

Calgary

December 2, 2020

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Toronto

Our Matter Number: 1167150

Montréal

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Ottawa

Grassy Mountain Coal Project Joint Review Panel
Impact Assessment Agency
160 Elgin Street, 22nd Floor
Place Bell Canada
Ottawa, ON K1A 0H3

Vancouver

New York

Attention: Alex Bolton, Chair, Joint Review Panel

Dear Mr. Bolton:

**Re: Benga Mining Limited (“Benga”)
Grassy Mountain Coal Project (“Project”)
CEAA Reference No. 80101
Response to Undertakings #27 and #28**

We write to provide Benga’s response to undertakings #27 and #28, given in the public hearing for the above noted Project.

Undertaking #27

Undertaking #27: Conduct a recalculation of the incremental lifetime cancer risk (ICLR) for arsenic exposure for Blairmore Creek using the updated water quality modelling results, ensuring that both the air deposition and the water-based pathways are both included in the calculation, and a recalculation of the hazard quotient (HQ) for the contaminant of potential concern (COPC) which had the greatest increase in predicted concentrations in water relative to the original GoldSim modelling and was one of the COPCs that exceeded the risk quotient of 0.2 (CIAR #931 at PDF 5867:2-17).

Benga’s Response: Attached at Appendix “A” is a memorandum setting out the recalculated ICLR for arsenic and the recalculated HQ for copper¹ for Blairmore Creek using the revised, and higher predicted surface water concentrations.

Status: Complete

¹ Copper was the COPC with the greatest increase between the original modelling results and the revised Blairmore Creek modelling results out of those with an existing HQ greater than or equal to 0.2.

Undertaking #28

Undertaking #28: Produce the results of recalculated exposure ratios for aquatic wildlife, applying the updated surface water modelling results for Blairmore and Gold Creeks, and incorporate any error checks that may have been done.

Benga's Response: Attached at Appendix "B" is a memorandum setting out the recalculated exposure ratios for aquatic wildlife, applying the updated surface water modelling results for Blairmore and Gold Creeks.

Status: Complete

Conclusion

We assume the above responses satisfy the undertakings given.

Yours truly,

<Original signed by>

Martin Ignasiak

cc. Gary Houston
Mike Bartlett

Appendix “A”

Human Health Risk Assessment - Undertaking 27

In response to undertaking #27, Benga re-assessed potential risk from arsenic and copper in Blairmore Creek using the revised, and higher predicted surface water concentrations provided in CIAR 313, Appendix 6.25-1 based on mean monthly hydrology. The panel requested two COPCs be re-assessed, arsenic, and a COPC represented by a hazard quotient (HQ) with the greatest increase between the original modelling results and the revised Blairmore Creek modelling results as well as an HQ equal or greater than 0.2. Copper was selected as the second COPC based on the percent difference between the original versus revised surface water modelling results.

In response to the request by the Panel, the HHRA model was re-run for arsenic and copper. Total exposure included deposition from air to surface water as predicted by the multimedia model, plus the revised Blairmore creek concentrations. The surface water concentration used in the re-assessment are the same as those used in the wildlife screening assessment and have been provided in Undertaking #28, Table 27.1.

Table 1 below provides the original and revised incremental lifetime cancer risk (ILCR) and HQs for each COPC. The result demonstrates a small increase in predicted risk associated with exposure to the increased predicted water concentrations however, the results do not change substantially from the original assessment and thus the conclusions of the HHRA do not change.

Table 27.1 Revised Hazard Quotients and ILCR for the Multimedia Assessment Blairmore Creek			
Parameter	Project	Baseline¹	Application
Total Composite ILCR			
Arsenic – revised	3.2x10-5	N/A	N/A
Arsenic - original	2.5x10-5	N/A	N/A
Total HQ – Toddler Receptor			
Copper - revised	7.1E-03	2.0E-01	2.1E-01
Copper - original	3.6E-03	2.0E-01	2.0E-01

The HQ results for copper demonstrated no substantial change in risk when the revised surface water concentrations were applied and is determined to pose no risk of adverse health effects.

The total ILCR At Blairmore Creek was predicted to be slightly higher than the target risk of 1×10^{-5} (3.2×10^{-5}). An ILCR greater than 1×10^{-5} , is not automatically an indication of potential risk of cancer (Government of Alberta 2019, HC 2012). The HHRA guidance states that an ILCR greater than 1×10^{-5} is an indication that the predicted exposures exceed negligible levels, thus additional assessment was conducted as per Health Canada and Alberta Health HHRA guidance (Government of Alberta 2019; HC 2012, HC 2010a, HC 2010b) to determine whether the result indicates potential risk of adverse health effects, or are the results of conservative assumptions built into the exposure assessment and risk characterization steps of the HHRA. The lines of evidence pursued included:

- Determination of the magnitude of exceedances of the ILCRs with respect to negligible rates. Review of conservative assumptions included in the exposure assessment.
- Comparison of the predicted surface water concentrations to existing Canadian surface water and drinking water guidelines.
- Comparison of the predicted surface water concentrations with current monitoring data from the Grassy Mountain area (Blairmore Creek, Gold Creek, Crowsnest River) and the Rocky Mountain area.

Conservative assumptions built into the exposure assessment of the HHRA results in purposeful overestimation of potential risks. The current HHRA assumed a person lives in the area 100% of their lifetime at each location assessed and surface water was assumed to be the only source of drinking water. This is believed to be overly conservative as there are no permanent residences within the local study area (LSA) and historically human activities have been recreational. These assumptions have overestimated potential exposure and thus overestimated potential risk of adverse health effects.

Although the ILCRs predicted for Blairmore Creek was greater than 1×10^{-5} , the predicted surface water concentration ($5.77\text{E-}04$ mg/L) is lower than the surface water (freshwater aquatic life; $5.0\text{E-}03$ mg/L) and human drinking water guidelines ($1.00\text{E-}02$ mg/L) (provided in CIAR 360, Table 7.1-2, pdf 13). Arsenic is a naturally occurring compound found in rock, soil, water and air throughout Canada. Soil and water concentrations are often reported greater than Canadian guidelines (HC 2012).

Additional assessment of arsenic included consideration of the baseline surface water concentrations measured at the site and in the surrounding drainage basin, and investigation of typical Albertan background surface water concentrations in the Alberta foothills. Measured arsenic concentrations in surface water collected from creeks and rivers located in the Rocky Mountain Foothills and the Grassy Mountain area are lower than the surface water (freshwater aquatic life) and human drinking water guidelines, whereas a regional study reports a range of

concentrations with some values greater than one or both guidelines (CIAR 360, Table 7.1-3, pdf 14). The predicted surface water concentrations for Blairmore Creek are within the same order of magnitude of measured surface water from the Grassy Mountain area as well as other creeks and rivers monitored in the Rocky Mountain Foothills (CIAR 360, Tables 7.1-2 and 7.1-3).

The HQs and ILCR for Blairmore Creek were determined to represent a low potential risk of adverse health effects. The assessment indicated that existing concentrations at the site and typical background Albertan surface water concentrations are at a similar magnitude to the predicted Project and Application concentrations at Blairmore Creek. They are below Canadian surface water and drinking water guidelines with a few exceedances.

REFERENCES

- Alberta Environment and Parks. 2020. Alberta Surface Water Quality Monitoring Data. Retrieved from <https://www.alberta.ca/surface-water-quality-data.aspx>
- HC (Health Canada). 2012. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0.
- HC (Health Canada). 2010a. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0.
- HC (Health Canada). 2010b. Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRACHEM).
- Government of Alberta. 2019. Alberta Health, Government of Alberta August 2019 Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta, Version 2.0 ISBN: 978-1-4601-4359-9

Appendix “B”

Wildlife Risk Assessment – Undertaking 28

On November 30th, 2020, at the request of the Joint Review Panel (the Panel) Benga agreed to produce the results of recalculated exposure ratios for aquatic wildlife, applying the updated surface water modelling results for Blairmore Creek, and incorporating any other revisions that may be necessary (Hearing Transcript Volume 27, November 30, 2020, pdf 5922). The data presented herein replaces the previously presented wildlife risk assessment output for Blairmore Creek (CIAR 313, Addendum 11, Appendix 6.28-1, Table D-5; and CIAR 360, Addendum 12, Package A, Table 7.1-5) and applies the revised water quality modelling using mean monthly hydrology presented in CIAR 313, Addendum 11, Appendix 6.25-1.

Aligned with the process for selecting concentrations that are believed to represent the upper distribution of predicted exposure, the higher of the 95th percentile for the operations and closure project phases, surface water concentrations from model node BC07 on Blairmore Creek was selected. This nodal output represents the highest concentrations predicted. These updated surface water concentrations for Blairmore Creek are provided in Table 28.1. Notable is the selected input value for sulphate when calculating selenium uptake modelling. The average sulphate concentration for the time period with the highest predicted selenium was selected (682.6 mg/L, Blairmore Creek).

Based on the updated data, aluminum was newly identified as a contaminant of potential concern in Blairmore Creek; applying the same process outlined in CIAR 313, Addendum 11, Appendix 6.28 (pdf 1289-1293). As such, risk for aluminum was also assessed. A wildlife daily threshold exposure dose (DTED) was identified for aluminum as per methods described in CIAR 313 Addendum 11, Appendix C (pdf 1320) and has been included in Table 28.2. Additionally, a change to the nickel DTED for mammals to align with the more current CCME guidance was made and references have also been updated as noted. Finally, the assessment included the previously noted adjustment for sediment (CIAR 360, Addendum 12, IR 7.1).

The result of the noted changes increased predicted exposure ratios; however, the changes were not substantial enough to change the overall conclusions. These results indicate a low potential for adverse effect for the piscivorous mammal and bird surrogate on Blairmore Creek. Apart from selenium, all other exposure ratios were less than 1.0. The updated exposure ratios for Blairmore Creek are provided in Table 28.3.

While the magnitude of the predicted exposure ratios is marginally higher for selenium, the overall conclusions remain the same. Risk assessment purposefully over-predicts exposure. Risk results

above acceptable thresholds indicates i) risk assessment methodologies may require increased site-specific precision (*e.g.*, measured tissue data), and ii) where monitoring and mitigation programs should be focused. As such, reliance on the specific exposure ratio rather than magnitude and range against baseline is not intended.

Table 28.1 Surface Water Concentrations (mg/L)				
Parameter	Applied Screening Value (mg/L)	Blairmore Creek		
		Project	Background	Application
Total Ammonium (NH ₄)	1.90E-02	6.54E+00	5.00E-02	6.59E+00
Total Antimony (Sb)	2.00E-02	2.04E-03	1.25E-04	2.16E-03
Dissolved Aluminum (Al)	5.00E-02	5.00E-02	5.13E-03	5.52E-02
Total Arsenic (As)	5.00E-03	3.87E-04	1.90E-04	5.77E-04
Total Barium (Ba)	1.00E+00	1.97E-01	8.14E-02	2.78E-01
Total Beryllium (Be)	1.10E-02	0.00E+00	4.42E-04	4.42E-04
Total Bismuth (Bi)	-	1.79E-08	0.00E+00	1.79E-08
Total Calcium (Ca)	-	4.49E+01	5.03E+01	9.52E+01
Total Cadmium (Cd)	9.00E-05	2.76E-04	1.32E-05	2.89E-04
Total Chloride (Cl)	1.20E+02	2.69E+00	4.25E-01	3.12E+00
Total Cobalt (Co)	8.00E-04	1.16E-03	2.67E-04	1.42E-03
Total Chromium (Cr)	1.00E-03	5.44E-04	5.19E-04	1.06E-03
Total Copper (Cu)	7.00E-03	1.41E-03	3.91E-04	1.80E-03
Total Fluoride (F)	1.00E+00	3.73E-01	0.00E+00	3.73E-01
Dissolved Iron (Fe)	3.00E-01	1.34E-01	1.59E-02	1.50E-01
Total Lead (Pb)	1.00E-03	1.87E-04	5.42E-05	2.41E-04
Total Lithium (Li)	-	1.66E-02	4.17E-03	2.07E-02
Total Mercury (Hg)	5.00E-06	5.48E-06	2.75E-07	5.76E-06
Total Magnesium (Mg)	8.20E+01	5.01E+01	1.09E+01	6.09E+01
Total Manganese (Mn)	1.20E-01	3.43E-02	4.84E-03	3.92E-02
Total Molybdenum (Mo)	7.30E-02	2.92E-02	1.13E-03	3.04E-02
Total Nickel (Ni)	2.50E-02	6.26E-03	6.61E-04	6.92E-03

Table 28.1 Surface Water Concentrations (mg/L)				
Parameter	Applied Screening Value (mg/L)	Blairmore Creek		
		Project	Background	Application
Total Nitrite (NO ₂)	2.00E-02	1.88E-02	1.00E-03	1.98E-02
Total Nitrate (NO ₃)	3.00E+00	1.04E+00	7.18E-02	1.11E+00
Total Phosphorus (P)	3.50E-02	1.61E-02	2.66E-03	1.88E-02
Total Potassium (K)	-	2.30E+00	6.31E-01	2.94E+00
Total Sodium (Na)	-	1.73E+01	3.13E+00	2.04E+01
Total Sulphide	1.90E-03	5.25E+01	1.82E-03	5.25E+01
Total Selenium (Se)	1.00E-03	8.80E-03	7.77E-04	9.58E-03
Total Silicon (Si)	-	1.37E+00	0.00E+00	1.37E+00
Total Silver (Ag)	2.50E-04	2.81E-05	1.75E-05	4.56E-05
Total Sulphate (SO ₄)	1.28E+02	1.10E+03	1.94E+01	1.12E+03
Total Strontium (Sr)	-	1.17E-01	0.00E+00	1.17E-01
Total Tin (Sn)	-	0.00E+00	4.26E-03	4.26E-03
Total Titanium (Ti)	-	0.00E+00	3.82E-04	3.82E-04
Total Thallium (Tl)	3.00E-04	3.36E-05	4.42E-05	7.77E-05
Total Uranium (U)	5.00E-03	1.61E-04	4.42E-04	6.02E-04
Total Vanadium (V)	2.00E-02	1.22E-03	3.28E-04	1.54E-03
Total Zinc (Zn)	7.50E-03	1.04E-02	3.25E-03	1.36E-02
Total Zirconium (Zr)	4.00E-03	3.80E-07	0.00E+00	3.80E-07

Notes:

Surface water concentrations align with CIAR #313 Addendum 11, IR 6.25

Surface water concentrations run in risk assessment model include concentrations as presented above in addition to the maximum point of impingement (MPOI) atmospheric deposition as presented within the "Grassy Mountain Coal Project Environmental Impact Assessment Updated Human Health and Wildlife Screening Risk Assessment" (Addendum 10, Appendix 4.9-1, CIAR #251).

Table 28.2 Selected Daily Threshold Exposure Doses*				
Chemical	Mammalian DTED		Avian DTED	
	Value (mg/kg/d)	Test Species	Value (mg/kg/d)	Test Species
Aluminum	19.3 ^a	Mouse	109.7 ^a	Ringed Dove
Nickel	14.6 ^b	Cow	77.4	Mallard
Selenium	0.33	Rat	0.3 ^c	Chicken

a - Sample, B.E., D.M. Opresko and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. US Department of Energy, Office of Environmental Management. Oak Ridge National Laboratory. ES/ER/TM-86/R3.

b – Canadian Council of Ministers of the Environment, 2015. Scientific Criteria Document for Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Nickel.

c – No change to value, updated reference only. Canadian Council of Ministers of the Environment, 2009. Canadian Soil Quality Guidelines Selenium Environmental and Human Health Effects, Scientific Criteria Document.

Table 28.3 Predicted Exposure Ratio for the Multimedia Assessment Blairmore Creek

Parameter	Aquatic																				
	Mammalian Receptors									Avian Receptors											
	Northern River Otter			Beaver			Little Brown Bat			American Dipper			Goose			Great Blue Heron			Mallard Duck		
	Project	Baseline	Application	Project	Baseline	Application	Project	Baseline	Application	Project	Baseline	Application	Project	Baseline	Application	Project	Baseline	Application	Project	Baseline	Application
Aluminum	1.2E-02	1.2E-03	1.3E-02	1.0E-02	5.3E-02	6.3E-02	3.4E-03	2.4E-01	2.4E-01	2.8E-03	2.9E-04	3.1E-03	1.0E-03	1.7E-02	1.8E-02	2.4E-03	2.5E-04	2.6E-03	6.8E-03	1.4E-02	2.1E-02
Cadmium	6.1E-03	3.6E-04	6.3E-03	4.1E-03	2.5E-03	6.1E-03	7.3E-04	5.6E-04	1.3E-03	1.2E-03	7.2E-05	1.3E-03	4.1E-04	1.1E-03	1.5E-03	2.3E-03	1.4E-04	2.4E-03	2.7E-03	1.0E-03	3.7E-03
Chromium II/III (total)	7.5E-04	6.4E-04	1.4E-03	1.9E-03	9.1E-04	2.5E-03	1.9E-04	2.6E-03	2.8E-03	1.1E-03	9.6E-04	2.0E-03	5.1E-04	4.4E-04	9.3E-04	1.1E-03	9.5E-04	2.0E-03	2.9E-03	2.4E-03	5.2E-03
Cobalt	2.9E-04	6.8E-05	3.6E-04	1.3E-03	3.7E-04	1.5E-03	6.0E-07	4.0E-04	4.0E-04	1.1E-04	2.5E-05	1.3E-04	3.3E-04	2.1E-04	5.3E-04	4.1E-04	9.5E-05	5.0E-04	4.9E-04	2.2E-04	6.9E-04
Copper	2.6E-03	6.8E-04	3.1E-03	2.8E-03	7.8E-03	1.0E-02	3.9E-04	4.9E-04	8.6E-04	2.0E-03	5.2E-04	2.4E-03	1.3E-04	1.4E-02	1.4E-02	3.1E-03	8.4E-04	3.8E-03	4.2E-03	1.2E-02	1.6E-02
Lead	2.3E-05	5.9E-06	2.6E-05	1.0E-04	3.5E-05	1.2E-04	7.3E-06	9.4E-05	1.0E-04	1.5E-03	3.8E-04	1.7E-03	4.4E-04	1.0E-03	1.4E-03	1.2E-03	3.0E-04	1.3E-03	3.7E-03	1.7E-03	4.9E-03
Manganese	1.1E-03	1.6E-04	1.3E-03	2.6E-03	1.0E-02	1.3E-02	1.7E-06	5.2E-03	5.2E-03	1.3E-04	1.8E-05	1.5E-04	3.8E-04	5.3E-03	5.7E-03	4.8E-04	7.2E-05	5.5E-04	5.4E-04	4.1E-03	4.6E-03
Methylmercury	1.2E-03	1.2E-04	1.3E-03	7.7E-03	1.5E-03	7.7E-03	5.2E-08	1.0E-08	5.3E-08	8.8E-04	8.8E-05	9.1E-04	2.2E-03	2.2E-04	2.3E-03	4.0E-03	4.0E-04	4.1E-03	3.9E-03	4.7E-04	4.0E-03
Mercury	1.2E-05	1.2E-06	1.3E-05	1.1E-04	2.2E-05	1.1E-04	5.2E-08	1.0E-08	5.3E-08	5.4E-06	5.4E-07	5.6E-06	1.6E-05	1.6E-06	1.7E-05	2.0E-05	2.0E-06	2.1E-05	2.7E-05	3.3E-06	2.8E-05
Nickel	1.0E-03	1.1E-04	1.1E-03	2.8E-03	5.3E-04	3.1E-03	4.7E-06	1.4E-04	1.4E-04	6.5E-05	7.3E-06	7.2E-05	1.7E-04	4.9E-05	2.2E-04	2.6E-04	3.0E-05	2.9E-04	2.6E-04	5.3E-05	3.1E-04
Selenium	1.2E+00	1.2E+00	1.3E+00	9.7E-02	9.1E-03	1.1E-01	6.4E-02	6.5E-02	6.6E-02	4.6E-01	4.4E-01	4.6E-01	6.4E-02	1.6E-02	6.9E-02	1.6E+00	1.6E+00	1.7E+00	8.5E-01	7.7E-01	8.7E-01
Silver	4.6E-06	2.9E-06	7.5E-06	2.4E-06	1.5E-06	3.9E-06	4.6E-07	2.9E-07	7.5E-07	7.6E-06	4.8E-06	1.2E-05	5.5E-06	3.4E-06	9.0E-06	1.6E-05	9.9E-06	2.6E-05	1.8E-05	1.1E-05	3.0E-05
Thallium	1.7E-02	1.9E-02	3.6E-02	1.6E-02	8.4E-03	2.2E-02	6.7E-03	7.9E-03	1.4E-02	2.9E-02	3.2E-02	6.0E-02	3.7E-03	4.2E-03	7.8E-03	1.9E-02	2.1E-02	3.9E-02	6.6E-02	7.3E-02	1.4E-01
Zinc	1.3E-02	4.0E-03	1.7E-02	1.3E-02	8.9E-03	2.0E-02	1.8E-03	1.6E-03	3.4E-03	1.4E-03	4.3E-04	1.8E-03	4.2E-04	1.7E-03	2.1E-03	2.4E-03	7.3E-04	3.1E-03	3.3E-03	2.2E-03	5.3E-03

An exposure ratio greater than 1.0 is bold.