EVALUATING THE PRESENCE AND IMPACT OF ACID DRAINAGE FROM INDUSTRIAL ROADS IN BRITISH COLUMBIA

FREP

EXTENSION NOTE #42

Prepared by David Maloney and Brian Carson

February 2018

1.0 INTRODUCTION

Drainage generated by industrial roads can impact water quality by transporting fine sediment and other road-based contaminants directly into streams. Such potentially contaminating sites are usually associated with bridge and culvert crossings, but can occasionally include rock quarries and other surface disturbances.

In some regions of British Columbia, rocks containing iron sulphide are relatively common. The iron sulphide can be found in diffuse patterns throughout the rock, along open fissures, or in enclosed veins. Rocks containing acid-generating minerals, such as pyrite (also known as fool's gold), oxidize naturally over time through exposure to air and water, producing sulphuric acid and dissolved iron. When the rocks are extracted, crushed, and exposed to the elements (e.g., road alignments, ballast, culvert armouring, and/or road surfacing materials), this process accelerates and produces higher concentrations of acids. Stormwater runoff from these types of materials is usually more acidic (lower pH) and capable of seriously impacting the water quality of receiving streams.

Reduced pH water has the ability to dissolve the heavy metals often associated with mineralized rocks. The more finely pulverized the rock and the lower the pH, the greater the potential for contamination with higher concentrations of heavy metals. These changes to water chemistry constitute a serious threat to both aquatic health and drinking water.

Once sites are contaminated with acid rock drainage, they can continue to pollute water sources for many years. While most of the recognized sites impacted by acid rock drainage in B.C. are associated with old mines, local road networks built with acid-generating rock also have the potential to impact the water quality of local streams.

2.0 PURPOSE OF THIS EXTENSION NOTE

This extension note is to inform land managers and stewardship monitoring staff of the need to recognize and avoid acid-generating rock along road networks. Identifying potential acid-generating rock in quarries and avoiding its use at sensitive locations in watersheds is key to developing effective management strategies. A three-stage assessment process for identifying the presence of acid-generating rock, evaluating potential risks, and implementing remediation efforts is presented below.

Figure 1. *Iron staining downstream from a culvert outfall resulting from acid rock drainage generated by road ballast. Unrecognized use of acid-generating rock adjacent to streams can cause local pH levels to drop below 4.0 and make the heavy metals associated with sulphide deposits more dissolvable. While acid road drainage is not in the same league as acid mine drainage, impacts can be severe on local fish, plants and wildlife.*

FREP Mission:
Collect and communicate the best available natural resource monitoring information to inform decision making, improve resource management outcomes and provide evidence of government's commitment to environmental sustainability. *http://www.for.gov.bc.ca/hfp/frep/index.htm*

BRITISH COLUMBIA

Figure 2. *When rust staining is noticed in rock quarries or road prism culverts, managers need to determine whether the use of acid-generating rock is impacting water quality.*

Figure 3. *Typical iron staining in quarry rock. Fissures in acid-generating rock exhibit this rust staining on exposure to air and water. Where the rock is not fractured, staining may become apparent only after the rock is crushed.*

3.0 THREE-STAGE ASSESSMENT PROCESS

Stage 1. Determine if acid rock drainage is a potential issue in your area.

Certain geological formations have a much greater chance of generating acid rock drainage. For instance, the Coast Mountains contain inclusions of sulphides from ancient undersea volcanic landscapes. However, the degree of diversity of B.C. geological formations and the variable occurrence of sulphites within those formations makes predictions of local acid rock drainage difficult. The presence of a historic or active mine in the area may suggest a greater likelihood of acid- generating materials.

Experience and local knowledge are important when screening for acid rock drainage. Are there reports of fool's gold in the area? Do existing rock quarries show strong iron staining? Have existing culvert outfall channels become stained over time? Are stream and lake waters more acidic than might otherwise be expected (pH <5.6)? Signs such as these can mean that acid rock drainage may be an issue and more systematic investigation is required. If acid rock drainage is positively identified in specific rock types or existing quarries within local watersheds, these areas should be avoided. In extreme cases, an existing quarry may have to be abandoned and a new quarry opened where sulphites are not present. If there has been no use of identified acid-generating rock on the road network, then the evaluation is complete and no further action is required.

Stage 2. Evaluating the risk if acid rock drainage is recognized in your area.

If acid-generating rock has been unwittingly used to develop a watershed's road network and signs of acid rock drainage are apparent, it is important to evaluate the potential threat to the environment, primarily heavy metal contamination downstream. Discussions with road builders may assist in obtaining information on where suspect rock has been used in close proximity to natural streams.

Where road segments are identified as having received acid-generating rock for ballast and/or road surfacing material, an evaluation of the potential impact to water quality is required. The Forest and Range Evaluation Program (FREP) Water Quality Effectiveness Evaluation (WQEE) protocol can be used to identify the area of acid-generating material in the road base or surfacing material that could potentially contaminate nearby surface water. Acid-generating materials within this area (i.e., a mini watershed) would have to be removed or remediated if the contamination is serious enough to affect local domestic water supplies and/or fish habitat. The potential impact of acid-generating rock on receiving waters requires detailed analysis and investigation of the discharge and sensitivity (buffering capacity) of the receiving waters, as well as the physical, geological, geochemical and mineralogical composition of the rocks generating the acid drainage – see also: http://www.miningfacts.org/Environment/What-is-acid-rock-drainage

Figure 1. *While this road next to a stream on northern Vancouver Island is built with potential acid-generating rock, it does not seriously impact water quality. The FREP WQEE value at this site was determined to be "very low" for fine sediment generation, which also applies to acid-generating discharge. All road (and ditch) drainage is designed to flow away from the bridge and be deposited on the forest floor away from the stream where it can be neutralized. Forest floors have a very high buffering capacity for acid rock drainage.*

Stage 3. Mitigation of acid rock drainage on sensitive sites

If acid rock drainage is suspected to be impacting natural drainage, an evaluation of the road drainage water and the potential effect on adjacent streams should be undertaken. Water samples should be taken upstream and downstream of the site, as well as sampling the actual drainage exiting the contaminated road prism materials.

The timing of sampling is important as measured pH and heavy metal content varies considerably with the seasons and individual storm events. Generally, there is a spike in acidity and heavy metal loading of water immediately after rainfall when dissolved and fine particulate materials are flushed from the system. For this reason, single water samples should not be relied upon.

At a minimum, pH should be measured from multiple water quality samples and any values below 5.5 considered suspect. Further analysis on low pH water samples should include testing for a range of heavy metals, including arsenic, copper, lead, etc. If it is determined that water quality has been seriously compromised, and contamination is substantial, a site mitigation plan should be developed. This may include isolating road surface drainage to flow away from streams, incorporating limestone into road surfaces, and, in extreme cases, removing acid-generating rock material and storing it in a safe location.

4.0 CHECKLIST FOR EVALUATION OF ACID ROCK DRAINAGE ON INDUSTRIAL ROADS.

Stage 1. Determine whether you have acid-generating rocks within your area of operations.

Are sulphide-bearing rocks present in the watershed? (Sometimes pyrite is finely divided and not readily apparent until it weathers.) Do local rock quarries exhibit patches or streaks of iron staining? Is ballast on the road showing patches or streaks of iron staining? Where there is doubt, rock samples can be analyzed by simple laboratory procedures to determine their acid-generating potential. If there is no indication of potential for acid rock drainage, the evaluation is complete.

Stage 2. If acid rock drainage is present in your area, evaluate the potential risks.

Is mineralized quarry rock used in close proximity to local streams or lakes, or as ballast or road-capping material at stream crossings? Is significant surface drainage from acid-generating rock able to reach streams by surface flow? Use the methodology developed for the FREP WQEE to make this determination. The fine particles and dissolved minerals that generate acid drainage behave in much the same way as fine sediments predicted by the WQEE. Therefore, an assessment of fine sediment generation, transport and delivery to natural streams will mirror what will happen to acid rock drainage from the road.

Stage 3. Mitigation of acid rock drainage on sensitive sites.

If significant acid rock drainage is impacting a natural water body, are there means to mitigate it (e.g., remove grader berms, install culverts, etc.)? If not, investigate the possible role of limestone or other acid rock drainage neutralizing mechanisms mixed with road materials or drainage water in sumps installed for this purpose. In extreme cases, removal of the contaminated road material and containment in a safe location may be required.

Key Messages for Resource Managers:

- In some areas of B.C., acid-generating rock used in industrial road construction has the potential to contaminate streams and pose a serious risk to aquatic health and drinking water.
- The FREP Water Quality Effectiveness Evaluation (WQEE) protocol can be used to determine if acid-generating road material inadvertently used in road construction has the potential to contaminate nearby water sources.
- Mitigation efforts to address water quality concerns related to acid rock drainage include: directing road drainage away from streams and other water bodies, incorporating limestone into road surfaces, and, in occasional extreme cases, removing acid-generating rock from the site and storing it in a safe location away from potential surface and/or internal drainage.

5.0 BIBLIOGRAPHY

BC AMD Task Force. 1989. **Draft Acid Rock Drainage Technical Guide**. British Columbia Acid Mine Drainage Task Force, with funding from Energy, Mines and Resources Canada and the British Columbia Ministry of Energy, Mines and Petroleum Resources under the Canada/British Columbia Mineral Development Agreement 0985-90).

BC Ministry of Forests. 1996. **Community Watershed Guidebook**. Section 9.2.3. Acid Drainage Rock. Retrieved from: https://www.for.gov.bc.ca/TASB/LEGSREGS/FPC/FPCGUIDE/WATRSHED/Watertoc.htm.

BC Ministry of Transportation and Infrastructure. 2013. **Evaluating the Potential for Acid Rock Drainage and Metal Leaching at Quarries, Rock Cut Sites and From Stockpiled Rocks or Talus Material Used by MOTI**. Technical Circular T -04/1.3.

BC Wild and Environmental Mining Council of B.C. (undated) **Acid Mine Drainage**. Mining and Water Pollution and Issues in BC. Retrieved from: http://www.protectfishlake.ca/media/amd.pdf.

Buchanan, Robert G. 2004. **Testing at Quarry and Rock Cut Sites**. BC Ministry of Transportation and Infrastructure - Technical Circular T -10/04 – ARD.

Huckabee, J W, C. Goodyear, and R.D. Jones. 1975. **Acid rock in the Great Smokies: unanticipated impact on aquatic biota of road construction in regions of sulfide mineralisation**, *Trans Amer Fisheries Soc*. 104:677-684.

Koyanagi, V.M. and A. Panteleyev. 1994. **Natural acid rock drainage in the Red Dog-Hushamu-Pemberton Hills area, Northern Vancouver Island (92L/12)**. in Geological Fieldwork 1993. BC Ministry of Energy, Mines and Petroleum Resources. Paper 1994-1, pp. 119-125.

Massey, N.W.D. 2000. **Volcanogenic Massive Sulphide Deposits of British Columbia. Ministry of Energy and Mines.** Retrieved from: http://www.empr.gov.bc.ca/mining/geoscience/publicationscatalogue/openfiles/1999/pages/1999-2.aspx.

Price, William, and John C. Errington. 1994. **ARD Guidelines for Mine Sites in British Columbia**. Proceedings of the 18th Annual British Columbia Mine Reclamation Symposium in Vernon, BC, 1994. The Technical and Research Committee on Reclamation. Retrieved from: http://www.empr.gov.bc.ca/mining/geoscience/publicationscatalogue/miscellaneouspublications/documents/mp-56.pdf.

Sahat, A M, and C.W. Sum. 1990. **Disintegration of road aggregates along parts of the Gurun-Alor Setar and Ipoh-Changkat Jering highways**, *Warta Geologia*, 16(3):142.

U.S. Environmental Protection Agency. 1994. **Acid Mine Drainage Prediction**. Technical document EPA 530-R-94-036. NTIS PB94-201829.