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Memorandum

To	Matthew McElwaine - PWGSC	Page	1
CC	Barry Fedorak - AECOM		
Subject	Durban Island and Padloping Island Borrow Source Geochemistry		
From	Cathy Corrigan		
Date	January 14, 2013	Project Number	60214959

In response to the Nunavut Water Board's request for testing of borrow sources to assess acid rock drainage (ARD) potential at Durban and Padloping Islands, we provide the following the discussion regarding geochemistry, the potential for ARD at the sites, and the need for testing.

The geochemistry of ARD can be explained by two main reactions: the breakdown of sulphide minerals in the presence of oxygen and water (chemical weathering) results in the generation of acid, and the creation of acidic conditions more readily solubilizes metals that have low potential for mobility under neutral or alkaline conditions. Sulphide minerals are metal-sulphur compounds and are ubiquitous in the environment. They are particularly enriched in certain rock types, and form the primary minerals in many metal ore deposits. Sulphide minerals are formed under reducing conditions; as a consequence, they are not stable in atmospheric conditions. The weathering of sulphide minerals is therefore a naturally occurring, common process in a surficial environment where sulphide minerals are present. The difference between the common occurrence of weathering of sulphide minerals and of ARD is a matter of scale. The British Columbia Department of Energy and Mines provides this useful definition of ARD:

> "Metal leaching and acid generation are naturally occurring processes which may have negative impacts on the receiving environment. The environmental impact of ML/ARD will depend on their magnitude, the sensitivity of the receiving environment and the degree of neutralization, dilution and/or attenuation. Factors which enhance metal leaching include rapidly weathering metal-containing minerals, drainage conditions that increase solubility and high flow rates through contaminated materials."

ARD is typically associated mining. This is because the process of mining – the extraction and crushing of the bedrock to release the ore – creates optimal conditions to rapidly weather minerals: subsurface rock becomes exposed to atmospheric conditions at surface and is broken down into granular material thereby creating huge surface areas available to both air and oxygenated surface water. Furthermore, metal mines typically contain a high proportion of sulphide minerals. Thus, the bedrock geochemistry and the mining process itself are the primary factors that lead to ARD generation.

At Durban Island, the bedrock types have been identified as:

- The Cape Dyer Formation (on high plateaus) – unmetamorphosed basaltic volcanic rock that has been previously documented to contain exceptionally high nickel and chromium concentrations;
- The Hoare Bay Group (at lower elevations) – metasedimentary rocks (metagreywacke, metasiltstone, and metapelite) and migmatites of sedimentary origin;
- The Cape Searle and Quqalluit Formations (over small area approximately 2 km northeast of the Upper Site) – unmetamorhposed sedimentary rocks (subarkosic sandstone, mudstone, and conglomerates), locally identified as containing coal; and
- The Cumberland Batholith (locally present between the Cape Dyer Formation and Hoare Bay Group) - felsic (light coloured minerals – primarily feldspar and quartz) and rare mafic (dark coloured minerals – primarily ferromagnesian) plutonic rocks.

At Padloping Island, the only bedrock type in the vicinity of the site is the Hoare Bay Group.

The background geochemical assessment at both sites has documented naturally occurring high concentrations of metals, some of which may have been derived from sulphide minerals. It should be noted, however, that previous studies have identified the elevated nickel and chromium concentrations were derived from the weathering of oxide minerals in the Cape Dyer Formation volcanics, and not sulphides. Nonetheless, it is likely that unweathered bedrock at the sites, particularly the fine-grained rocks of sedimentary origin, contains sulphide minerals.

Surface deposits – both bedrock and overburden – have been subject to weathering for thousands of years since glacial retreat of this area. During yearly freshet and heavy precipitation events, water flow would be extensive through these sites - flow that is likely turbulent at times because of the steep topography. Thus, it is expected that the water is oxygenated. There is little organic material at surface, the decomposition of which would consume dissolved oxygen in groundwater. Based on these combined factors, minerals that are not stable at surface conditions (i.e. sulphides) are unlikely to be remaining in any significant volume in surface deposits. Indeed, a common occurrence in sulphide mineral deposits at surface is the creation of “gossans” which are surficial zones where all the sulphide minerals have been weathered away, oxide minerals have formed in place, and metals have been released and, transported downward through percolating groundwater until they are re-precipitated at depth where the geochemical conditions are reducing.

All of the borrow sources identified for use at Durban and Padloping Islands are granular surface deposits. There will be no quarrying of bedrock. Furthermore, no crushing of oversized granular material is proposed by the contractor. Thus, there will be no increase in rock surface area which would increase the rate of weathering, and no fresh surface faces created that would expose previously unweathered surfaces. To refer back to the definition above, the extraction of surficial granular borrow deposits will not create factors that enhance the rate of metal leaching. There is, therefore, no reason, from a geochemical perspective, to expect the development of ARD conditions from borrow extraction. Consequently, no testing for acid-base accounting or metal leaching potential is considered warranted at these sites.

I trust that this information meets your requirements. Please contact me or Barry Fedorak should you require additional information.

Sincerely,
AECOM Canada Ltd.

Cathy Corrigan, M.Sc., P.Eng.
Senior Geological Engineer
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References:

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Memorandum

To	Stephen Hooey - AANDC	Page	1
cc	Matt McElwaine - PWGSC		
Subject	Durban Island and Padloping Island – NWB Condition for the Provision of Landfarm Monitoring Wells		
From	Barry Fedorak - AECOM		
Date	July 17, 2013	Project Number	60214959

In response to the Nunavut Water Board's request for the provision of upgradient and downgradient monitoring wells for the landfarm treatment facilities at the Padloping and Durban Island sites, AECOM submits the following discussion regarding this item.

The landfarm treatment areas at Padloping and Durban Island are temporary facilities and expected to be in operation for only one or two summer construction seasons. There are no requirements for long term monitoring of landfarm treatment areas in the Abandoned Military Site Remediation Protocol which forms the framework for site remediation requirements. There is provision in the contract for a baseline soil sampling and analysis program in the area of the stockpile and treatment areas to verify existing conditions, as well as a confirmatory testing program to be provided by the contractor for these areas upon completion of the treatment operations. This level of environmental monitoring is considered suitable with respect to these types of facilities and time frame for which they are expected to operate. If these landfarms are operational for longer than two years, then the provision of monitoring wells and groundwater sampling and testing would be considered suitable for monitoring purposes.

We trust that this information meets with your requirements. Please contact the undersigned should you require additional information.

Sincerely,
AECOM Canada Ltd.

Barry Fedorak, P.Eng.
Senior Project Engineer
barry.fedorak@aecom.com

Amendment Application: Durban and Padloping Island

BR1-DPI1217

Summary

Aboriginal Affairs and Northern Development Canada (AANDC) requests three changes to the water licence.

1. Part D, #16: Sampling and analysis of borrow material

Borrow sources on Padloping and Durban Islands are highly unlikely to show any acid rock drainage or metal leaching potential. Therefore, we do not believe further evaluation through geochemical testing is warranted and request that the board review and consider removing this provision.

2. Part K, #2, DPI 5, DPI-6, DPI-8 and DPI-9: Monitoring Wells for Landfarms

We believe the provision of monitoring wells to support landfarm operations for this project are not required and request the board review and consider removing this provision. A baseline soil sampling and analysis program in the area of the stockpile and treatment areas will be used to verify existing conditions and a confirmatory testing program will be conducted upon completion of operations.

If landfarm operation continues for more than two years monitoring wells will be installed.

3. Water Source Change –Padloping Island

The water source originally planned cannot be accessed reliably. A small steam close to the camp will be used for water. Water usage will be less than 4 m3/day from this source.

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<u>BR1-DPI1217</u>

<u>ᓇᐃᓈᖅᓯᒪᔪᖅ ᑐᑭᓯᑎᑦᑎᔪᖅ</u>

ᐃᓄᓕᕆᔾᔪᑎᒃᑯᑦ ᑲᓇᑕᒥ ᐱᔪᒪᔪᑦ ᒪᕐᕉᖕᓂ ᐊᓯᑦᓲᔪᒪᓪᓗᑎᒃ ᑕᑐᒧᖕᒐ ᐃᒪᓕᕆᓂᕐᒧᑦ ᓚᐃᓴᓯᒥᖕᓄᑦ.

1. ᐃᓚᖓ D, ᓈᓴᐅᑖ 16: ᖃᐅᔨᓴᕈᑎᑖᕐᓂᖅ ᐊᒻᒪᓗ ᓱᖁᐃᖅᓯᓇᓱᖕᓂᖅ ᐲᔭᕐᕕᐅᔪᑦ ᐱᖁᑎᓂᒃ

ᐲᔭᕐᕕᐅᔪᑦ ᑭᓱᓂᒃ ᑕᐃᑲᓂ ᐹᓪᓚᒡᕕᒃ ᐊᒻᒪᓗ ᑑᐸᓐ ᕿᑭᖅᑕᖏᓐᓂ ᑕᒪᐃᓐᓇᐅᔫᑰᓐᖏᑦᑐᖅ ᓴᕿᑦᑎᔭᕆᐊᒃᓴᖅ ᓇᓪᓕᐊᖕᓂ ᐊᐅᓯᔪᓐᓇᖅᑐᓂᒃ ᐅᔭᖃᓂ ᑰᒑᔭᕐᒪᖐᑕ ᐅᒡᒍᓘᓐᓃᑦ ᓴᕕᖄᔭᒃᓴᒥᒃ ᑯᕕᔪᖃᕐᓂᐊᖁᓂ. ᑕᐃᒪᐃᒻᒪᑦ, ᖃᐅᔨᓴᑲᓐᓂᕆᐊᖃᕈᓐᓃᖅᑐᖅ ᑖᒃᑯᖓ ᓄᓇᐅᑉ ᖄᖓ ᖃᓄᐃᑉᐸᓪᓕᐊᓂᖓ ᐊᒻᒪᓗ ᐱᔪᒪᔪᑦ ᐅᑯᐊ ᑲᑎᒪᔩᑦ ᕿᒥᕐᕈᐊᕐᓗᒋᑦ ᐊᒻᒪᓗ ᐃᓱᒪᒋᓗᒋᑦ ᐲᖅᐸᓪᓕᐊᓕᕐᓗᒍ ᐅᓇ ᑐᖖᒑᔾᔪᑖᑦ.

2. ᐃᓚᖓ K, ᓈᓴᐅᑖ 2, DPI 5, DPI-6, DPI-8 ᐊᒻᒪᓗ DPI-9: ᒥᐊᓂᕆᔭᐅᓂᐊ ᐃᒥᖃᕐᕕᐅᔪᖅ ᐅᔭᕋᖕᓂᐊᖅᑕᐅᓂᕕᕕᓂᕐᓂᑦ ᐆᒪᔫᖅᑲᑎᖏᓐᓄᑦ ᓴᓗᒻᒪᖅᓴᖅᑕᐅᓗᑎᒃ ᐃᓚᔭᐅᖃᑦᑕᕐᓗᑎᒃ

ᐅᒃᐱᕈᓱᒃᑐᒍᑦ ᑐᖖᒑᔾᔪᑕᐅᓂᖓ ᒥᐊᓂᕆᓂᖅ ᐃᒪᖃᕐᕕᐅᔪᓂ ᐃᑲᔪᕐᓗᕆᑦ ᓴᓗᒻᒪᖅᓴᑕᐅᔾᔪᓯᖓᒍ ᑕᒪᑐᒥᖓ ᐱᓕᕆᐊᖑᔪᒥᒃ ᐊᑐᓇᐊᖅᑲᖏᑦᑐᑦ ᐊᒻᒪᓗ ᐊᐱᕆᔪᒪᔪᒍᑦ ᑲᑎᒪᔩᑦ ᕿᒥᕐᕈᐊᖁᓪᓗᒍ ᐊᒻᒪᓗ ᐃᓱᒪᒋᓗᒍ ᐅᓇ ᑐᖖᒑᔾᔪᑖᑦ ᒪᓕᒐᑎᒍᑦ. ᐅᓇ ᐊᑐᖅᓯᓪᓗᑎᒃ ᐃᔾᔪᓂᒃ ᖃᐅᔨᓴᕈᑎᑖᖅᓗᑎᒃ ᐊᒻᒪᓗ ᓱᖁᐃᖅᓯᔾᔪᑕᐅᔪᖅ ᐱᓕᕆᑎᑦᑎᔾᔪᑕᐅᔪᖅ ᓄᓇᖓᓄ ᓄᐊᑕᐅᕙᓪᓕᐊᔪᓂᒃ ᐊᒻᒪᓗ ᓴᓗᒻᒪᖅᓴᐅᑕᐅᔪᓂᒃ ᐊᑐᖅᑕᐅᓂᐊᖅᑐᖅ ᒫᓐᓇᐅᔪᖅ ᖃᓄᐃᓕᖓᓂᖓ ᒪᓕᒃᓗᒍ ᐊᒻᒪᓗ ᑕᒪᖅᓯᒪᔪᓐᓃᖅᑎᑦᑎᓗᑕ ᖃᐅᔨᓴᖅᑲᑦᑕᕐᓗᑎᒃ ᐱᓕᕆᑎᑦᑎᔾᔪᑎᖃᕐᓗᑕ ᑕᒪᓐᓇ ᐱᔭᕇᖅᓯᒪᓕᖅᐸᑦ ᐊᐅᓚᑦᑎᓂᖓᑦ.

ᒥᐊᓂᕆᓂᖅ ᐊᑐᖅᑕᐅᑉᐸᓐ ᐊᕐᕌᒍᓂᑦ ᒪᕐᕉᓐᓂᒃ ᐅᖓᑖᓄᑦᑐ ᐃᒪᖃᕐᕕᐅᔪᖅ ᐋᕿᒋᐊᖅᑕᐅᒐᔭᖅᑐᖅ

3. ᐃᒥᖅᑕᖅᕕᐅᓲᖅ ᐹᓪᓚᕕᒻᒥᑦ ᓅᑕᐅᓂᓇᒐᔭᖅᑕᖓ

ᐃᒥᖅᑕᖅᕕᐅᖅᑲᑦᑕᖅᓂᐊᓚᖅᑐᖅ ᐊᑐᐃᓇᐅᑎᐊᖏᓐᓂᖓᓄᑦ, ᐊᓯᐊᓂ ᒥᑭᓂᖅᓴᕐᒥᑦ ᐊᑐᐃᓐᓇᐅᓂᖅᓴᕐᒥᑦ ᐋᕿᓯᕕᐅᒐᔭᖅᑐᖅ.

Freshwater Lake

Stream

Camp

Padloping Island

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Image Landsat

8229 ft

Imagery Date: 4/9/2013 2006

67°02'38.62" N 62°44'31.55" W elev 92 ft

Eye alt 35296 ft

Google earth