supporting XRF Measurement Data

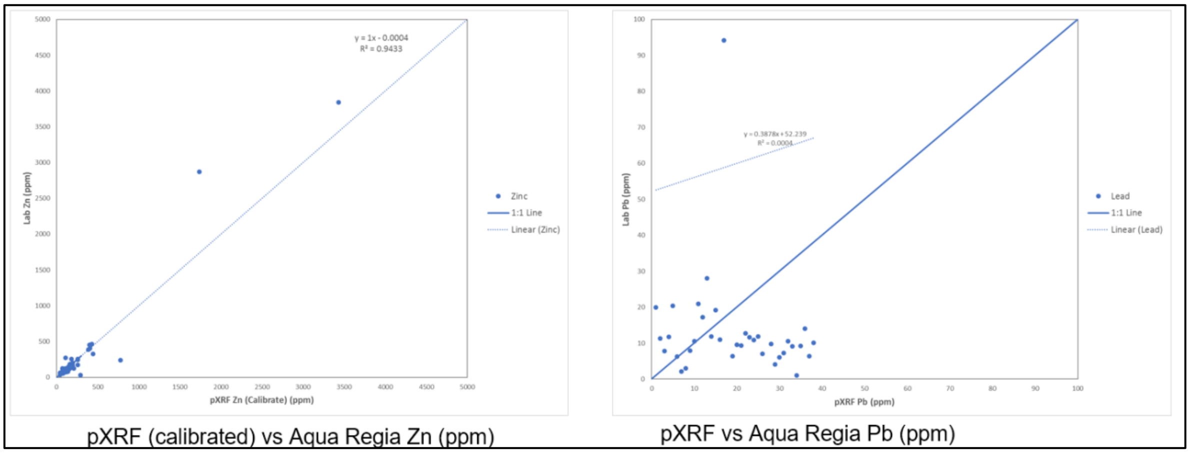

Figure 11. Comparison of XRF and Lab results for Zn and Pb

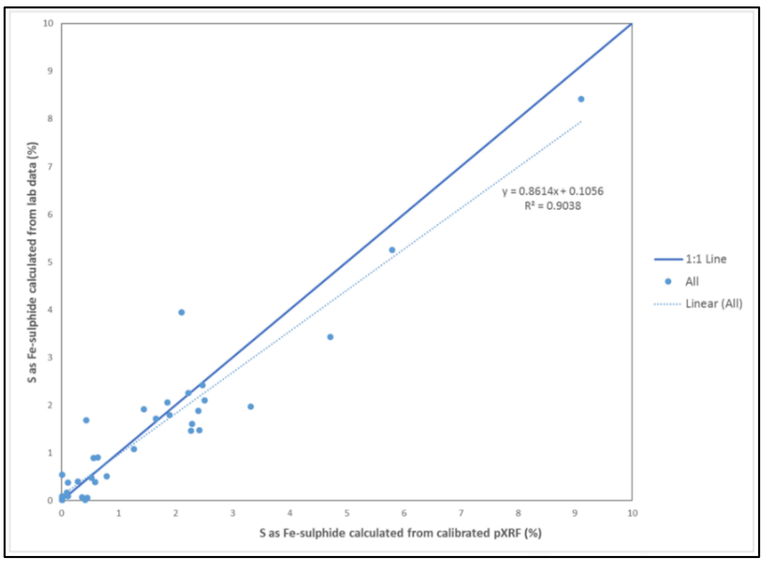

Figure 12. Comparison of Calibrated XRF and Lab results for S as Fe-sulfide

Figure 13 uses the NP/AP ratios from the lab data and it is plotted against the calibrated XRF data for S as Fe-sulfide. The sample points are also color coded as PAG, non-Pag or Uncertain based on the lab data. The plot shows that a line at 0.1% S as Fe-sulfide broadly separates non-PAG samples from PAG and Uncertain samples. Admittedly the PAG field does include 4 samples that are color-coded as non-PAG based on the lab data. But this just means that using the 0.1% S as Fe-sulfide as a cutoff is conservative in that you may be placing non-PAG material in the segregated PAG stockpile, but you will not be placing PAG as construction fill, which is the highest priority. Another line at approximately NP/AP ratio of 9 generally separates a group of non-PAG samples that exceed the 0.1% S as Fe-sulfide. These samples have abundant calcite which exhibits strong effervescence in HCl. So, for field samples that have S as Fe-sulfide values of 0.1 to 10% but also exhibit strong effervescences, they can be classified as non-PAG. The 0.1% S as Fe-sulfide cutoff in the graph translates to an equivalent Acid

Potential (AP) of 3.125% $kgCaCO^3$/tonne which is what the BMP's in this Handling Plan are based on.

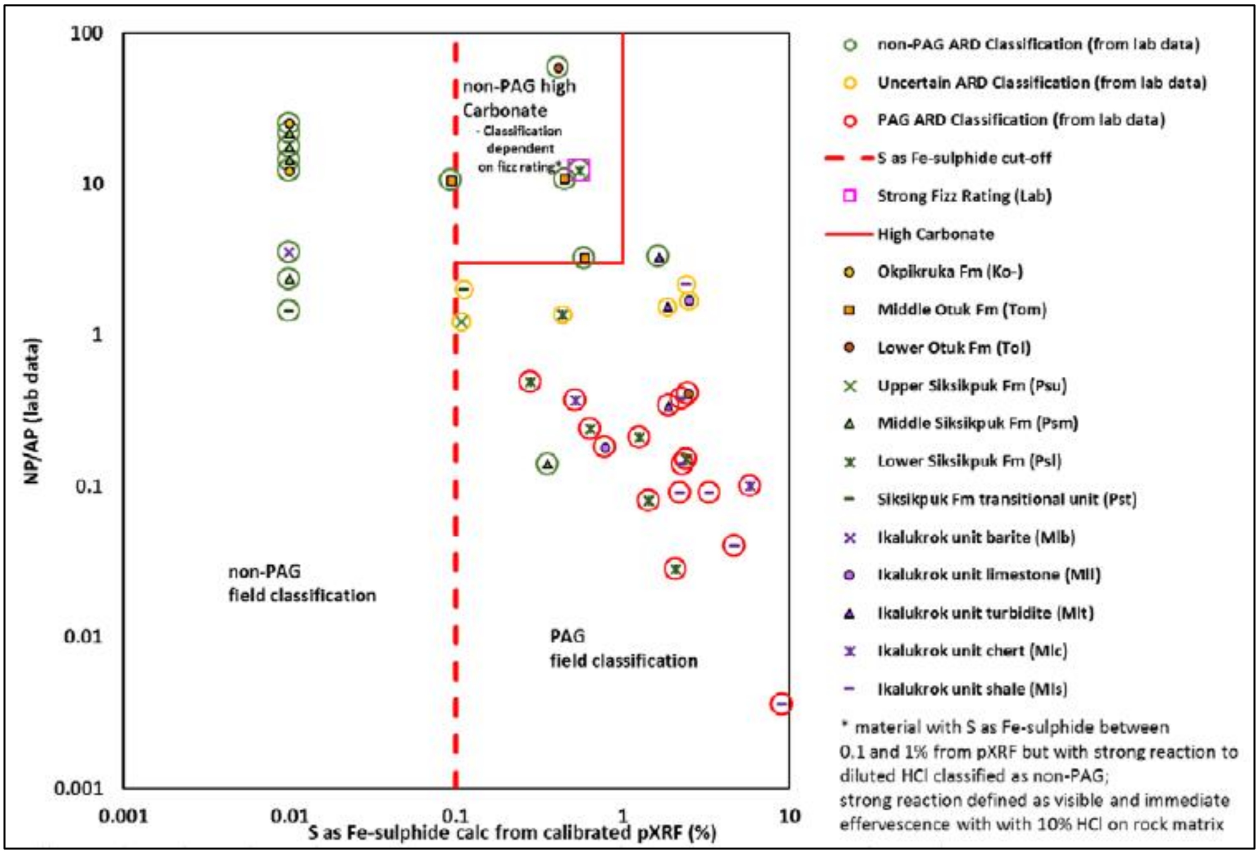

Figure 13. Comparison of calibrated XRF data for S as Fe-sulfide and NP/AP ratios from lab data

APPENDIX A

ANARRAAQ AND AKTIGIRUQ ROAD DEVELOPMENT FIELD SEGREGATION CRITERIA MEMO

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Memo

To:	Jack DiMarchi, TAI	**Client:**	Teck America Inc.
From:	Jeff Clarke SRK Kelly Sexsmith, SRK	**Project No:**	1UT016.009
Cc:	Don Hufsmith TAI Warren Yau TAI	**Date:**	December 18, 2018
Subject:	Anarraaq and Aktigiruq Road Development Field Segregation Criteria		

1 Introduction

Teck American Inc (TAI) are proposing the construction of a road, pad sites and material sites to access and develop the Anarraaq and Aktigiruq (A&A) project located 8 miles northwest of the Red Dog mine site. This memo summarizes a field segregation strategy to separate non-potentially acid generating (non-PAG) material from uncertain or PAG material, as well as a synopsis of the existing results and trials used to develop the segregation criteria and plan. Non-PAG material will be usable as construction material, whereas material classified as uncertain or PAG material will require additional management.

2 Supporting Information

2.1 Geochemical Characterization Results

In 2017 and 2018, SRK collected a total of 81 surface rock samples from outcrop, subcrop and angular float, and near surface drill core samples from areas near planned cuts along the road design, pad sites and material sites. Acid-base accounting (ABA) and elemental analysis was completed on these samples to assess the metal-leaching/acid-rock drainage (ML/ARD) potential and requirements for management of the material. Details on the 2017 and 2018 geochemical characterization programs and results are provided in “Interim Static and Kinetic Geochemical Characterization of Access Road Cuts, Material Sites and Pad Sites Anarraaq and Aktigiruq Project” and “Interim Static and Kinetic Geochemical Characterization of Waste Rock from Proposed Underground Exploration Workings at the Anarraaq and Aktigiruq Project” (SRK 2018a, b).

The ARD classification criteria and calculation methods used is outlined in Section 3.5 and 3.6 of SRK 2018a. Figure 2-1 presents results of acid potential (AP) versus modified neutralization potential (NP) to show the distribution of samples classified as PAG, uncertain and non-PAG by rock type from samples collected near the cut sites.

Most samples had a very low sulfide content and therefore low AP (<5 kg $CaCO_3$/t), indicating limited acid potential. These samples have been classified as non-PAG to uncertain depending on the rock type on the basis that even very small amounts of buffering provided by certain types of silicate minerals is likely to be sufficient for maintaining neutral conditions. Within this group, some of the more siliceous samples such as chert and siliceous shale (circles in red in Figure 2-1) are classified as having an uncertain potential for ARD due to uncertainties regarding the amount of buffering capacity available.

These results highlight the typical geochemical characteristics of the various stratigraphic units expected to be encountered during development of road cuts, material sites and pads. Based on the ARD classifications using the NP to AP ratio all 13 samples of the Middle Siksikpuk formation (Psm), nine samples of the Okpikruak formation (Kos, Ko-), four samples of the Kogruk formation limestone and chert (Mg-) and two samples of the Ipewik formation (Ji-) were classified as non-PAG. Most of the 12 samples of the Ikalukrok unit chert and shale (Mls, Mlc) and the single samples of the Lower Otuk formation (Tol) were classified as PAG to uncertain. Samples from the Middle Otuk formation (Tom), Lower and Upper Siksikpuk formation (Psu) had variable ARD classification from non-PAG to uncertain.

The analytical results indicate that cut material of the Middle Siksikpuk shale (Psm), Okpikruak formation mudstone and sandstone (Ko-, Kos), Ipewik formation (Ji-) and Kogruk formation limestone (Mg-) is likely be usable as fill for the road construction. Material from the Lower Otuk formation (Tol) and Ikalukrok unit chert shale (Mlc and Mls) has a higher likelihood of requiring segregation and management as PAG material. Material from the Middle Otuk formation (Tom), Upper and Lower Siksikpuk formation (Psu, Psl) have variable geochemical characteristics which may be usable as fill or may require segregation following further segregation screening. The range of ARD classifications by stratigraphic unit from the surface rock sample set is summarized in Table 2-1.

Table 2-1: Range of ARD Classifications *by* Rock Type from Sample Set

Formation / Unit	Range of ARD Classifications from Sample Set
Okpikruak formation (Ko-)	non-PAG
Okpikruak formation sandstone (Kos)	non-PAG
Ipewik formation (Ji-)	non-PAG
Middle Otuk formation (Tom)	non-PAG to uncertain
Lower Otuk formation (Tol)	Uncertain to PAG
Upper Siksikpuk formation (Psu)	non-PAG to uncertain
Middle Siksikpuk formation (Psm)	non-PAG
Lower Siksikpuk formation (Psl)	non-PAG to uncertain
Ikalukrok unit chert (Mlc)	Uncertain to PAG
Ikalukrok unit shale (Mls)	Uncertain to PAG
Kogruk formation (Mg-)	non-PAG

Source: \\VAN-SVR0\Projects\01_SITES\Red_Dog\1UT016.009_Access Road & UGDev Geochem\!080_Deliverables\Road Construction Management\Tables\[Road_Sample_ARD_Class_by_Unit_1UT16.009_JAC_REV01.xlsx]

The NP/AP results and field observations (including presence and abundance of Fe-sulfides) was compiled to create maps defining the likely ARD potential of the various cut sites along the road, pads and material sites (Appendix A). These maps also identify shallow cut areas where outcrop is not expected to be encountered and areas with higher geologic uncertainty owing to a lack of outcrop exposure in the vicinity of the cut. These maps are intended to be used as a guide during construction to highlight areas with higher potential to expose PAG material, however the segregation of non-PAG and PAG material should rely on geologic review during construction phase. Particular interest during segregation is warranted in areas highlighted as PAG or uncertain, and areas with high geologic uncertainty. The ARD classification (or range of classification) outlined in Table 2-1 is also included in the legend with the stratigraphic unit name for units that are expected to be encountered at the cut sites.

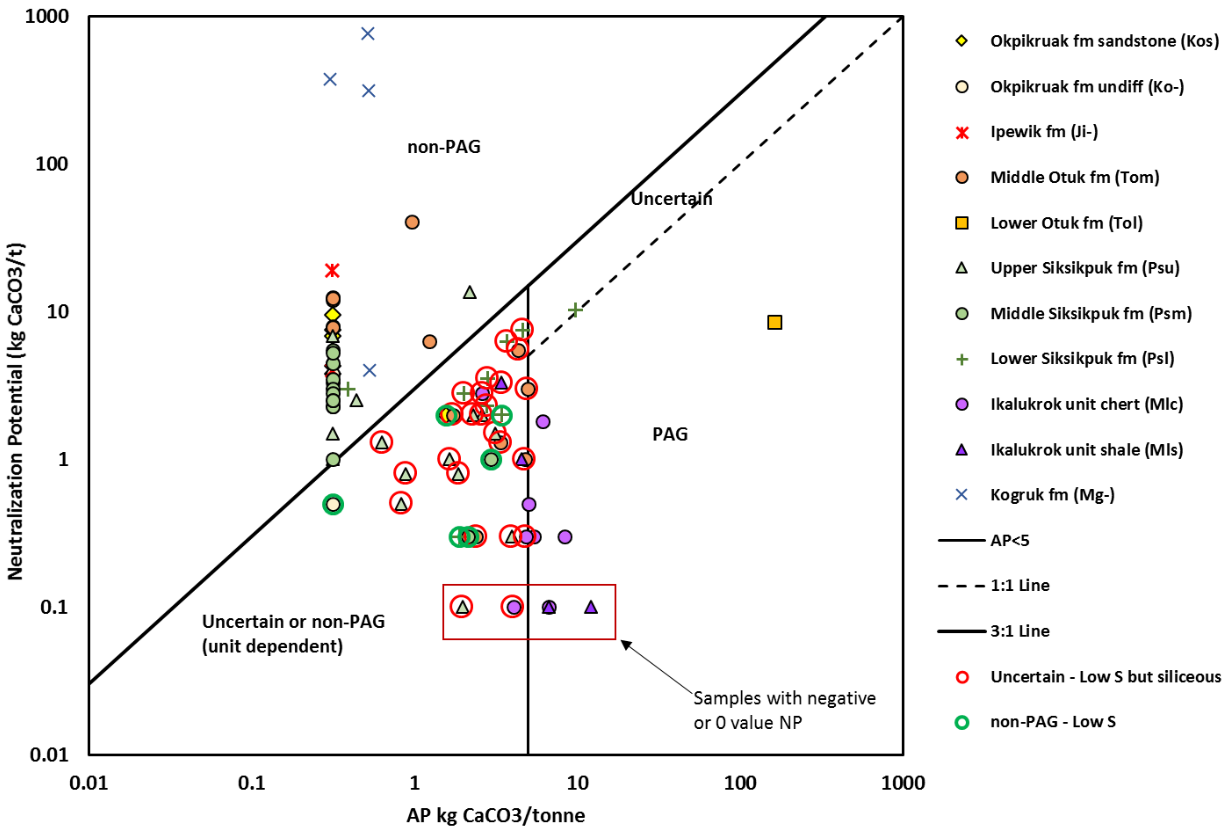

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Figure 2-1: ARD classifications of all near surface samples from 2017 and 2018 sampling near cut sites

2.2 Portable X-Ray Fluorescence (pXRF) Trial Results

A pXRF trial was conducted on coarse reject material from three surface rock samples along the road alignment and 35 drill core samples near the proposed underground development to assess the suitability of the pXRF as a tool to segregate PAG and uncertain from non-PAG material. Details of the results of this trial with key plots is summarized in Appendix B. Most of the sample material used in the trial presented in Figure 3-1 are from drill core material near the Anarraaq and Aktigiruq deposits. These drill core samples include the same stratigraphic units expected at the cut sites, however being sourced from near the Anarraaq and Aktigiruq deposits, have a greater abundance of Fe-sulfide than the existing surface samples from the 2018 sampling program (SRK 2018a).

The pXRF results for both sulfur and barium (two parameters which are important for the AP calculation outlined in Section 3.5 of SRK 2018a) returned linear relationships with strong positive correlations (r^2 of >0.9) in comparison to the lab results. A sample from the Ikalukrok barite with high Ba (>50%) was removed from the Ba statistical analysis as this unit has much higher Ba than is expected from the cut sites and furthermore, this unit is not expected to be encountered at the cut sites.

A calibration factor was required to adjust the pXRF values. The calculated AP using the calibrated pXRF results also had a strong positive correlation (r^2 = 0.90) with the AP calculated from lab results (Figure 2-2). The pXRF can be programmed to adjust the results with calibration factors and calculate the AP or sulfur as Fe-sulfide in the field.

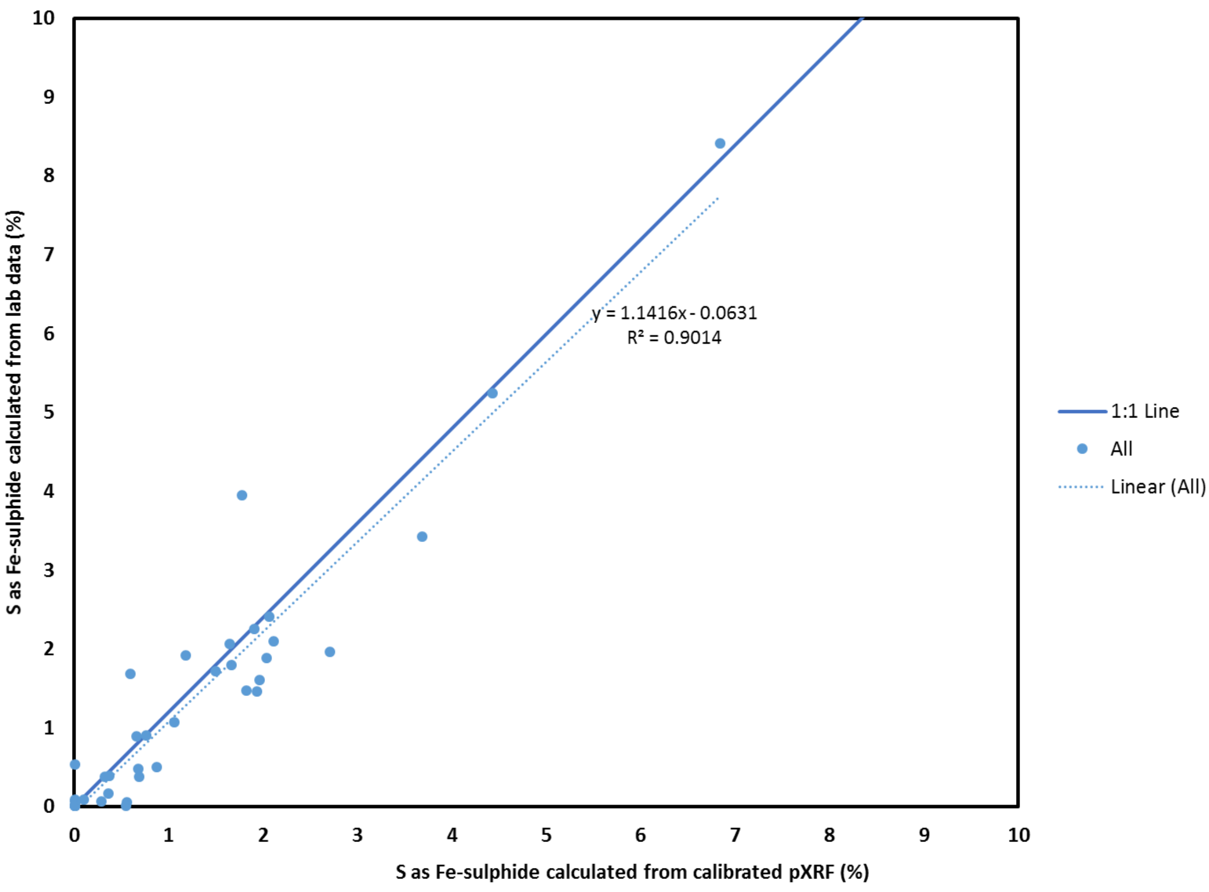

Figure 2-2: AP calculated from pXRF results vs AP calculated from lab results

3 Segregation Criteria

Based on the findings of the characterization programs and the pXRF trial, a combination of rock type and field tests is proposed as a strategy for segregation of non-PAG from PAG material in the field.

Samples identified as Middle Siksikpuk formation (Psm) and Kogruk formation limestone or chert (Mg-) are known to have favourable geochemical characteristics and can be classified as non-PAG. Samples identified as Ikalukrok unit chert or shale (Mlc, Mls), or Lower Otuk formation (Tol) are known to have unfavourable geochemical characteristics and can be classified as PAG or uncertain. All other rock types are recommended to be classified on the basis of the calculated AP from pXRF results and field fizz tests (using diluted HCl to identify material with abundant carbonate).

The pXRF can be used to test the geochemical characteristics of the Ikalukrok unit shale and chert, however caution should be exercised on relying on the pXRF results from these units to screen PAG and non-PAG material due to localized variability of sulfide content in these units. As these units are known to commonly have ARD classifications ranging from uncertain to PAG, it is recommended to manage cut material from these units as PAG regardless of the calculated AP from pXRF analysis.

Sample classification would be as follows (Figure 3-1):

Non-PAG:

- Samples with calculated AP from pXRF of < 3 kg $CaCO_3$/t (or 0.1% sulfur as Fe-sulfide)
- Samples with calculated AP from pXRF of 3 to 31 kg $CaCO_3$/t and a moderate or strong fizz rating
- No sulfide or trace sulfide from visual estimate from inspection of cut material

PAG:

- Samples with calculated AP from pXRF of > 3 kg $CaCO_3$/t (equivalent to 0.1% sulfur as Fe-sulfide) and a weak or negligible fizz rating
- Samples with calculated AP from pXRF of > 31 kg $CaCO_3$/t (equivalent to 1.0% sulfur as Fe-sulfide)
- Greater than trace sulfide from visual estimate from inspection of cut material

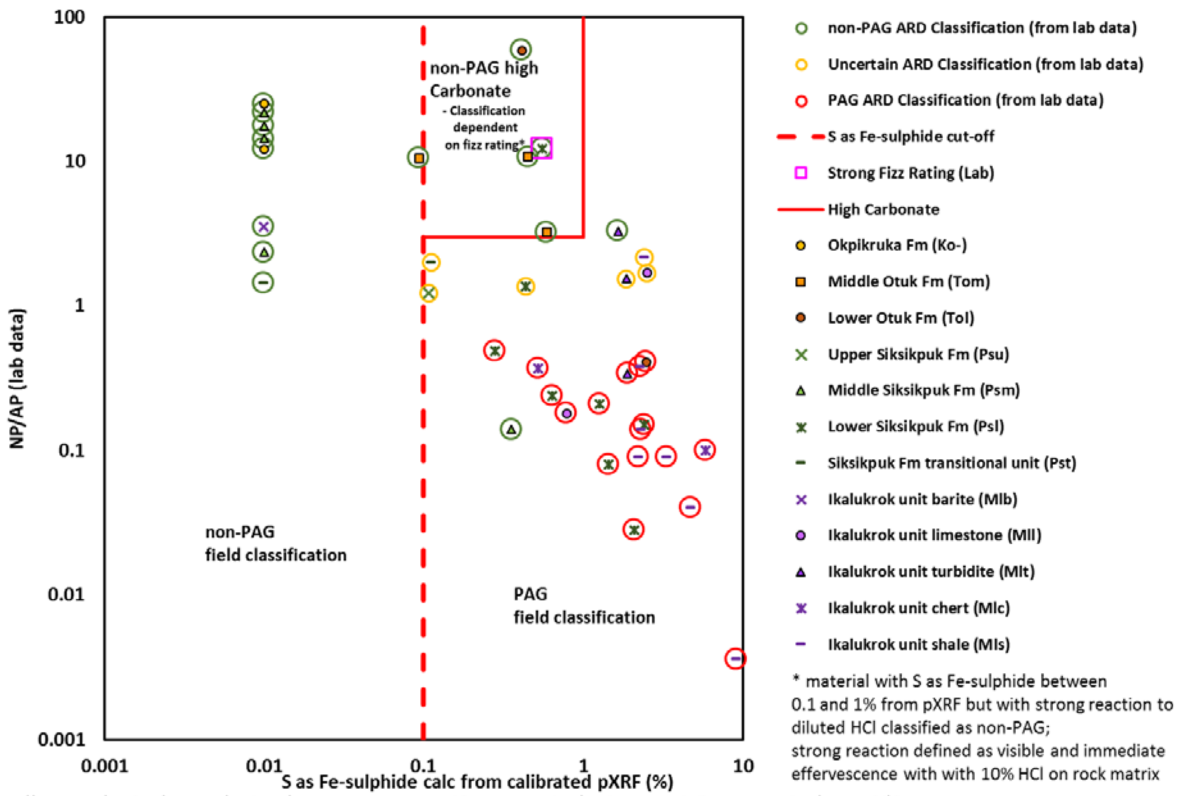

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Figure 3-1: S as Fe-sulfide cut-off vs NP/AP results and classification from lab results highlighting effectiveness of pXRF cut-offs relative to lab data

To illustrate the expected distribution of samples from the road cuts, pad and material sites, Figure 3-2 shows a similar plot to Figure 3-1 with NP/AP ratios from lab data versus S as Fe-sulfide calculated from lab data. The results show that the majority of the samples would be classified as non-PAG.

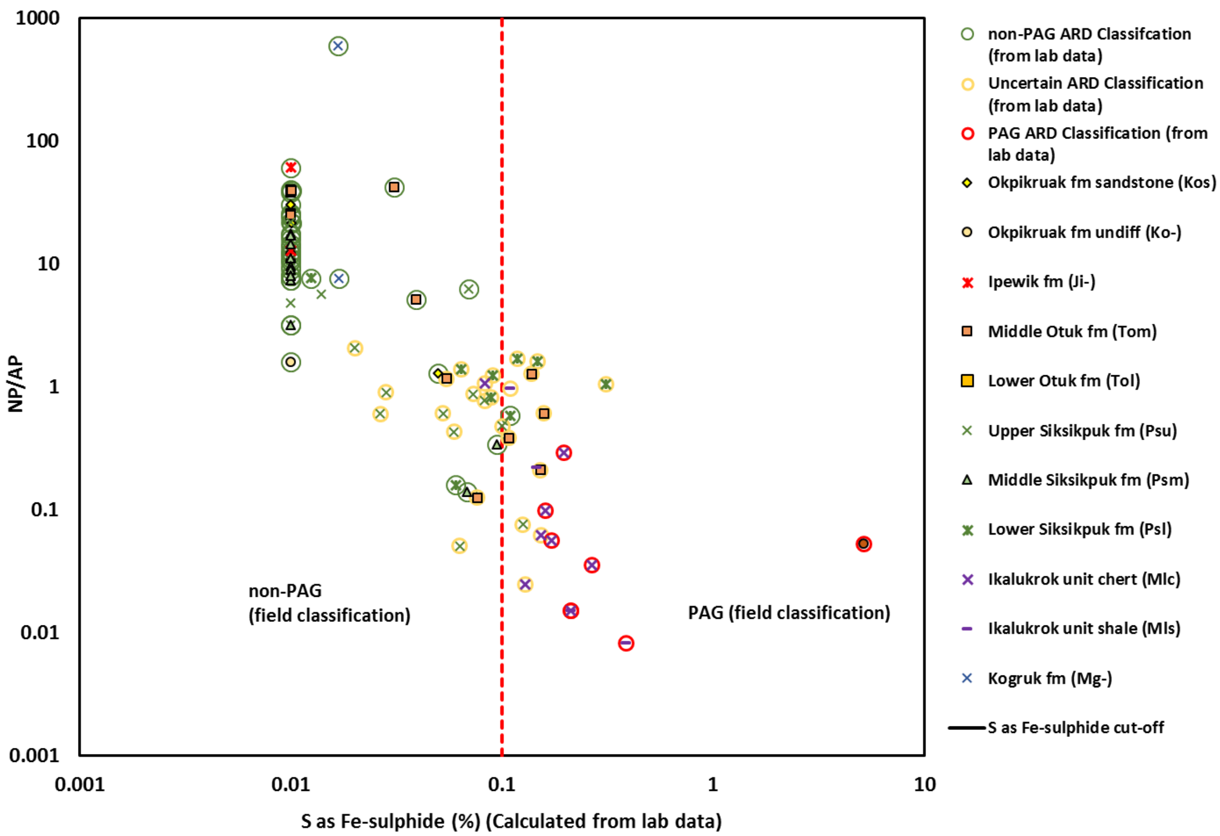

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Figure 3-2: S as Fe-sulfide from lab data vs NP/AP results and ARD classifications from surface rock samples

This plot highlights samples from the Upper Siksikpuk formation (Psu), Lower Siksikpuk formation (Psl) and Middle Otuk formation (Tom) that have sulfur as Fe-sulfide <0.1% but are classified as having an uncertain ARD classification due to uncertainties with the buffering capacity of silicate in these siliceous units. Kinetic humidity cell tests (HCTs) are underway from drill core samples from these three stratigraphic units as part of a geochemical characterization study near the Anarraaq and Aktigiruq project site. The sample of Psu selected for HCT has a comparable sulfur as Fe-sulfide, whereas the three samples selected for HCTs from Tom and Psl have more abundant sulfur as Fe-sulfide than the samples from these units presented in Figure 3-2. Following 10 weeks of HCT operation, the results indicate stable and alkaline pH conditions between 8 and 9 (Figure 3-3) and no metal leaching concerns. The HCT results support the basis of classifying samples from the Tom, Psl and Psu with sulfur as Fe-sulfide below 0.1% from the pXRF results as non-PAG.

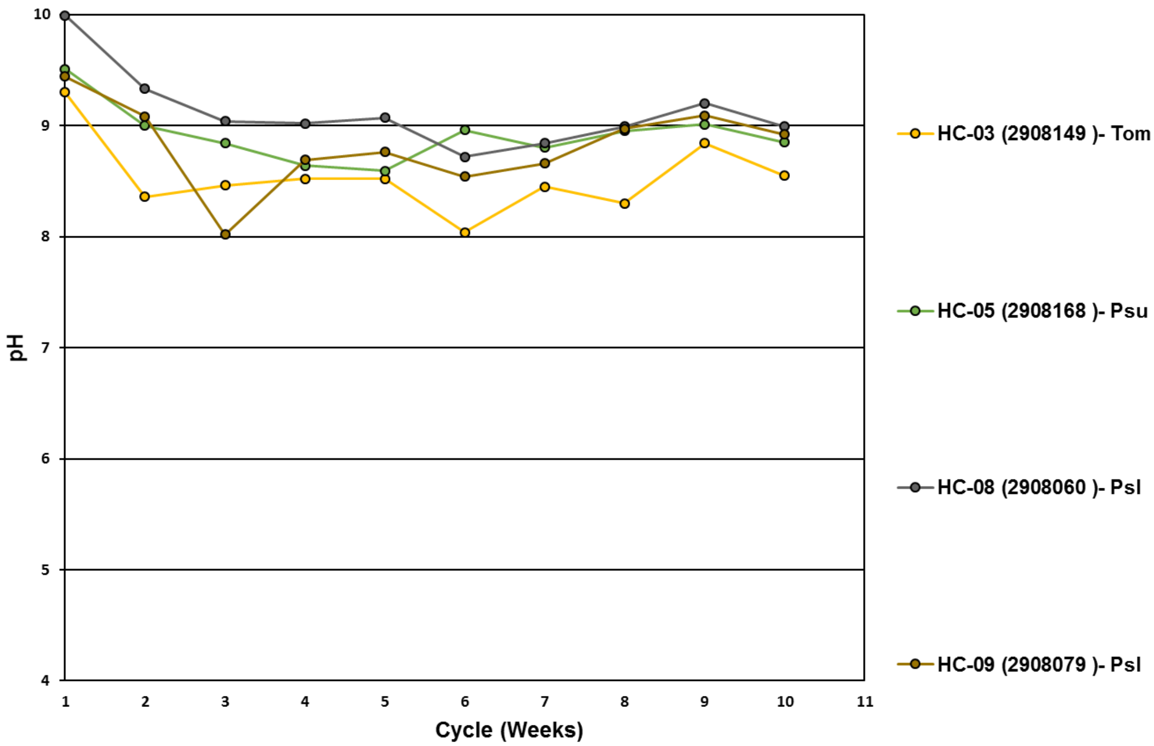

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Figure 3-3: pH results from HCTs from drill core at the Anarraaq and Aktigiruq project after 10 weeks for stratigraphic units with variable ARD classifications

4 Field Classification Method

Section 3 outlines the recommended criteria to be used to segregate PAG and uncertain from non-PAG material in the field. The recommended segregation criteria includes geologic observations including identification of the stratigraphic unit and rock type, an estimate of the abundance and types of sulfide and presence and abundance of carbonate. Analyzing samples of cut material using a pXRF is recommended as an additional screening tool to estimate AP and classify and separate PAG or uncertain material from non-PAG material.

The steps in the recommended segregation plan are as follows;

- Prior to excavation, a geologist will refer to the maps provided in Appendix A to determine the likely ARD classification and geochemical characteristics of a specific cut area.
  - If the cut is located in one of the areas identified as PAG or non-PAG, a geologist knowledgeable in the local stratigraphy will examine the bedrock in the cut area and confirm the identity of the stratigraphic unit and rock type shown on the maps.

- The geologist will examine hand samples of the bedrock exposed in the cut and estimate the abundance and species of sulfides in each lithologic unit of the cut, and assuming the results are consistent with the ranges typically found in these units, the material will be managed according to the classifications indicated by the geology as shown on the maps.

- If the cut is located in one of the areas identified as having an Uncertain ARD classification,
  - The geologist will collect pXRF measurements on fresh surfaces from a minimum of five hand samples of each lithologic unit deemed to be representative of the cut every 25 m^2.
  - The geologist will use dilute (10%) HCl to test for the presence of carbonate and describe the effervescence as none, weak (few bubbles, slight and delayed reaction), moderate (near immediate reaction, many bubbles) or strong (immediate reaction, audible 'fizz') on each of the hand samples.
  - The geologist will classify the samples according to the criteria defined in Section 3.
- If the cut is located in one of the areas identified as having geologic uncertainty owing to a lack of outcrop, and the geologist determines that the cut is entirely within surficial overburden materials, no special management is required. If, however the cut does not intersect bedrock but is within colluvial or talus material with angular boulders the geologist will follow the screening procedure as outlined in this Section 4.

5 Monitoring and Verification

Within 1 year of construction, fill areas on the road is recommended to be inspected to ensure that the type and characteristics of rock used for construction are non-PAG. This inspection is recommended to be conducted by a geologist familiar with the local stratigraphy to ensure that the rock types are non-PAG or uncertain, and that sulfide content is within expected ranges. Additionally, monitoring sampling with ABA and metal analyses is recommended at a frequency of one sample every 500 m. If the inspections or testing identify that PAG material has been inadvertently used in construction, further investigation is recommended to determine the physical extent of the material, and where needed, remedial actions to be initiated.

6 Recommendations and Conclusion

To further validate the pXRF as a screening tool and to determine instrument specific calibration factors for key parameters, an additional validation program is recommended using the brand and type of pXRF which will be used during field segregation. This additional validation is recommended to be conducted on the pulp and coarse reject samples from the 2018 surface rock sampling which is representative of material at or near the cut sites.

This report outlines the field classification method and criteria for segregating non-PAG material usable as fill with PAG material requiring management. Accompanying reports will be provided by Teck which will describe how the materials will be handled.

Prepared by,

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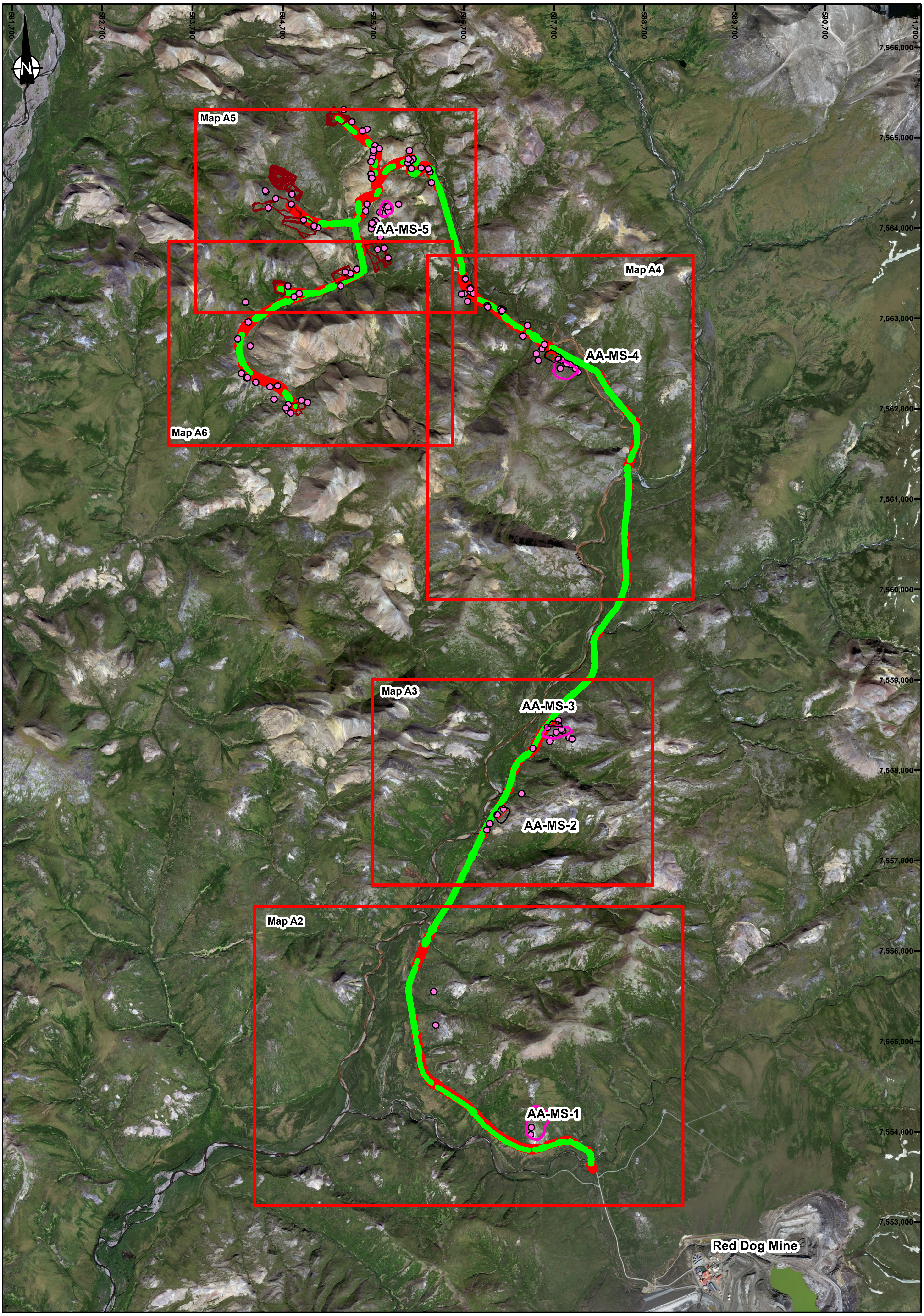
The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

7 References

SRK Consulting 2018a. Interim Static and Kinetic Geochemical Characterization of Access Road, Material Sites and Pads Sites at the Anarraaq and Akigiruq Project, Alaska. Prepared for Teck America Inc. (In preparation).

SRK Consulting 2018b. Interim Static and Kinetic Geochemical Characterization of Waste Rock from Proposed Underground Exploration Workings at the Anarraaq and Akitgiruq Project, Alaska. Prepared for Teck America Inc. (In preparation).

Appendix A – Surface Geology and ARD Classifications at Cut Sites



Notes:
Less desirable areas were identified as having limited outcrop mapping information, a high degree of geological complexity or rock units with uncertain or increased potential for metal leaching and/or acid rock drainage. Further geological and geochemical characterization is required to develop quarries in these areas.
Coordinate System: WGS 1984 UTM Zone 3N
Units: Meter

Legend

- Geologic Mapping Field Station
- Proposed Material Site - Less Desirable Area
- Proposed Material Site
- Mine Infrastructure Design

Road Alignment

- Road - cut area
- Road - fill area

Coordinate System: WGS 1984 UTM Zone 3N
Projection: Transverse Mercator

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

0 0.5 1 Kilometers

srk consulting | Teck | Anarraaq & Aktigiruq Project — Road, Pad, Material Site ARD Classification Reference Map

Job No:
Filename: ANQ_AKT_Road_ARD_ReferenceMap_1UT016.009_Rev01

Date: Dec 2018 | Approved: JAC | Figure: A1

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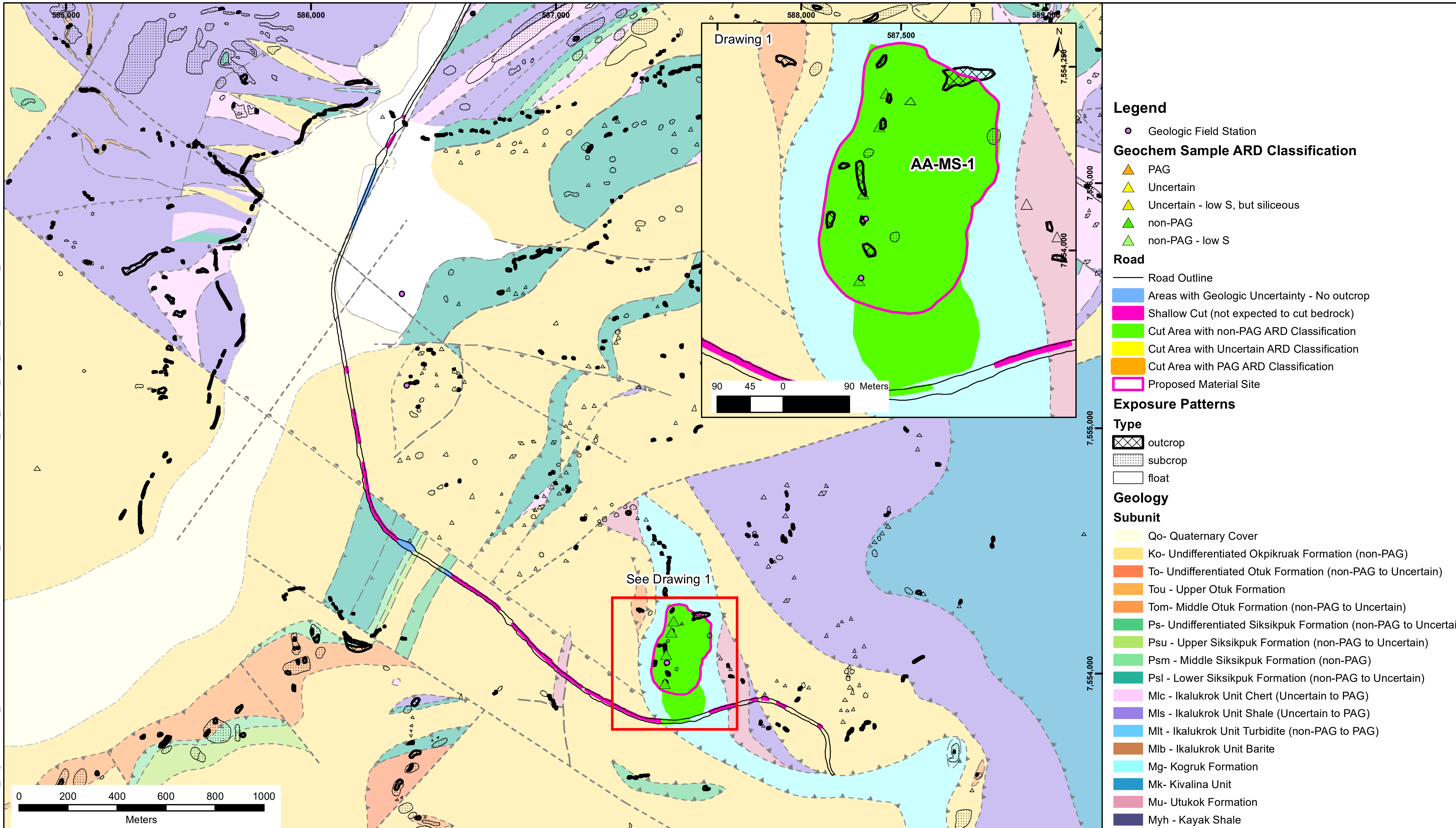

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Datum: WGS 1984

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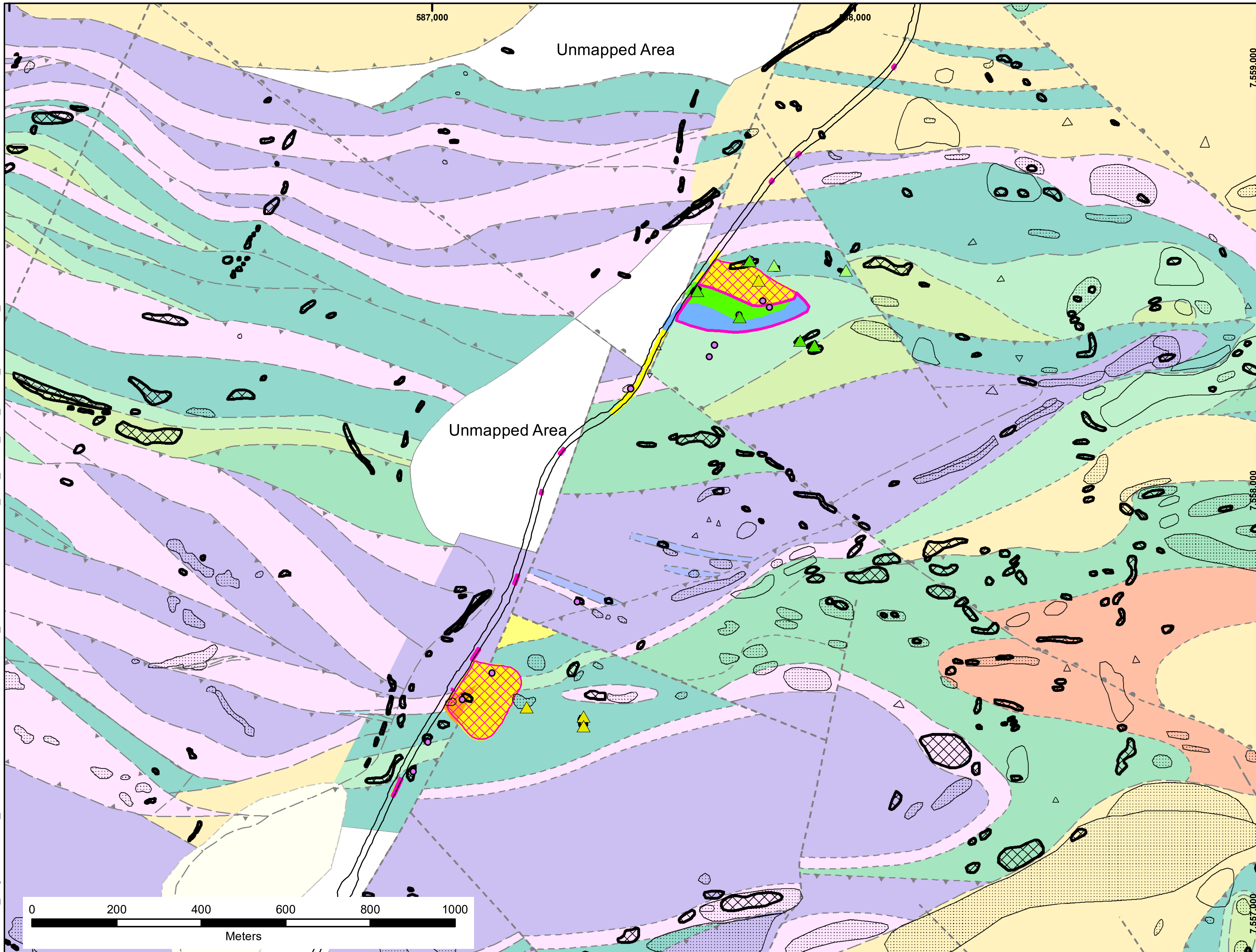
Filename: ANQ_AKT_ROAD_ARD_CLASS_1UT016.009_REV01

ANARRAAQ and AKTIGIRUQ MLE EXPLORATION

Anarraaq & Aktigiruq Project

ARD Classifications at Road, Pad and Material Cut Sites AA-MS-1

Date:	Approved:	Figure:
Dec 2018	JAC	A2



Legend

Geologic Field Station

Geochem Sample ARD Classification

- PAG
- Uncertain
- Uncertain - low S, but siliceous
- non-PAG
- non-PAG - low S

Road

- Road Outline
- Areas with Geologic Uncertainty - No outcrop
- Shallow Cut (not expected to cut bedrock)
- Cut Area with non-PAG ARD Classification
- Cut Area with Uncertain ARD Classification
- Cut Area with PAG ARD Classification
- Material Site - Less Desirable Area
- Proposed Material Site

Exposure Patterns

Type

- outcrop
- subcrop
- float

Geology

Subunit

- Qo- Quaternary Cover
- Ko- Undifferentiated Okpikruak Formation (non-PAG)
- To- Undifferentiated Otuk Formation (non-PAG to PAG)
- Tol- Lower Otuk Formation (Uncertain to PAG)
- Ps- Undifferentiated Siksikpuk Formation (non-PAG to uncertain)
- Psc - Siksikpuk Formation Chert (non-PAG to uncertain)
- Psu - Upper Siksikpuk Formation (non-PAG to uncertain)
- Psm - Middle Siksikpuk Formation (non-PAG)
- Psl - Lower Siksikpuk Formation (non-PAG to uncertain)
- Ml- Undifferentiated Ikalukrok Unit (Uncertain to PAG)
- Mlc - Ikalukrok Unit Chert (Uncertain to PAG)
- Mls - Ikalukrok Unit Shale (Uncertain to PAG)
- Mlt - Ikalukrok Unit Turbidite (non-PAG to PAG)
- Mll - Ikalukrok Unit Limestone (non-PAG to PAG)
- Mlb - Ikalukrok Unit Barite
- Mlp - Pyritic Ikalukrok Unit (PAG)
- Mk- Kivalina Unit

N

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Coordinate System: WGS 1984 UTM Zone 3N
Projection: Transverse Mercator
Datum: WGS 1984

Notes:
Less desirable areas were identified as having limited outcrop mapping information, a high degree of geological complexity or rock units with uncertain or increased potential for metal leaching and/or acid rock drainage. Further geological and geochemical characterization is required to develop quarries in these areas.
Coordinate System: WGS 1984 UTM Zone 3N
Units: Meter

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Job No: 1UT016.009
Filename: ANQ_AKT_ROAD_ARD_CLASS_1UT016.009_REV01

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ANARRAAQ and AKTIGIRUQ MLE EXPLORATION

Anarraaq & Aktigiruq Project

ARD Classifications at Road, Pad and Material Cut Sites AA-MS-2 & AA-MS-3

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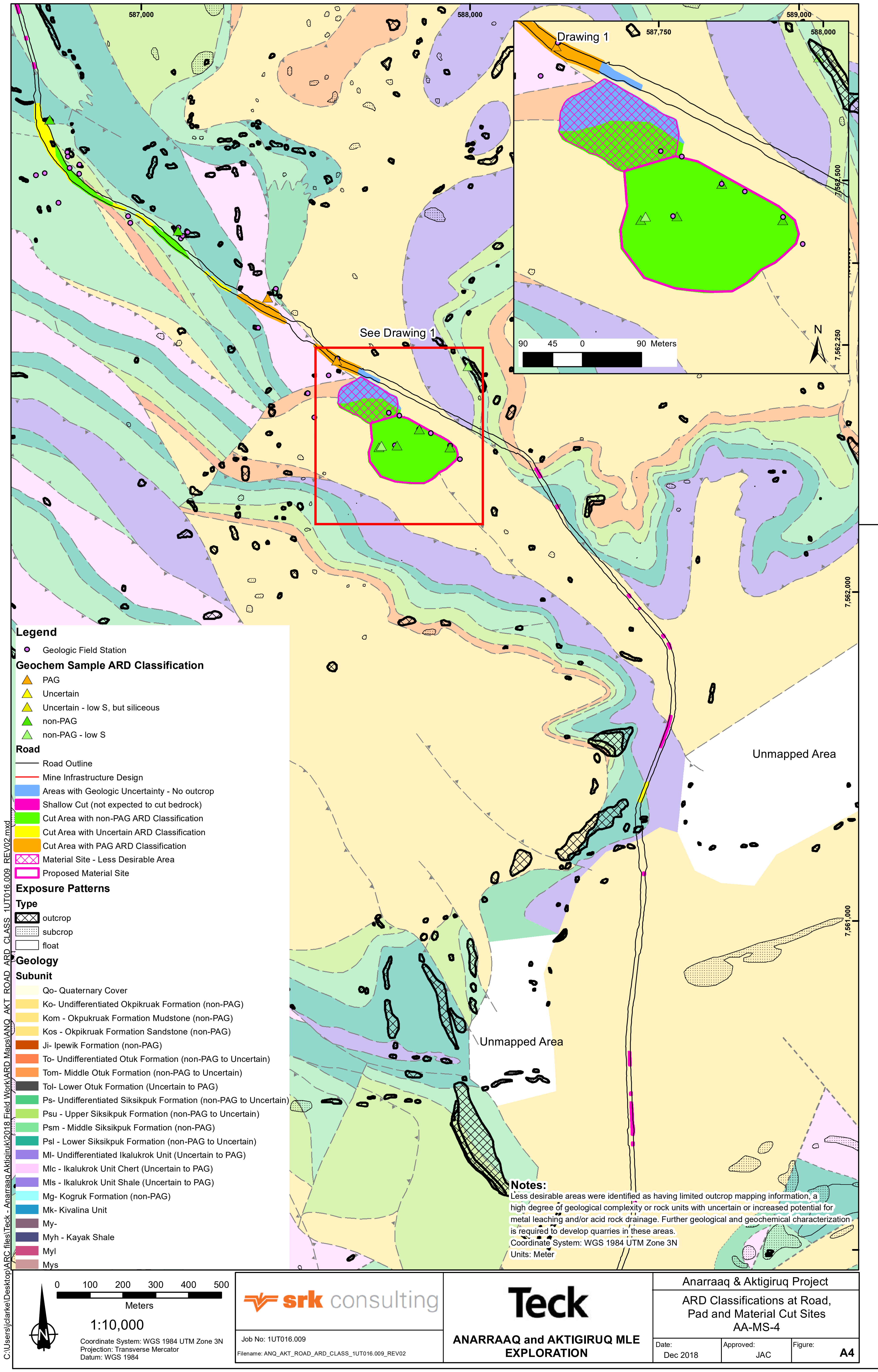

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Unmapped Area
Unmapped Area
Legend
Geologic Field Station
Geochem Sample ARD Classification
PAG
Uncertain
Uncertain - low S, but siliceous
non-PAG
non-PAG - low S
Road
Road Outline
Mine Infrastructure Design
Areas with Geologic Uncertainty - No outcrop
Shallow Cut (not expected to cut bedrock)
Cut Area with non-PAG ARD Classification
Cut Area with Uncertain ARD Classification
Cut Area with PAG ARD Classification
Material Site - Less Desirable Area
Proposed Material Site
Exposure Patterns
Type
outcrop
subcrop
float
Geology
Subunit
Qo- Quaternary Cover
Ko- Undifferentiated Okpikruak Formation (non-PAG)
Kom - Okpukruak Formation Mudstone (non-PAG)
Kos - Okpikruak Formation Sandstone (non-PAG)
Ji- Ipewik Formation (non-PAG)
To- Undifferentiated Otuk Formation (non-PAG to Uncertain)
Tom- Middle Otuk Formation (non-PAG to Uncertain)
Tol- Lower Otuk Formation (Uncertain to PAG)
Ps- Undifferentiated Siksikpuk Formation (non-PAG to Uncertain)
Psu - Upper Siksikpuk Formation (non-PAG to Uncertain)
Psm - Middle Siksikpuk Formation (non-PAG)
Psl - Lower Siksikpuk Formation (non-PAG to Uncertain)
Ml- Undifferentiated Ikalukrok Unit (Uncertain to PAG)
Mlc - Ikalukrok Unit Chert (Uncertain to PAG)
Mls - Ikalukrok Unit Shale (Uncertain to PAG)
Mg- Kogruk Formation (non-PAG)
Mk- Kivalina Unit
My-
Myh - Kayak Shale
Myl
Mys
Notes:
Less desirable areas were identified as having limited outcrop mapping information, a high degree of geological complexity or rock units with uncertain or increased potential for metal leaching and/or acid rock drainage. Further geological and geochemical characterization is required to develop quarries in these areas.
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ANARRAAQ and AKTIGIRUQ MLE EXPLORATION
Anarraaq & Aktigiruq Project
ARD Classifications at Road, Pad and Material Cut Sites
AA-MS-4
Date:
Dec 2018
Approved:
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Figure:
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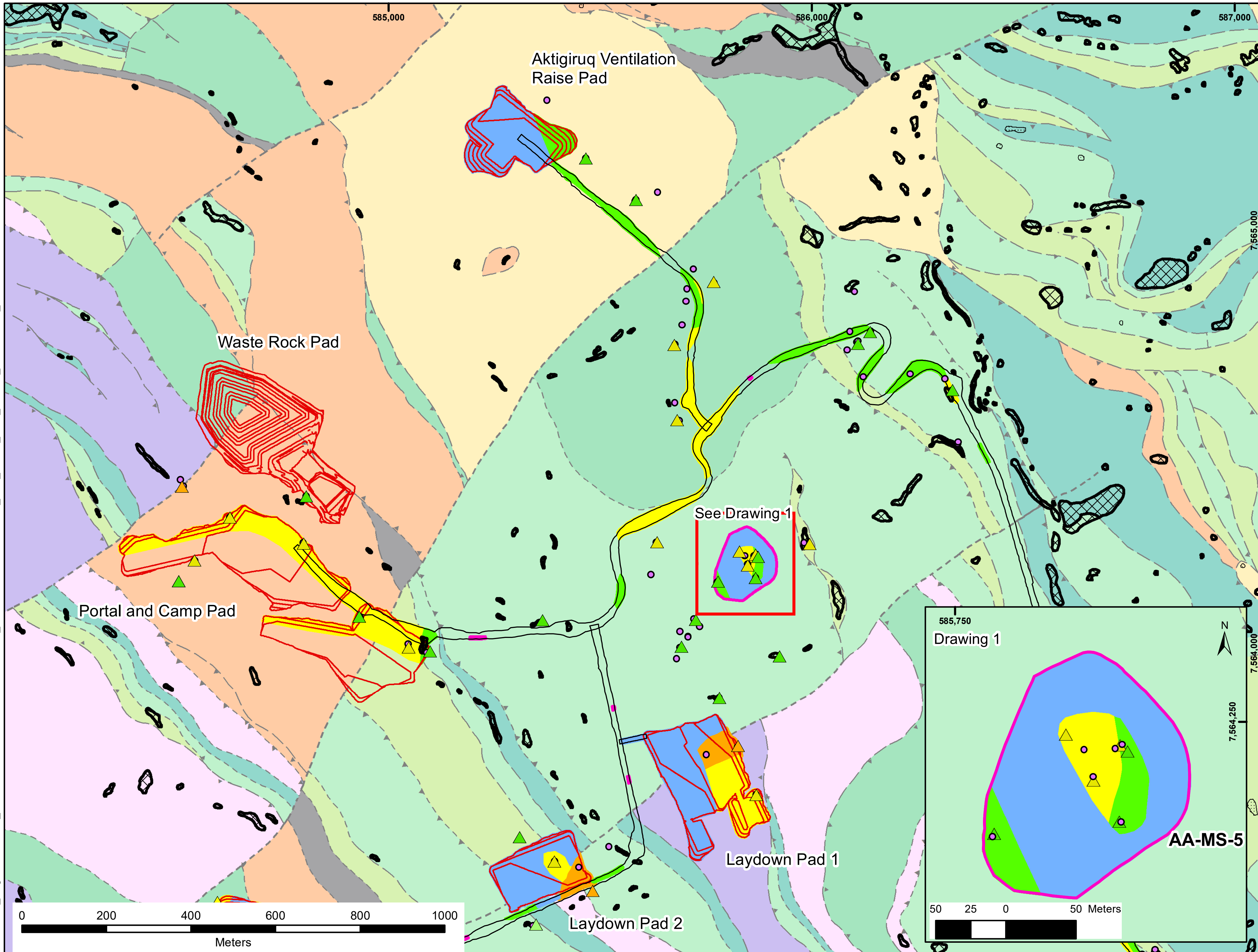

Legend

- Geologic Field Station

Geochem Sample ARD Classification

- PAG
- Uncertain
- Uncertain - low S, but siliceous
- non-PAG
- non-PAG - low S

Road

- Road Outline
- Mine Infrastructure Design
- Areas with Geologic Uncertainty - No outcrop
- Shallow Cut (not expected to cut bedrock)
- Cut Area with non-PAG ARD Classification
- Cut Area with Uncertain ARD Classification
- Cut Area with PAG ARD Classification
- Proposed Material Site

Exposure Patterns

Type

- outcrop
- subcrop
- float

Geology

Subunit

- Ko- Undifferentiated Okpikruak Formation (non-PAG)
- Kos - Okpikruak Formation Sandstone (non-PAG)
- To- Undifferentiated Otuk Formation (non-PAG to Uncertain)
- Tom- Middle Otuk Formation (non-PAG to Uncertain)
- Tol- Lower Otuk Formation (Uncertain to PAG)
- Ps- Undifferentiated Siksikpuk Formation (non-PAG to Uncertain)
- Psu - Upper Siksikpuk Formation (non-PAG to Uncertain)
- Psm - Middle Siksikpuk Formation (non-PAG)
- Psl - Lower Siksikpuk Formation (non-PAG to Uncertain)
- Ml- Undifferentiated Ikalukrok Unit (Uncertain to PAG)
- Mlc - Ikalukrok Unit Chert (Uncertain to PAG)
- Mls - Ikalukrok Unit Shale (Uncertain to PAG)
- Mk- Kivalina Unit

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Projection: Transverse Mercator
Datum: WGS 1984

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ANARRAAQ and AKTIGIRUQ MLE EXPLORATION

Anarraaq & Aktigiruq Project

ARD Classifications at Road, Pad and Material Cut Sites Aktigiruq / AA-MS-5

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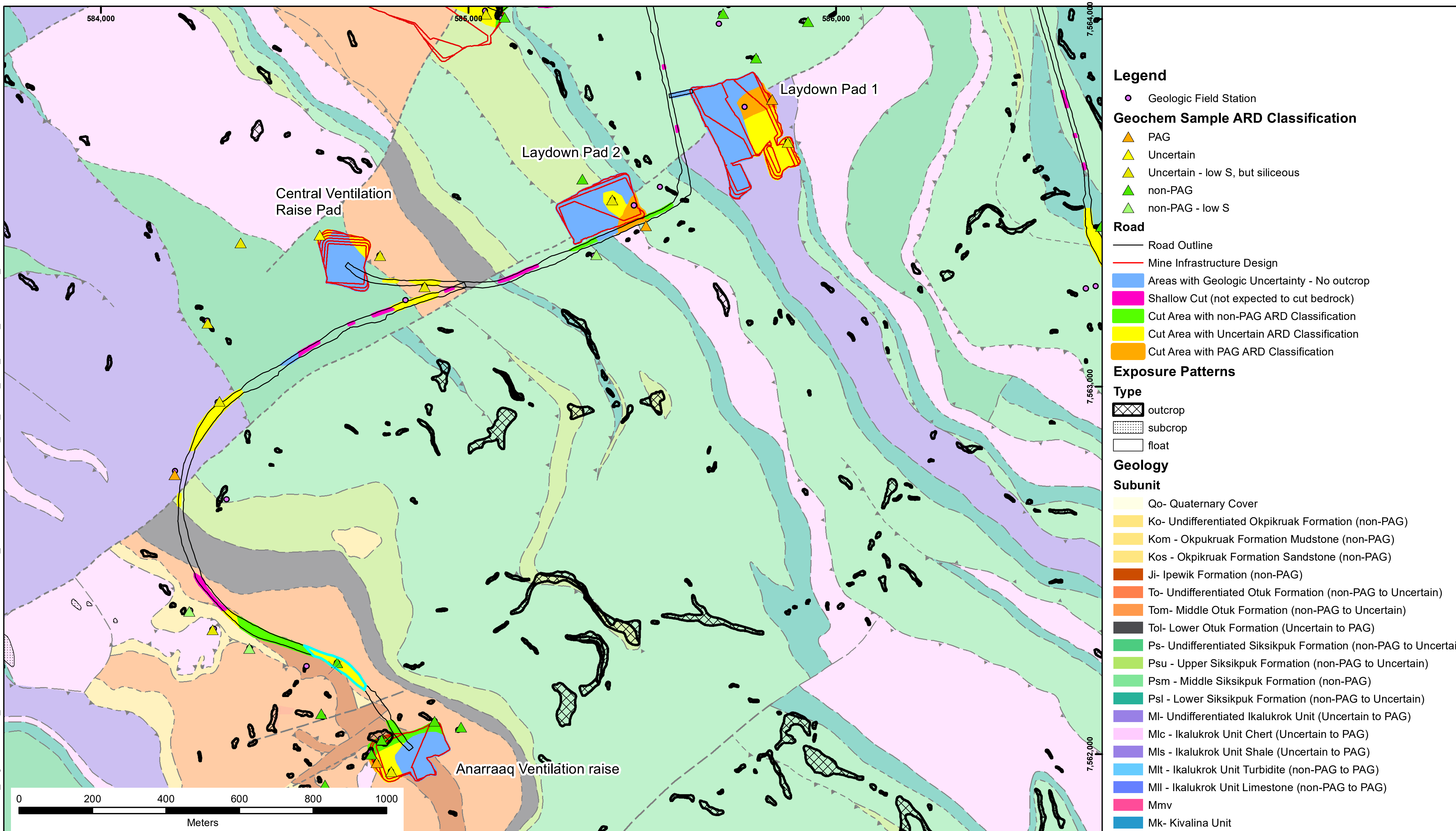

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ANARRAAQ and AKTIGIRUQ MLE EXPLORATION

Anarraaq & Aktigiruq Project

ARD Classifications at Road, Pad and Material Cut Sites Anarraaq

Date:	Approved:	Figure:
Dec 2018	JAC	A6

Appendix B – pXRF Trial Summary

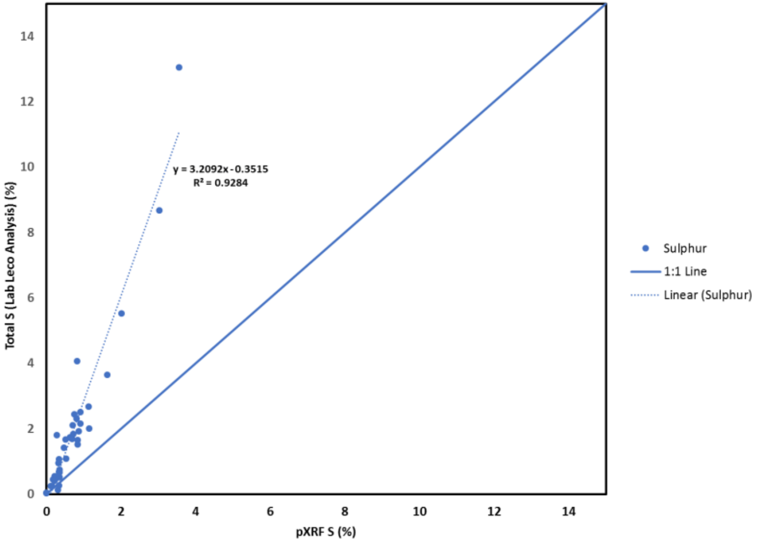
Red Dog A&A

Summary of trial study on the application pXRF to segregate PAG and non-PAG material during road construction

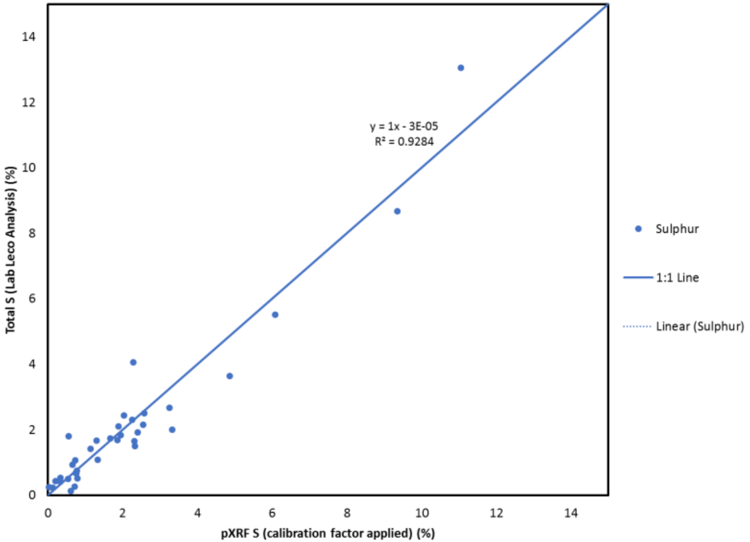
pXRF Trial

- pXRF trial conducted to assess validity of using handheld pXRF for use as screening tool to segregate PAG vs non-PAG cut material in the field during road construction
- pXRF readings conducted on -1/4” crush material from samples from 35 drill core samples near the Anarraaq and Aktigiruq deposit, and 3 surface rock samples along the road alignment collected form the 2017 sampling program
- In total 38 samples were trialed on crush material representing a range of lithologies and ARD classifications from samples collected from drill core and surface rock samples
- pXRF scan trialed on 38 scans of the same sample to assess reproducibility on matrix
- Reviewed lab vs. pXRF results for key parameters (sulphur, barium, zinc, lead)

Total Sulphur



pXRF vs Lab Total Sulfur (Lab Leco analysis)



pXRF (calibrated) vs Leco S

- Linear correlation of pXRF Sulphur vs. total Sulphur by Leco with high r2
- Linear, but not 1:1. pXRF values adjusted with calibration factor.

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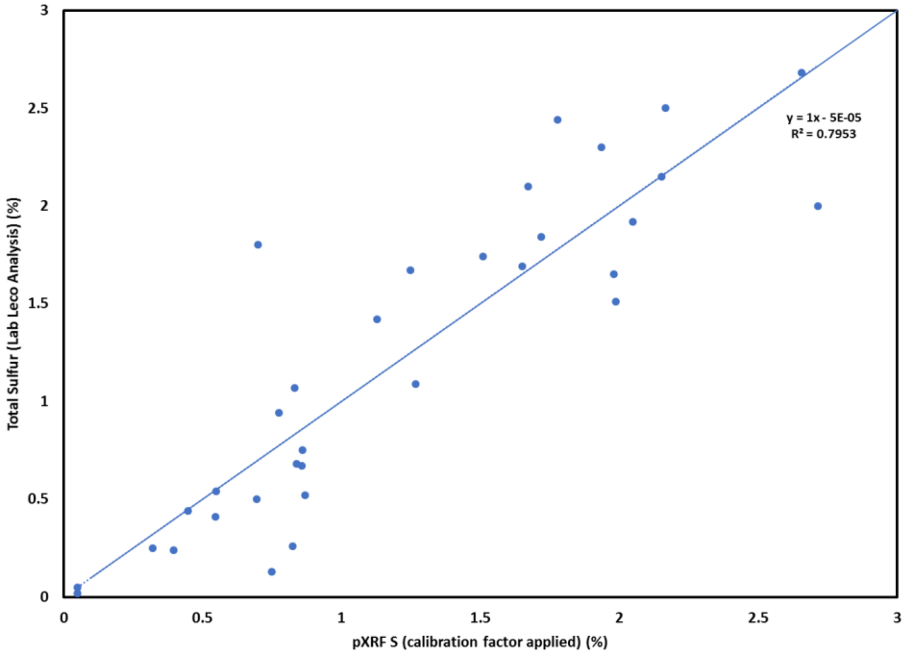
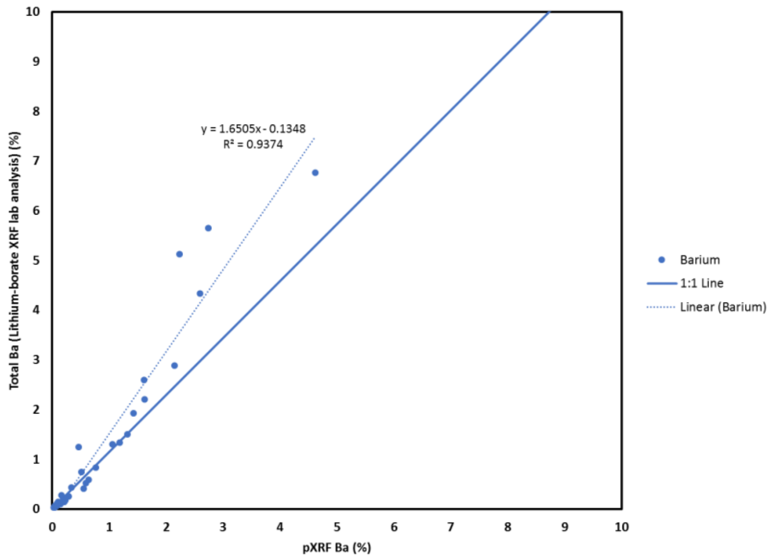
Total Sulphur

- Values with >3% sulphur were removed, and calibration factor recalculated
- Low end (<1% sulphur) suggests pXRF is overrepresenting sulphur (conservative estimate)
- Some scatter emphasizes need for averaging pXRF results from multiple measurements at a cut site

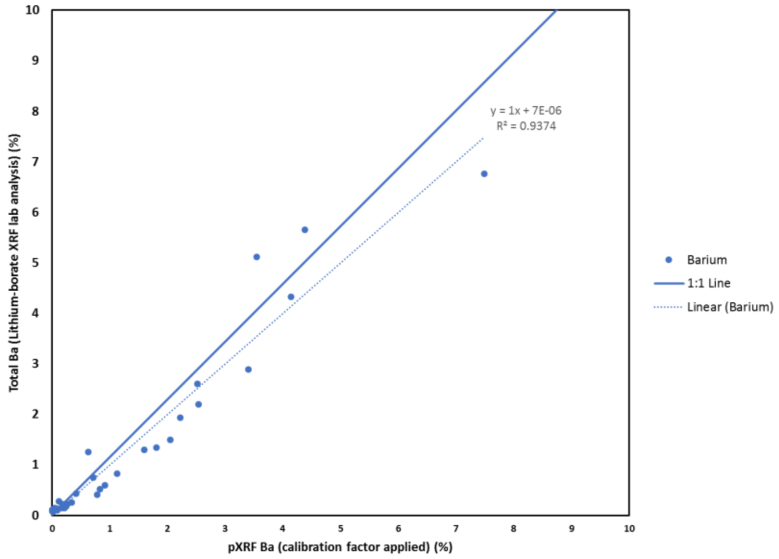


pXRF (calibrated) vs Leco S

Total Barium



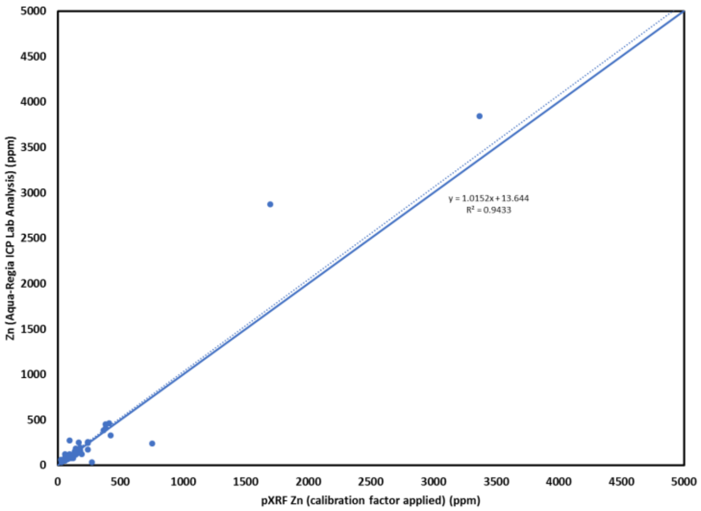
pXRF vs Whole Rock Barium (%)



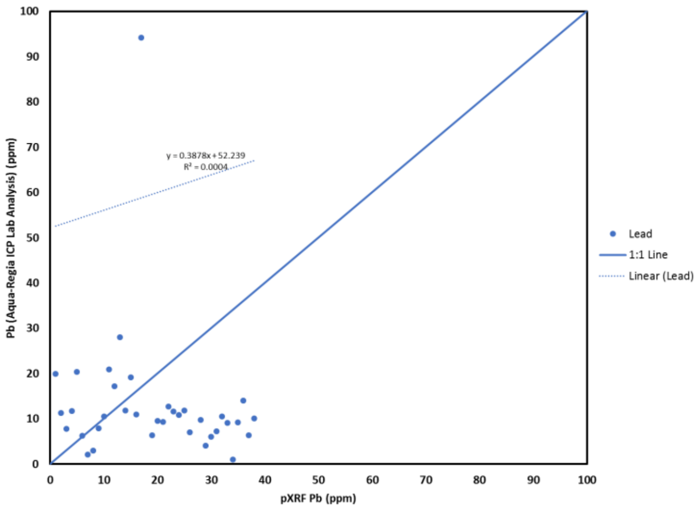
pXRF (calibrated) vs Whole Rock Barium (%)

- Linear correlation of pXRF barium vs. total barium by lithium borate fusion and XRF finish with high r2
- pXRF values adjusted with calibration factor to adjust the data to near 1:1.

Zinc & Lead



pXRF (calibrated) vs Aqua-regia Zn (ppm)



pXRF vs Aqua Regia Pb (ppm)

- Linear correlation of pXRF zinc vs. zinc from aqua regia and ICP analysis with high r2
- Poor correlation with lead, but all low values (<100 ppm)

Sulphur as Sulphide (Acid Potential)

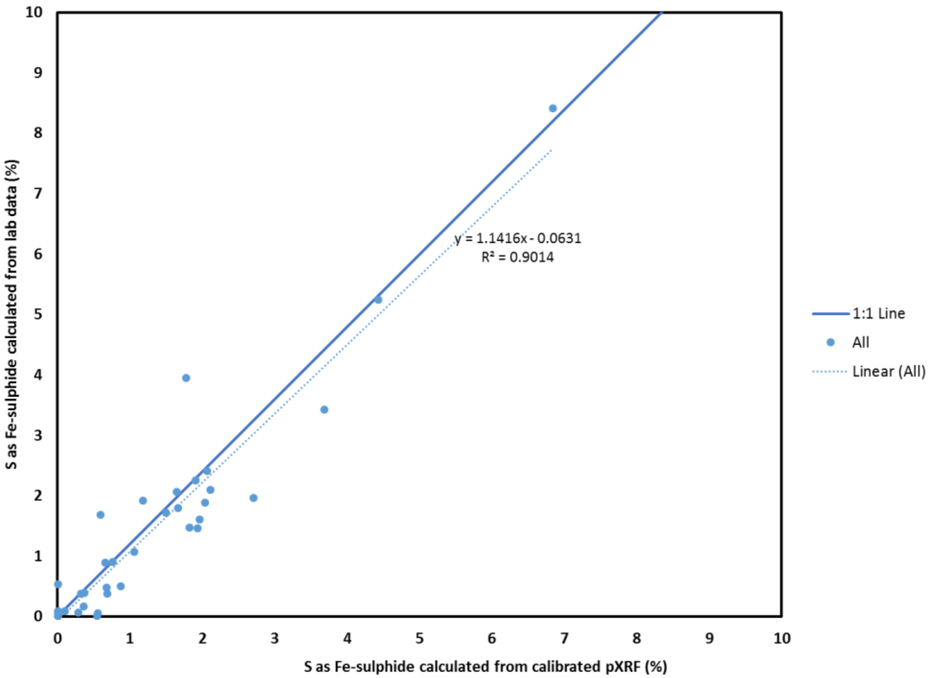
- AP based on amount of Fe-sulphide present in sample
- Calculated using method outlined by SRK (2003)

Sulphur as Fe-sulphide = Total S (Leco) – S as barite – S as sphalerite – S as galena

Assumes all barium is hosted as barite, all zinc is hosted as sphalerite and all lead as galena

Sulphur as Fe-Sulphide

- S as Fe-sulphide calculated from lab and calibrated pXRF data with r2=0.9
- High confidence in S as Fe-sulphide calculated from pXRF data allows using AP (calculated from S as Fe-sulphide) cut-off to segregate PAG from non-PAG material



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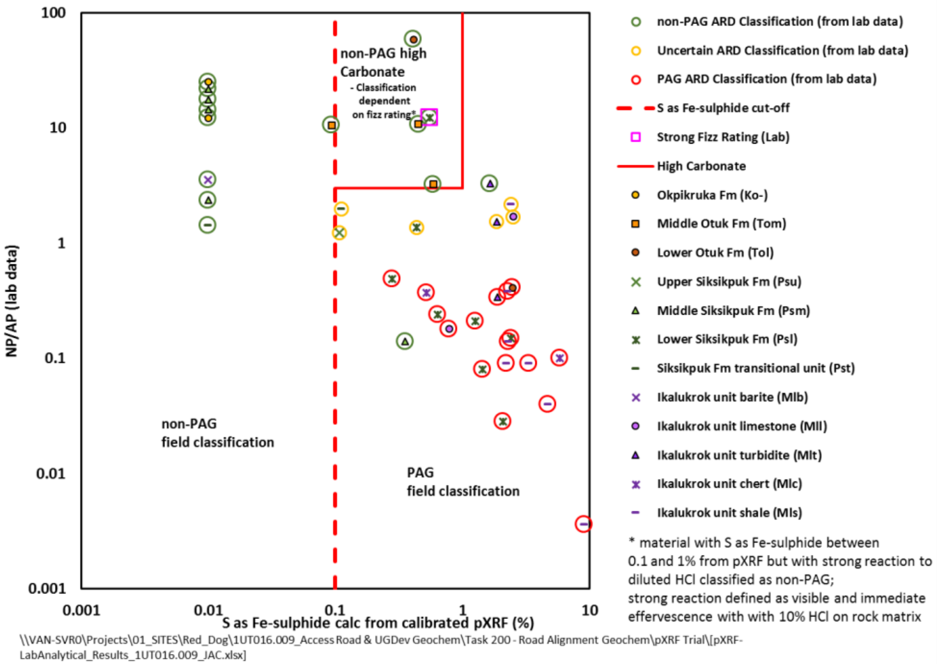
Sulphur as Fe-Sulphide Cut-Off

- AP cutoff of 3 kgCaCO3/t (or 0.1% S as Fe-sulphide) from 2017 lab results from Anarraaq and Aktigiruq drill core separates material classified as PAG from non-PAG
- This approach would misclassify only a small grouping of outliners classified as non-PAG from lab results with high NP and AP
- Field fizz test recommended to further segregate material with elevated S as Fe-sulphide but with sufficient carbonate to buffer



Fe as sulphide of 0.1% screen with ARD classifications from 2017 lab analytical data

pXRF Reproducibility

- Reproducibility of the pXRF was tested by analyzing 10 different pXRF sample sites from crush material of the same sample
  - Sulphur results within 13% of average; calculated standard deviation of 463 ppm with average value of 9167 ppm
  - Barium results within 28% of average; calculated standard deviation of 214 ppm with average value of 1420 ppm
- Variable reproducibility for key parameters highlights need to average results from multiple pXRF readings for each lithology in a cut
- Recommended to further validate this method with 2018 surface rock samples when lab results are returned (more representative of material in cuts and material sites)