December 3, 2013

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 November 25 and 26, 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:

- Site-Specific Water Quality Objectives (SSWQOs);
- Water Quality Planning Model;
- Mitigation Measures and Management Scenarios; and,
- General Comments and Advice.

1.0 Site-Specific Water Quality Objectives

Work Package #3 included one document on the Calculation of Site-Specific Water Quality Objectives for Selenium, Sulphate, Nitrate, and Cadmium in Support of the Elk Valley Water Quality Plan. Specific advice regarding the calculation of SSWQOs includes:

- Step 1 of the SSWQOs derivation process involves identification of the B.C. water quality guidelines (BC WQGs) for each of the chemicals of potential concern (COPCs) that are named in the Order. For total selenium and nitrate, the 30-d average or maximum WQGs can be used directly as presented in the WQGs documents. However, the WQGs for sulphate and cadmium are hardness dependent. Stroich *et al.* (2013) used the median water hardness for the Fording River station (FR_UFR1) and Elk River station (GH_ER2) to calculate the preliminary SSWQOs for sulphate and cadmium. However, such SSWQOs may not be protective during periods when water hardness is less than the median values. For this reason, an estimate of the lower limit of water hardness (e.g., 5^{th} percentile) should be used to calculate the preliminary SSWQOs for sulphate and cadmium.

Advice: Utilize the 5th percentile water hardness for the reference stations to derive SSWQOs for sulphate and cadmium.

- Stroich *et al.* (2013) derived SSWQOs for total selenium, nitrate, sulphate, and total cadmium for the Elk and Fording Rivers. Table 5 of the document presents the preliminary SSWQOs as specific values for total selenium and nitrate, and as ranges for sulphate and total cadmium. However, the document does not include a table that presents the final recommended SSWQOs for these substances. For this reason, a table should be created that explicitly describes the recommended SSWQOs for each river.

  Advice: Develop a table that presents the recommended SSWQOs for total selenium, nitrate, sulphate, and total cadmium for the Elk and Fording Rivers. The table should explicitly indicate the period of the year in which the SSWQO applies (e.g., spring freshet, recession, low flow) and define the duration of each period (e.g., low flow period is December through March).

- Stroich *et al.* (2013) derived SSWQOs for total selenium, nitrate, sulphate, and total cadmium in surface water for the Elk and Fording Rivers. However, other substances have the potential to exceed BC WQGs in surface water, sediments, or tissues in the Fording River, Elk River, and/or Lake Koocanusa. For this reason, the available surface water chemistry, sediment chemistry, fish-tissue chemistry, invertebrate-tissue chemistry, and bird-egg tissue chemistry should be reviewed and evaluated to identify exceedances of BC WQGs. The SSWQOs should be established for any substance for which exceedances of the BC WQGs have occurred within the period of record. BC WQGs are considered to be applicable for all other substances.

  Advice: Develop a list of substances and media types for which SSWQOs are required, based on exceedances of the BC WQGs. Derive SSWQOs for each substance in each media type included on the list.

- Stroich *et al.* (2013) derived SSWQOs for total selenium, nitrate, sulphate, and total cadmium for the Elk and Fording Rivers. However, SSWQOs were not recommended for Lake Koocanusa. For this reason, SSWQOs should be derived for total selenium, nitrate, sulphate, and total cadmium in Lake Koocanusa.

  Advice: Derive SSWQOs for total selenium, nitrate, sulphate, and total cadmium in Lake Koocanusa, including season-specific SSWQOs if warranted by variability in water quality conditions.

- Stroich *et al.* (2013) derived SSWQOs for total selenium, nitrate, sulphate, and total cadmium for the Elk and Fording Rivers. Several refinements to the SSWQO-derivation process are identified in this advice. For this reason, the Technical Memorandum should be revised to incorporate the advice on the derivation of SSQWOs.

  Advice: Revise the technical memorandum entitled "Calculation of Site-Specific Water Quality Objectives for Selenium, Sulphate, Nitrate, and Cadmium in Support of the Elk Valley Water Quality Plan" to address the advice included in this letter.

2.0 Water Quality Planning Tool

Work Package #6A is intended to document the water quality planning model that has been developed to support the EVWQP. The work package consists of four documents, including:

1. Overview of the Water Quality Planning Model;
2. Water Quality Modeling Report;
3. Hydrology Modeling Report; and,
4. Geochemical Source Term Inputs and Methods Report.

Advice on the overall approach to water quality modeling, geochemistry inputs, hydrology inputs, and the water quality planning model are provided in this section.

- Model Domain - The water quality planning model was developed to simulate concentrations of cadmium, selenium, nitrate, and sulphate at selected stations in the Fording and Elk rivers. While simulations of historic and future water quality conditions in the Fording and Elk rivers are directly relevant to the water quality planning process, predictions of future water quality conditions in Lake Koocanusa under various management scenarios are also required. Therefore, the water quality planning model should be modified to facilitate prediction of water quality conditions in Lake Koocanusa.

  Advice: Modify the water quality planning model to provide a reliable tool for predicting water quality conditions in Lake Koocanusa (i.e., not just at the mouth of the Elk River).

- Model Domain - The water quality planning model was developed to simulate concentrations of cadmium, selenium, nitrate, and sulphate at selected stations in the Fording and Elk rivers. While simulations of historic and future water quality conditions in the Fording and Elk rivers are directly relevant to the water quality planning process, predictions of future water quality conditions in the tributaries to these rivers are required to evaluate the costs and benefits of various candidate mitigation measures and management scenarios.

> Advice: Modify, if necessary, the water quality planning model to provide a reliable tool for predicting water quality conditions in the tributaries to the Fording and Elk rivers that are affected by coal-mining activities. Report the results of water quality predictions for all coal-mining affected tributaries and utilize these results in the EVWQP development process.

- Model Domain - The water quality planning model was developed to simulate concentrations of cadmium, selenium, nitrate, and sulphate at selected stations in the Fording and Elk rivers. This approach assumes that predictions of surface water chemistry provide the necessary and sufficient information for evaluating management scenarios and developing the EVWQP. However, adverse effects on fish and other aquatic organisms can also occur as a result of exposure to sediment-associated COPCs. For this reason, an approach to modeling the concentrations of selected COPCs in sediments needs to be developed to support the EVWQP.

> Advice: Develop a planning model to facilitate predictions of COPC concentrations in sediments within tributary streams, the Fording River, the Elk River, and Lake Koocanusa. Report the results of the sediment quality predictions for the tributary streams, the Elk and Fording rivers, and Lake Koocanusa and utilize these results in the EVWQP development process.

- Model Inputs - The water quality planning model is dependent on estimates of stream flows and water chemistry at 35 nodes within the Elk River watershed. For the purpose of model development, the required information has been estimated based on hydrological monitoring data and estimation procedures, as well as water quality monitoring data and estimation procedures. In the future, simultaneous water quality monitoring and hydrological monitoring should be conducted at each of these nodes to provide the information needed to validate and refine the water quality planning tool.

> Advice: Include water quality monitoring and streamflow monitoring at the modeling nodes included in the water quality planning model. The frequency and duration of monitoring at each location should be determined with input from the TAC.

- Based on the results of water quality modeling conducted to simulate historical conditions, it appears that the water quality planning model may provide a relevant basis for predicting the concentrations of certain water quality variables (e.g., selenium, sulphate), but not for other variables (i.e., nitrate and cadmium). These inconsistencies in model performance suggest that key mechanisms controlling the release and/or transport of certain variables may not be adequately accounted for in the model assumptions and/or model development. For this reason, development of mechanistic, rather than empirical, model is likely to be more effective for nitrate and cadmium.

> Advice: Develop a mechanistic model to facilitate predictions of the concentrations of cadmium and nitrate in tributaries, the Fording River, the Elk River, and Lake Koocanusa. Compare the performance of the empirical and mechanistic models, and select the more reliable model for use in water quality planning in the Elk River watershed. Develop a strategy for collecting information relevant to model refinement and for refining the water quality planning model(s) as additional information is generated.

- Currently, the water quality planning model does not include the potential effects of climate change on hydrological conditions in the Elk Valley or on other variables that are included in the model. However, climate change has the potential to influence climatic conditions in the future and such changes should be accounted for in the water quality planning model. For this reason, relevant climate change models should be reviewed to identify potential climate-related effects in the Elk Valley. This information should be used to adjust assumptions related to future hydrological conditions and other variables considered in the water quality planning model.

> Advice: Revise the water quality planning model by incorporating predictions of the influence of climate change on hydrological conditions and other variables considered in the water quality planning model.

- Currently, the water quality planning model provides simulations of historical conditions (i.e., 2004 to 2012). This model will be used as a basis for making predictions regarding future water quality conditions in the Elk and Fording rivers. To ensure that such predictions provide a fulsome basis for decision making regarding water management options, water quality predictions should extend at least 100 years beyond closure of coal mines in the valley.

> Advice: Extend water quality modeling to encompass a post-closure period of 100 years for coal mines in the Elk Valley.

- Based on the information that was presented during the TAC meeting, it appears that the geochemical inputs assume no decreased contaminant loading in association with cover placement over waste rock piles (i.e., decreased infiltration into waste rock piles is assumed to result in increased residence time and, hence, increased concentrations of COPCs in seepage). This assumption creates a strong bias against incorporation of covers into the overall water quality plan for the Elk Valley. As the assumption regarding the impact of covers on contaminant loadings is not supported by any data, a range of alternate assumptions should be developed and incorporated into the water quality modeling activities.

> Advice: Develop alternate assumptions regarding the efficacy of various types of covers (including no cover, simple covers, complex covers, and geomembrane-incorporating covers) for reducing net percolation and loadings of contaminants to receiving waters in the Elk Valley.

3.0 Mitigation Measures and Management Scenarios

During the third TAC meeting, a number of presentations were made regarding potential mitigation measures and management scenarios that could be used to address water quality issues in the Elk Valley, including:

1. Water Treatment Options;
2. Water Management Measures;
3. Assessment of Covers;
4. Management Scenarios to Mitigate Water Quality;
5. Applied Research and Development Program; and,
6. Incorporation of Mitigation Measures into the Water Quality Planning Model.

Advice on the overall approach to development of management scenarios, mitigation measures, representative management scenarios, and incorporation of mitigation measures into the water quality planning tool is provided in this section.

- To fully evaluate the various management scenarios that may be developed for the EVWQP, the TAC will require a detailed understanding of the locations of the various types of facilities (waste rock piles, mined out pits, haul roads, etc.). Information on the volume of waste rock or coal rejects in each facility is also required. Furthermore, information is required on the locations and volumes of contact and non-contact water throughout the watershed.

> Information Request: Provide information on locations of facilities and volumes of materials located in each facility, including existing

facilities and planned future facilities. Provide information on the locations and volumes of contact and non-contact water throughout the watershed. Provide GIS coverages showing the locations of facilities and water sources.

- To fully evaluate the various management scenarios that may be developed for the EVWQP, the TAC will require a detailed understanding of the volumes and characteristics of water that may be treated in various active water treatment facilities.

  Information Request: Provide information on the volume and water quality characteristics of waters that are proposed for treatment using active water treatment facilities. Information on the assumed post-treatment water quality characteristics for each facility, including variability, is also requested.

- To fully evaluate the various management scenarios that may be developed for the EVWQP, the TAC will require a detailed understanding of the current status of progressive reclamation of waste rock piles throughout the watershed.

  Information Request: Provide information on the status of active reclamation of waste rock piles throughout the watershed. Provide GIS coverages that colour-code reclamation status for each facility. For waste-rock facilities that have not been subject to active reclamation, please provide a rationale for not conducting reclamation, a schedule for conducting reclamation, and a description of the type of reclamation that is anticipated for each facility.

- The development of management scenarios that provide a basis for meeting short-term, medium-term, and long-term targets will require a substantial number of assumptions and information inputs. These underlying assumptions and information inputs need to be clearly documented and referenced to provide confidence in the EVWQP that is ultimately established.

  Advice: Clearly identify all of the assumptions and information inputs that are used to develop and evaluate the various management scenarios that are considered during formulation of the EVWQP. For each management scenario, prepare a table that identifies the information requirements, documents the information or assumptions used, and the rationale/source of the information or assumptions.

- While a number of management scenarios are being developed for consideration during development of the EVWQP, it is likely that the TAC will provide specific advice regarding the modification or refinement of the management scenarios and/or underlying assumptions. Therefore, it is important to develop the water quality planning tool and associated elements in a manner that facilitates efficient consideration of alternative information, different assumptions, and/or refined management scenarios.

> Advice: Ensure that the water quality planning tool and associated elements are designed in a manner that facilitates timely consideration of alternative information, different assumptions, and/or refined management scenarios, as provided by the TAC and/or the public.

4.0 General Comments and Advice

The TAC process appears to be providing a useful basis for reviewing and evaluating the work packages that are being developed by Teck to support the EVWQP. While these work packages represent important elements of the overall EVWQP development process, there are other topics that require input from the TAC. Therefore, it is essential that the agendas for the TAC meetings include time for the TAC to identify and discuss other issues related to the development of the EVWQP. Some of the topics that should be considered in the near term include:

- Methodology for developing short-term water quality targets;
- Schedule for implementing short-term water quality targets;
- Options for providing independent oversight on the implementation, interpretation, and refinement of monitoring programs;
- Options for modeling the fate and effects of contaminants in Lake Koocanusa;
- Options for providing independent oversight on the auditing and refinement of the water quality planning tool;
- Options for providing independent oversight on the implementation and evaluation of the EVWQP; and,
- Options for providing independent oversight on applied research and development activities in the Elk Valley.

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

Sincerely,

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Principal, MacDonald Environmental Sciences Ltd.
Canadian Director, Sustainable Fisheries Foundation