Summary Table			
Category	**#**	**Description of "Technical Advice" from Mtg**	**Rationale**
Ecological Effects Assessment / Overall Approach *Work Package #2b: Preliminary Results of the Assessment of Ecological Effects*	**A4-1**	For toxicity benchmarks, rename the "no effects", "low effects", and "intermediate effects" benchmarks to terms that are more neutral (e.g. A, B, C or ECx ranges that the benchmark represents).	Generic terms such as "no-effect", "low-effect" and "intermediate-effects" are subjective. EC10 by definition is a 10% effect level, EC20 is a 20% effect level etc. If using ECx ranges report the associated endpoints (i.e. growth, reproduction, death).
	A4-2	Always include measures or descriptions of uncertainty (i.e. confidence intervals around estimates and error bars for figures).	Reporting error and confidence intervals will help when determining the uncertainty associated with effects estimates. Also it may be desirable to use the lower confidence interval for benchmarks given all the uncertainties identified when developing them.
	A4-3	Document the rationale and all of the conditionalizing assumptions in characterizing effects in the matrices.	Clearly identify all the assumptions and rationale used when developing the effects matrices.
Ecological Effects Assessment / Interactive Effects *Work Package #2b: Preliminary Results of the Assessment of Ecological Effects*	**A4-4**	Clarify the evaluation of interactive effects from various constituents of concern (or COPCs) and other stressors during the effects assessment. Clarify how different COCs effects matrices will be more easily summarized with one another (and ideally cumulatively aggregated in some way).	There are a variety of stressors that could adversely affect aquatic organisms in receiving waters. The proposed effects matrices provide a basis for evaluating effects associated with individual stressors. To evaluate the interactive effects of multiple stressors, it will be necessary to combine the results that are obtained for individual stressors. However, no information has been provided on how such aggregation of effects information will be conducted.
	A4-5	For Cd, SO_4, and NO_3 where invertebrates are sensitive indicators, available bio-assessment data (e.g., field monitoring of macroinvertebrate abundance and composition) should be used to validate predictions in the effects matrix on the effects of mixtures.	The toxicity data used to develop toxicity thresholds for Cd, SO_4 and NO_3 are not comprehensive. Therefore, predictions of toxicity (or lack thereof) are subject to errors associated with incomplete knowledge and extrapolation from the lab to the field. Such errors can, in part, be addressed by compiling and evaluating effects data from the field (e.g., bio-assessment data) to validate predictions regarding effects from exposure data.

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Selenium Ecological Effects Assessment *Work Package #2b: Preliminary Results of the Assessment of Ecological Effects*	**A4-6**	Comparatively evaluate one-step vs. multi-step models. In particular, evaluate whether the uncertainty (as indicated by the UCL and UPL) in the one-step model is greater than in the multi-step model. Additionally, please present the multi-step models as single figures rather than individual figures for each step (see Adams et al. 1999 for example).	It is recognized that combining uncertainty from each step in a multi-step model is not readily accomplished, as simple multiplication at each step will result in significantly inflated uncertainty values for the model as a whole. Conversely, the characterization of uncertainty based on only a single step in the multi-step model is likely to underestimate the overall uncertainty. Comparison of the uncertainty in a one-step model vs. a multi-step model will provide some quantification of the maximum amount of this underestimate.
	A4-7	Review selenium bioaccumulation model dataset for locations where samples were taken across multiple trophic levels as an opportunity to further validate the model outputs.	There is substantial uncertainty in the bioaccumulation models. By identifying "matching" data from the overall data set, it may be possible to reduce variability in models derived using the data that are most closely matched.
	A4-8	As telemetry data for Westslope Cutthroat Trout (WCT) becomes available, continue to assess whether point estimates of selenium exposure concentrations are representative of water concentrations in areas where fish are moving through.	The migratory nature of WCT complicates development of the Se bioaccumulation model because tissue concentrations may not reflect exposure conditions where they are captured. The telemetry data will be useful for determining how water and tissue samples should be collected and evaluated to assess bioaccumulation.
	A4-9	Check whether there are differences in fish tissue selenium concentrations as a function of fish size (may see difference between age and size across egg tissue).	There is evidence from some studies that Se concentrations are higher in younger/smaller fish. If this is the case here, the egg Se distribution may be biased if the sample data do not reflect the age/size class distribution of instream populations.

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	A4-10	Review selenium dataset in close proximity to the Order stations (e.g. ~1km upstream and downstream) to relate potential future target water concentration levels with empirical data on selenium tissue concentrations.	It is important to try and validate modelled results wherever there is data given the level of uncertainty associated with the analyses and the development of benchmarks.
	A4-11	Where the information is available, preference should be given to characterizing effects using the dose - response data as much as possible rather than for example relying on effects thresholds (EC x).	In the field, exposure data is highly variable, ranging from low levels to levels that may be several multiples of the toxicity thresholds. Dose-response relationships provide a basis for evaluating the magnitude of effects associated with exceedance of toxicity thresholds, not just the frequency of exceedance.
	A4-12	Review the lentic periphyton database (2009 to 2010-2013) to see if there is a tighter relationship between selenium water concentration and selenium tissue concentration in periphyton based on water residence time (e.g. based on surface water connection/ distance from mainstem).	In the field, exposure concentrations measured in water represent snapshots of conditions at the time of sampling. In contrast, periphyton tissue concentrations reflect exposure over the weeks or months prior to sampling. By focussing on exposure data that are more closely matched to the tissue data, it may be possible to reduce variability in the Kd estimates.
	A4-13	Evaluate whether a piecewise regression selenium bioaccumulation model provides a better fit for the lentic periphyton relationship (hockey stick) when aqueous selenium concentrations are at higher levels (vicinity of ~ 70 µg/l) and how this influences the proposed effects thresholds.	In observation of the data in slide 10, right panel (i.e., comparison of previous and updated lentic periphyton models), it appears as if the OLS linear model does not represent the data appropriately and in fact a piecewise regression model may be more appropriate. This has potential to influence trophic transfer in subsequent steps and thus should be considered in a more appropriate way.
	A4-14	Undertake an assessment of the uncertainty (e.g. sensitivity assessment) for the periphyton selenium bioaccumulation models.	Currently, uncertainty has only been considered in the last step of the 3 step models. It should be investigated whether more appropriate techniques for integrating uncertainty can be developed.

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	A4-15	For the invertebrate – amphibian bioaccumulation model, undertake a sensitivity analysis to show how the slope and intercept change when the invertebrate data points with the lowest concentrations are removed.	There are a few very low data points in the invertebrate-amphibian bioaccumulation model that visually appear to potentially have excessive leverage on the slope of the model. A sensitivity analysis is needed to evaluate this.
	A4-16	In addition to using the Upper Prediction Limit and Upper Confidence Limit to compare bioaccumulation model results to selenium toxicity benchmarks, provide the full probability distributions of effects (along with benchmarks for reference).	It would be more informative and transparent to integrate the entire data distribution rather than using UCLs and UPLs which may be perceived as under- or over-protective.
	A4-17	Where there are estimated selenium effects close to toxicity benchmarks for both juvenile growth and reproduction endpoints, assess the potential combined effects for a species.	Effects on the growth of fish and their reproduction are not independent. As smaller fish can produce fewer and, in some cases, less viable offspring, it is important to evaluate the combined effects associated with COPC exposures on these endpoints.
Cadmium Ecological Effects Assessment *Work Package #2b: Preliminary Results of the Assessment*	**A4-18**	Prepare species sensitivity distributions for BLM normalized and hardness normalized cadmium toxicity for two additional scenarios: (1) one reflective of lowest hardness conditions at the reference site, and (2) one reflective of higher hardness (e.g. 320mg/l). The purpose of this analysis is to evaluate the difference in the slope estimate between the BLM and hardness approach.	By providing an evaluation of the agreement between the BLM and hardness approaches by normalizing the effect values over a range of water hardness conditions, one can determine if the relative difference in toxicity estimates remains consistent across varying water quality conditions.
	A4-19	Evaluate data on the concentrations of cadmium in sediment cores at Elko (using toxicity data for *Hyalella azteca,* at a minimum).	Upon release into receiving waters, cadmium can remain dissolved in water or become associated with fine sediment. Such sediments may be transported to downstream areas, where they are deposited in low energy zones (depositional areas). In these areas,

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of Ecological Effects			sediment-associated cadmium can reach concentrations of concern relative to benthic invertebrates. As Elko Reservoir is one depositional area in the Elk Valley, it is appropriate to evaluate the potential effects of cadmium on this area (and others).
	A4-19b	**Description of Related Alternate (or Addn) Advice:** Evaluate and report on the data for concentrations of selenium, cadmium and additional COPC's in the benthic sediments of Elko and Koocanusa Reservoirs; including stratigraphic coring of sediments to determine depositional rates and some estimation of current and projected load to benthos.	The current effects assessments for selenium and cadmium lacks sufficient data on accumulation in benthic sediments. Data on current condition is necessary to characterize current baseline and evaluate projected benthic sediment levels in both reservoirs (use toxicity data for Hyalella azteca as a minimum). Given the physiochemical dynamics of reservoirs and the uncertainties surrounding storage capacity for metals, more evaluation is needed to effectively monitor benthic sediment, macro-invertebrates and fish in both reservoirs.
	A4-20	Design and implement a laboratory toxicity study to validate the application of the BLM for predicting the chronic toxicity of cadmium to fish and aquatic invertebrates.	The BLM that was developed for cadmium is based on laboratory toxicity and associated water chemistry data. However, much of the data on water quality conditions was estimated because major ion and/or DOC concentrations were not reported by the original investigators. Therefore, there is substantial uncertainty regarding the reliability of the BLM for predicting toxicity within the Elk River, Fording River, and associated tributaries. This uncertainty can be resolved by validating the applicability of the BLM with well-designed laboratory toxicity studies conducted using site water.
	A4-21	In the toxicity database for the Cadmium Biotic Ligand Model, undertake a sensitivity analysis to evaluate whether the assumption of 0.5 and 1 mg/L concentration of DOC is conservative given the DOC complexing capacity of the food provided to test organisms. Consult relevant literature to inform the range of DOC concentrations for sensitivity analysis.	DOC is an important parameter in the BLM model as it serves as a complexing agent, binding to cadmium and therefore reducing bioavailability. A sensitivity analysis should be conducted using a range of estimated DOC concentrations to evaluate changes to the normalized effect values. The sensitivity analysis should be informed by a literature review on the contributions of DOC from feed and the complexing ability of this DOC.

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	A4-22	In addition to showing seasonal variability for the Biotic Ligand Model normalized effects data, provide results on the seasonal variability for the hardness normalized effects data.	It is unclear whether sufficient data will be provided to validate the Cd BLM. Without this validation, it will be important to understand the effects of the Spring freshet on a hardness-only effects species sensitivity distribution (SSD).
Nitrate/ Sulphate Ecological Effects Assessment	**A4-23**	For the nitrate toxicity studies that were excluded on account of having testing conditions under 100 mg/L $CaCO_3$, transform the toxicity effects for species that are <u>not</u> already represented by studies above the 100 mg/L $CaCO_3$ threshold.	It is reasonable to exclude data below the 100 mg/L hardness threshold for species with data available at >100 mg/L. However, species should not be eliminated from the toxicity data analysis solely because data are unavailable at >100 mg/L hardness. For these species, the data should be normalized for hardness.
Work Package #2b: Preliminary Results of the Assessment of Ecological Effects	**A4-24**	Provide more qualifiers for characterizing "responses measurable in the field" to reflect the basis upon which this was determined.	How are you determining what response you will be able to detect in the field?
	A4-24b	**Description of Related Alternate (or Addn) Advice:** The effect sizes used to determine if responses are measurable in the field should be informed by the AEMP design (i.e., based on detectable effect sizes, necessary sample size and sampling frequency) rather than implying that a less than 20% effect is not measurable in the field.	
	A4-25	When assessing ecological effects of nitrate, consider effects on response variables of potential eutrophication along with toxicity (i.e., dissolved oxygen, pH, dissolved oxygen, etc.).	While nitrate toxicity is one potential impact to aquatic life within the Elk River (and its tributaries), it is well known that excess nutrients (i.e., eutrophication) has potential to cause many other undesirable water-quality effects including low dissolved oxygen (water column and inter-gravel), diurnal changes in pH, nuisance algal growth, and changes in selenium distribution coefficients between dissolved and particulate phases. These too should be considered as impacts to aquatic life and should be evaluated within the effects matrices proposed for the project.

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	A4-26	It is requested that an appropriate acknowledgement be made (i.e., *caveat emptor*) about the potential risk of eutrophication from proposed mine expansions and how eutrophication in Lake Koocanusa could potentially biomagnify selenium accumulation in the reservoir. Consequently, a very forward and concise statement must be prepared in the EVWQP discussing the risk of eutrophication if additional point and non-point phosphorous loads were added to the watershed and acknowledgement that future permitting of phosphorus sources (anywhere in the Koocanusa watershed) could have dramatic effects on reservoir eutrophication including harmful algal blooms, hypoxia in the forebay (more selenite than selenite), and increased bioavailability (and amount) of toxic constituents such as selenium at the base of the food chain.	Lake Koocanusa currently is an oligotrophic system that appears to be phosphorus-limited. In this regard, primary productivity (and pollutant bioaccumulation) are highly dependent on the scarcity of inorganic phosphorus. Mining activities have greatly increased nitrate levels and as a consequence, an adequate understanding of phosphorus controls in the watershed cannot be understated. These must be fully acknowledged along with the effects of what potentially could occur should phosphate sources be unchecked.
Water Quality Planning Model / Mitigation Measures	**A4-27**	Provide detailed information about what mitigation measures are being incorporated into the model, the assumptions for these measures, and a verification that these assumptions are consistent with what is occurring or will happen at the mine sites.	It is important to have a clear understanding of exactly which mitigation measures are included in the model (and which are not) and how they have been incorporated into the model (i.e. assumptions employed). It is also important to have confirmation that the mitigations proposed in the plan are consistent with conditions and plans for individual mines. If not these will be important to identify for future requirements and regulatory review. This is especially important for measures such as covers and water treatment that are modeled to commence in the near future. For example, if waste rock covers and reduction of infiltration are employed in the model, does that reflect the experience of actual/planned re-vegetation and reclamation practices on the mines? Does a commitment to a cover/partial cover necessitate re-sloping that could be problematic operationally?

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	A4-27b	**Description of Related Alternate (or Addn) Advice:** To supplement this advice, it is also recommended that further refinement be done of the GoldSim water quality model. In particular, constructive advice from TAC members (meeting 3) and also 3rd party water-quality model reviews indicate a number of areas of potential improvement which should be integrated into the EVWQP. In particular, the areas that influence the reliability of the model, especially simulating the reduction of net percolation and concomitant changes in geochemical loading terms is critically important to evaluating management scenarios. In this regard, it would be very worthwhile to provide information on what will be done to address these comments. It is recommended that at least a section of the EVWQP plan be devoted to providing details on how the model will be enhanced in the future, primarily the hydrology representation and geochemical source terms, and how they will be refined over time as new information becomes available.	A number of similarities have been noted between previous TAC advice (meeting 3) and the third party review of the GoldSim water-quality model. In particular, independent reviews by AMEC and Schlumberger Water Services echo comments made by several TAC members with respect to the empirical hydrologic or geochemical processes in the model (and their ability to make future predictions; see TAC Meeting 3 Advice items A3-3 and A3-4, associated comments in memo form, Advice item B3-2 by MOE, and the 3rd party reviews). Since management action effectiveness is largely being determined using this empirical approach, it is essential that appropriate steps are taken to address these deficiencies and describe how they will be reconciled going forward with the modeling.
	A4-28	Determine the influence (i.e., sensitivity) of assumptions made in the bituminous geomembrane (BGM) cover scenario, including the validity of the time-frame in which these covers become effective (i.e., between 8-26 years to reach 75% performance and 40-100 year period to full performance). Additionally, provide the TAC with details on the approach and associated calculations supporting this assertion (i.e., field capacity of spoil piles, hydraulic conductivity, etc.). Finally, after verifying the assumptions, complete a model run to assess the full benefit of the BGM cover options in the Elk Valley by running the model until it reaches a dynamic steady-state (i.e., until the BGM cover reaches its full potential). Only after the BGM has become fully effective, should loading comparisons (or pollutant concentration results) be presented. It is anticipated that concentrations from the BGM treated areas should approach that of natural background levels (assuming negligible flux through the spoils).	Currently, a 20 year model run is being used to evaluate the effectiveness of water-quality management considerations in the Elk Valley including active water treatment, clean water diversions, and bituminous geomembrane (BGM) covers. However, the analysis presented was not equitable as BGM cover in the simulation were not allowed to become fully effective in the model run (i.e., the simulation was terminated at the end of the planning period before the cover was fully efficient). This artificially discounts the effectiveness of BGM treatments and may lead to faulty conclusions about the effectiveness of management strategies in the watershed. In particular, Both the MT Govt and US Govt is concerned that BGM covers may be prematurely dismissed as a remediation strategy when in fact they may provide a suitable mechanism for long-term retention of selenium in the spoil piles (other than active water treatment which may be required for 100's -1000's of years).

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Ecological Effects Assessment for Tributaries	**A4-29**	In reporting on the estimates of water quality concentrations forecasted by the Water Quality Planning Model, ensure that the proper caveats are included with these predictions.	The Water Quality Planning Model is limited in its ability to forecast water quality concentrations in the tributaries to the Elk River and Fording River.
	A4-30	Clearly describe the nature (type), magnitude, and spatial extent of effects in each mining-affected tributary under current conditions and under future management scenarios.	Information on the effects within the tributaries under current conditions and under the proposed future management scenarios is required to understand the trade-offs that may need to be considered to balance economic, social, and environmental interests. By clearly documenting effects in each tributary under current conditions and describing how the proposed management scenarios will alter those conditions, the implications of the various management scenarios can be better understood.
	A4-31	With respect to the assessment of current conditions in tributaries, which will be documented in the Regional Aquatic Effects Monitoring Program Synthesis Report, assess the impacts as listed in Section B (Schedule C) of the Ministerial Order.	It is important to consider the requirements in the Order as part of the RAEMP report.
Calcite Management and Effects Assessment *Work Package #4: Approach and Methodology to Measure*	**A4-32**	Develop medium-term and long-term targets for calcite. As no targets have been proposed to date, the following targets are recommended for inclusion in the EVWQP: 1. Short-term goals: Within three years, survey all streams in the Elk Valley that are affected by coal mining-related activities; map the spatial extent and magnitude (i.e., low, moderate, and high) of calcite formation in all streams; evaluate the effects of calcite formation through the implementation of well-designed field studies that include appropriate effects metrics; complete and document laboratory and field investigations conducted to identify and evaluate candidate calcite management approaches and systems; identify the most effective	The Terms of Reference for the EVWQP indicate that medium-term and long-term targets and timeframes need to be established to reduce the rate and control the formation of calcite and manage impacted streams. Therefore, such targets need to be included in the EVWQP.

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and Assess Calcite		approaches to managing calcite formation for each type of source area and receiving water stream; and, complete a preliminary calcite management plan. 2. Medium-term target: Within 10 years, reduce the spatial extent of moderate and high levels of calcite by 50% relative to 2013/2014 levels. 3. Long-term target: Within 20 years, reduce the spatial extent of moderate and high levels of calcite by 80% relative to 2013/2014 levels.	
	A4-33	Revise the calcite monitoring program to include metrics that facilitate evaluation of effects on fish and other aquatic organisms associated with calcite formation in receiving waters. A before-after-control-impact approach should be used to evaluate the effects of calcite formation and associated management strategies to control calcite formation. The steps involved in the design of such a monitoring program should include: 1. Develop a conceptual model for calcite formation in receiving waters; 2. Identify all receiving waters in the Elk Valley with water quality conditions and/or mining activities potentially sufficient to promote calcite formation; 3. Classify receiving waters prone to calcite formation based on physical-chemical characteristics and habitat types; 4. Identify appropriate reference areas for type of receiving water that was identified within the mining-affected areas; 5. Identify the assessment endpoints and measurement endpoints that will be incorporated into the monitoring program; 6. Identify a number of representative reaches of each type of receiving water within mining-influenced and reference areas that will be used to support intensive effects monitoring; 7. Describe the type and frequency of sampling and analysis that will be conducted within each reach; 8. Describe the type and frequency of monitoring that will be conducted on other stream reaches to further evaluate the nature, extent, and magnitude of calcite formation; and,	The Terms of Reference for the EVWQP indicate that medium-term and long-term targets and timeframes need to be established to reduce the rate and control the formation of calcite and manage impacted streams. Therefore, such targets need to be included in the EVWQP.

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		9. Describe the procedures that will be used to evaluate the resultant data and determine the effects of calcite formation on aquatic organisms.	
Adaptive Management	**A4-34**	Recommend that a detailed adaptive management framework be included as part of the Elk Valley Water Quality Plan. A robust adaptive management framework should include specific triggers, feedback loops and specific actions to be taken. The adaptive management framework should also describe the linkages to future regulatory processes.	Understanding the specifics of the adaptive plan (i.e. steps, triggers and actions) will be important for implementation of the plan and demonstrating how the plan will be used and adapted to changing future conditions and how this links to regulatory processes and requirements at each site.