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Lynn Kriwoken,
Chair, Technical Advisory Committee
Elk Valley Water Quality Plan
B.C. Ministry of Environment
PO Box 9362 Stn Prov Govt
Victoria, BC V8W 9M2

Dear Lynn:

Further to the discussions that were convened during the October 29 and 30, 2013 Technical Advisory Committee (TAC) meeting in Cranbrook, B.C., I am pleased to submit the following recommendations related to development of the Elk Valley Water Quality Plan (EVWQP). These recommendations apply to the following topic areas:

- Completeness of the Proposed Work Packages;
- Values and Components;
- Ecological Effects Evaluation;
- Selenium Work Plan;
- Sulfate and Nitrate Work Plan; and,
- Cadmium Work Plan.

1.0 Completeness of the Proposed Work Packages

Teck has proposed to prepare a number of work packages to support the development of the EVWQP. While the proposed work packages are likely to be useful in terms of supporting development of the Plan, a number of additional packages also need to be prepared, including:

- Regulatory Context – Section 3.2 of the Terms of Reference for the EVWQP indicates that the plan will outline the current regulatory context for chemicals of potential concern (COPCs) and calcite in the Designated Area. While the Draft Planning Framework for

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Development of the EVWQP provides some regulatory context, the information contained therein generally identifies and briefly describes relevant legislation and policies. What is still needed is an evaluation of how the applicable legislation and policies will be considered and explicitly addressed during development of the EVWQP. More information on the relevance of existing treaties, inter-governmental agreements, and management plans to the EVWQP development process is needed. This information should be compiled in a work package or a standalone section of the EVWQP for review by the TAC.

- Assessing Impact - Section 3.8 of the Terms of Reference for the EVWQP indicates that the plan will, for the purposes of identification of scenarios and treatment options, address the impact of point and non-point sources of waste on water quality, aquatic biota, and human consumers, as well as the cumulative impacts of point and non-point sources and the potential interactive effects of the COPCs. To determine if Teck has used the best available science in these assessments, it is critical that the TAC be provided with a clear understanding of all of the point and non-point sources of waste in the Elk River and Lake Koocanusa watersheds. Therefore, it is recommended that a work package be developed that provides an inventory of waste sources and associated COPCs. In addition, this work package should describe the methods that will be used to evaluate the impacts and cumulative effects of all waste sources in the study area.

2.0 Values and Components

The Terms of Reference for the EVWQP indicates that the Plan will describe environmental management objectives and outcomes for the Designated Area, including protection of aquatic ecosystem health, management of bioaccumulation of selenium, cadmium, nitrate, and sulphate, protection of human health, and protection of groundwater. While these are important environmental management objectives for the Designated Area, they do not define all of the Values that need to be addressed in the EVWQP. In addition, the EVWQP needs to be developed to ensure that the following water uses are protected and, where necessary, restored:

- Agricultural water uses (i.e., livestock watering and irrigation);
- Wildlife watering;
- Recreational and aesthetic water uses;
- Cultural water uses (in this context, water quality requirements for cultural uses are those that are needed to support traditional lifestyles, including the perception that the water is safe to drink, and that the fish and other traditional resources are safe to use); and,
- International water uses (in this context, water quality guidelines for other water uses should not be considered to be pollute-up-to values. The assimilative capacity of Lake Koocanusa should be shared equitably by Canadian and U.S. interests).

3.0 Ecological Effects Evaluation

To support discussions related to the assessment of ecological effects for a range of water quality concentrations, Teck developed a generic water quality constituent influence diagram. This diagram describes the conceptual model that will guide the ecological effects evaluations. While the conceptual model is generally appropriate for its intended use, there are some additional considerations that need to be addressed, including:

- Direct linkages between mine components and groundwater need to be incorporated in the conceptual model;
- The toxicity of sediments within the study area to benthic invertebrates needs to be evaluated;
- Effects on benthic invertebrate community structure associated with exposure to degraded water quality and sediment quality need to be evaluated;
- Effects on wildlife associated with exposure to contaminated drinking water need to be evaluated;
- Effects on human health associated with exposure to contaminated surface water, groundwater, and biota need to be evaluated in relation to various water management and water treatment scenarios;
- Impacts of a broader list of COPCs associated with all point and non-point sources on water uses need to be evaluated; and,
- The spatial scale of the effects evaluation needs to be expanded to include locations throughout the Fording and Elk Rivers (i.e., not just the stations identified in the Order), the tributaries to these rivers, and Lake Koocanusa. To support such an evaluation a more robust data set needs to be compiled for the study area.

4.0 Selenium Work Plan

The approach that was described for evaluating the ecological effects associated with exposure to elevated levels of selenium in the water has the potential to support the development of science-based water quality targets for selenium. However, there are a number of issues that could influence the utility of the approach, including:

- Synoptically-collected water chemistry and algal tissue-chemistry data appear to be insufficient to support the derivation of reliable algal-water concentration ratios (K_d values). As these ratios are of fundamental importance to the overall bioaccumulation modeling for selenium, the K_ds that are derived from estimated exposure data (i.e., water chemistry data based on monthly sampling results averaged over some period of time) should be validated using the results of a site-specific investigation that involves deployment of plate samplers at multiple locations in the Elk/Fording/Lake Koocanusa system and intensive evaluation of exposure to selenium. The exposure assessment should be conducted by collecting water samples on a weekly basis for analysis of selenium and mine-related conventional variables

(e.g., alkalinity) and by conducting continuous monitoring of mine-related conventional variables (i.e., using continuous monitoring probes). This work should be conducted in the late summer and early spring to determine if K_ds vary on a seasonal basis, which could substantially affect the results of bioaccumulation modeling. The results of this work will support validation of the preliminary model that is used in the EVWQP;

- Exposure of aquatic organisms and wildlife species to selenium should be conducted separately for lentic and lotic habitats. In this way, effects on those species utilizing lentic habitats and on those species utilizing lotic habitats can be evaluated separately. For westslope cutthroat trout, it is understood that both lentic and lotic habitats may be utilized by individuals and/or by population segments. Nevertheless, it is recommended that the analysis of exposure (i.e., fish egg concentrations) be conducted separately for both habitat types;

- Effects on burbot utilizing lentic habitats in Lake Koocanusa associated with exposure to selenium need to be evaluated as part of the overall ecological effects assessment for selenium;

- Whenever available, the effects on ecological receptors under current and relevant historic conditions (i.e., where exposures may have been similar to some future exposure scenario) should be evaluated using measured data on the concentrations of selenium in invertebrates, fish, amphibians, and birds. These data should also be used to validate the bioaccumulation model used in the ecological effects assessment for selenium; and,

- Potential effects on human health associated with exposure to selenium from dietary sources needs to be evaluated. This evaluation should rely primarily on measured (rather than modeled) tissue selenium data and should identify uncertainties in the analysis associated with data gaps and other factors. The results of the LCOII human health risk assessment should be used as a primary basis for this work.

5.0 Sulphate and Nitrate Work Plan

The approach that was described for evaluating the ecological effects associated with exposure to elevated levels of sulphate and nitrate in water have the potential to support the development of science-based water quality targets for these COPCs. However, there are a number of issues that could influence the utility of the approach. Recommendations for addressing these issues include:

- The potential for adverse effects on mammalian wildlife species associated with exposure to nitrate via the drinking water pathway needs to be evaluated;

- The potential for adverse effects on primary productivity in tributaries, Fording River, Elk River, and Lake Koocanusa associated with releases of nitrate from mine-related activities, in conjunction with releases of nutrients from mining and other sources, needs to be

evaluated. Such an evaluation cannot be limited to the locations identified explicitly in the order for water quality target development;

- The potential for effects on ecological receptors utilizing habitats in the tributaries to the Elk and Fording River needs to be evaluated;

- It is not clear that the selected toxicity tests for evaluating the effects on aquatic organisms associated with exposure to nitrate or sulphate are the most sensitive and/or relevant (i.e., mayflies were not tested; amphipods were tested in 14-d exposures only; biomass and reproduction were not evaluated; amphibians were not tested). Therefore, the results of such toxicity tests cannot be used directly to identify toxicity thresholds for aquatic organisms relative to nitrate or sulphate. Therefore, an approach for translating empirically-derived toxicity thresholds (based on the results of toxicity tests) to estimated toxicity thresholds for communities in the Elk/Fording watershed needs to be developed;

- The evaluation of the ecological effects of nitrate and sulfate under current conditions must consider maximum exposures as well as average exposures to these substances. In conducting such assessments, it is important to recognize that the results of monthly water sampling represent the average concentration of the COPC for that month. Average COPC concentrations must be determined based on the results of five water samples collected within a 30-d period;

- Study Outlines, including toxicity test protocols, tables of test conditions, and general activity schedules, need to be provided to the TAC when the toxicity test results and water chemistry results are provided for review;

- Benthic invertebrate community structure data should be used as an independent line of evidence for evaluating the potential effects of mine-related discharges. In this respect, multivariate analysis (or similar methods) should be used to evaluate potential effects on benthic invertebrates relative to exposure to COPCs and habitat characteristics; and,

- The interactive effects of mixtures of COPCs and calcite formation needs to be evaluated in the tributaries and in the Elk/Fording mainstem habitats.

6.0 Cadmium Work Plan

The approach that was described for evaluating the ecological effects associated with exposure to elevated levels of cadmium in water have the potential to support the development of science-based water quality targets for this COPC. However, there are a number of issues that could influence the utility of the approach. Recommendations for addressing these issues include:

- The potential for adverse effects on aquatic organisms in tributaries, Fording River, Elk River, and Lake Koocanusa associated with releases of cadmium from mine-related activities must be evaluated. Such an evaluation cannot be limited to the locations

identified explicitly in the order for water quality target development;

- No site-specific toxicity tests have been conducted or have been proposed to support the development of toxicity thresholds or relationships for cadmium. Rather, the proposed approach is dependent on development of concentration-response relationships based on hardness normalization and/or biotic ligand modeling (BLM). Hardness normalization has been used to derive numerical water quality guidelines for cadmium by the CCME and BCMOE. However, BLM has not been used to derive water quality guidelines or water quality criteria for cadmium in Canada or the United States. Importantly, data from other sites suggest that the BLM approach can substantially under-predict toxicity to aquatic organisms (i.e., by a factor of three or more). Therefore, it is essential that the cadmium BLM that is developed for use in the Elk/Fording watershed be validated using site-specific chronic toxicity test data. The TAC should be provided with an opportunity to review the design of the toxicity testing program that is developed to generate the requisite site-specific toxicity data; and,

- The evaluation of the ecological effects of cadmium under current conditions must consider maximum exposures as well as average exposures to these substances. In conducting such assessments, it is important to recognize that the results of monthly water sampling represent the average concentration of the COPC for that month. Average COPC concentrations must be determined based on the results of five water samples collected within a 30-d period.

Here's hoping that this supplemental advice is useful to you and the rest of the Technical Advisory Committee.

Sincerely,

Don MacDonald, President,
RPBio., CFP
MESL/Pacific Environmental Research Centre