CANADIAN PARKS AND WILDERNESS SOCIETY
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These are the submissions of CPAWS Southern Alberta ("CPAWS") to the Joint Review Panel ("JRP") in relation to the impacts of Benga's Grassy Mountain Coal Project ("GMCP"). CPAWS retained Mr. Drew Yewchuk and Ms. Christine Laing as legal counsel, both with the University of Calgary Public Interest Law Clinic. Their contact information is as follows:

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CPAWS anticipates a brief opening statement of 30 minutes or less, and 60 minutes or less of direct examination for each of CPAWS's three experts. CPAWS anticipates requiring a maximum of 3 hours and 30 minutes to enter their evidence.

PART I: INTRODUCTION

The Canadian Parks and Wilderness Society is a nationwide charity dedicated to the protection and sustainability of Canada's public land and water, and ensuring that parks are managed to protect the nature within them. CPAWS Southern Alberta's role as an organization is to provide landscape-scale, science-based support and advice for the conservation and protection of Alberta's wilderness. CPAWS Southern Alberta has championed the protection of Alberta's diverse natural heritage since its establishment in 1967, and regularly collaborates with government, industry, and Indigenous communities on these issues. CPAWS Southern Alberta also strives to educate and bring awareness to Alberta's residents and visitors about the importance of protecting Alberta's wilderness.

CPAWS believes that mountain top removal coal mining is not an appropriate land-use in Southwest Alberta. The Rocky Mountains provide essential habitats for Alberta's iconic native species of wildlife and plants, including grizzly bear, elk and native trout. They have provided unsurpassed beauty, refuge, and bounty for thousands of years, and they will do so for thousands more, unless they are converted into industrial mined out areas that instead provide dust clouds, end-pits of water that poison birds, and streams with water quality is severely degraded by pollutants and sediments.

The GMCP involves the creation of a large source of selenium contamination, in addition to flow and temperature changes to Gold Creek, Blairmore Creek, and the Oldman Watershed. These changes are a significant adverse environmental effect on fish and fish habitat.

Reliable technology to mitigate the selenium contamination of the GMCP does not exist. CPAWS respectfully submits that based on the evidence before the JRP, the JRP must conclude

Benga's plan to control Selenium is speculative both in regard to (a) the efficacy and long-term sustainability of an onsite SBZ and (b) the rigor and efficacy of its future adaptive management regime. Even if taken together, these cannot constitute effective "mitigation" for the purposes of *Canadian Environmental Assessment Act 2012*. Further, evidence will show that

a) the duration Benga can generate a reliable revenue stream from high quality hard coking coal has been exaggerated, and
b) the full cost of effective selenium monitoring, containment, and clean-up has been seriously underestimated,

The JRP cannot reasonably conclude that Benga's intention to develop a solution for the selenium contamination problem in the future constitutes a technically and economically feasible mitigation measure.

Finally, CPAWS submits that the offsets for critical habitat proposed by Benga are not permissible under the *Species at Risk Act*. Unlawful activities do not fall within the range of acceptable mitigation. As such, the destruction of Westslope Cutthroat critical habitat within the mine footprint is a significant adverse environmental effect that cannot be mitigated.

Based on the submissions that follow, CPAWS believes the GMCP would significantly harm the landscape, rivers, and wildlife of Southern Alberta, and would not provide long-term net economic benefits for the citizens of Alberta, Canada, or the communities of the Crowsnest Pass.

In support of these submissions, CPAWS provides a book of three expert opinions:

1. The Expert Opinion of Marc W. Bowles and Sarah Dougherty, dated September 15, 2020,

2. The Expert Opinion of Cornelis Kolijn, dated September 16, 2020, and

3. The Expert Opinion of Martin Olszynski, dated September 18, 2020.

CPAWS also provides a letter from Dennis Lemly, along with his published 2019 paper on the environmental harms that will be caused by the GMCP attached to this submission at APPENDIX A.

CPAWS sent information requests to Benga while preparing for the hearing. This correspondence between CPAWS and Benga is attached to this submission at APPENDIX B.

CPAWS received the results of an *Access to Information Act* request for

> "All records relating to contacts with Riversdale Resources Limited, Benga Mining Limited, or any representative or consultant of those companies relating to offsetting under the Species at Risk Act or permitting under section 73 of the Species at Risk Act. The records were likely generated between January 1, 2015 to October 31, 2018."

Those records, along with colour versions of the graphs in the records, are attached to this submission as APPENDIX C.

CPAWS was disappointed to see the reference on page 000149 of those records to the use of communication between the Department of Fisheries and Oceans, the AER, and Benga prior to the selection of the JRP members in order to keep discussions about the use of offsetting for critical habitat off of the CEAA registry and away from public scrutiny. CPAWS is pleased to be able to place these records on the public registry.

CPAWS was also surprised to see that the Department of Fisheries and Oceans has a policy for offsetting impacts to critical habitat under the *Species at Risk Act*. No such document seems to be on the *Species at Risk Act* public registry, despite section 56 and 123(f) of the *Species at Risk Act* requiring guidelines on critical habitat protection to be on that registry.

Although CPAWS has a broad range of concerns about the environmental impacts of the GMCP, CPAWS has limited their submissions and experts in order to coordinate with other hearing participants and avoid the duplication of expert evidence and hearing submissions. As such, CPAWS endorses the evidence submitted by the Livingstone Landowners Group, the Alberta Wilderness Association, the Timberwolf Wilderness Society, and the MD of Ranchlands.

PART II: CPAWS OPPOSES MOUNTAINTOP REMOVAL COAL MINING IN ALBERTA BECAUSE OF THE RISK OF SELENIUM CONTAMINATION

CPAWS is concerned the GMCP will contaminate Blairmore Creek with Selenium, and produce a long term of risk of Selenium contamination for both Gold Creek and the Oldman Reservoir. The threat of selenium contamination has been known since at least 1978.[1] Since that time, selenium has been a growing problem in the United States, particularly the coal mining areas of Appalachia.

Teck has been aware of the selenium contamination problems from their metallurgical coal mines since 1995, if not sooner. The timeline of selenium control in the Elk Valley is a good guide to what Benga's proposed attempts to control water quality in Alberta will look like. Teck (a responsible and competent mining company) has spent twenty-five years on adaptive management trying to control their Selenium problem, and they have received a number of fines for violating their permit terms. B.C. regulators, caught between a mandate of environmental protection and encouraging resource extraction, stumbled in trying to protect water quality.[2] There is no certainty Teck has controlled their Selenium problem yet, and no certainty the solutions they have found will work in the long term.

The example of Teck dealing with Selenium in the Elk Valley shows the reality of attempts to control environmental problems that arise during the project lifetime. Once a project is built, a regulator is often reluctant to shut down the active project, and the company's attempts at

[1] Cumbie, P. M. and Van Horn, S. L. 1978. Selenium accumulation associated with fish mortality and reproductive failure. Proc. Annual Conf. Southeast. Assoc. Fish Wildlife Agencies 32, 612–624.
[2] British Columbia Auditor General, *An Audit of Compliance and Enforcement of the Mining Sector*, May 2016 (APPENDIX D).

adaptive management take decades and have damaging missteps like Teck's 2014 Fish kill and the associated four-year selenium treatment plant closure.[3]

Expert evidence will show that the Saturated Backfill Zone is still experimental technology. The Saturated Backfill Zone will not remove enough selenium to protect the waters of Blairmore creek, and will require expensive continuing research and maintenance work in order to keep it functioning on the timeframe that will be required for the GMCP.

The GMCP will create a risk of selenium contamination in the Oldman watershed that will last twice as long as the GMCP, and likely much longer. CPAWS considers the selenium release risk from the GMCP unacceptable.

The GMCP also involves the use of offsetting for the critical habitat of the Westslope Cutthroat Trout. The use of offsets, and their inherent uncertainty and timing issues, are incompatible with the role and function of critical habitat for species at risk. This direct impact on critical habitat, along with the flow, temperature, and water contamination impacts on critical habitat, regardless of offsetting plans, is a serious environmental impact, and is not permissible under the *Species at Risk Act.*

PART III: CPAWS OPPOSES NEW COAL MINING IN ALBERTA BECAUSE COAL MINES HAVE A MAJOR RISK OF BANKRUPTCY AND LONG-TERM ENVIRONMENTAL LIABILITIES

The key to protecting Alberta's mountains is the full enforcement of the polluter pays principle, a basic principle of Canadian environmental law. Canadian and Albertan citizens should not be subsidizing the destruction of Alberta's wilderness for the benefit of coal magnates. A key task of the JRP is to determine the required conditions for the project to guarantee that the project owner pays the entire cost of environmental monitoring, maintenance, and clean-up of the project. CPAWS is concerned that tomorrow's orphan coalmines will be the younger brother to the enormous orphan well problem Alberta already faces.[4]

The recent history of coal mining shows that coal mining is an environmentally catastrophic activity that does not bring long-term, or even medium-term benefits to communities. Coal companies in the United States have used strategies including spinning off underfunded subsidiaries with legal responsibility for the regulatory obligations of mines, strategic pre-bankruptcy conduct, and bankruptcy to avoid fulfilling the environmental obligations attached to

[3] Teck, Update Regarding 2014 Fish Mortality at Line Creek Dec 5, 2017 https://www.teck.com/media/Teck-News-Release-Oct-5-2017.pdf; Teck, West Line Creek Active Water Treatment Facility Restarts, October 4, 2018 https://www.teck.com/media/West-Line-Creek-Active-Water-Treatment-Facility-October-4-2018.pdf

[4] Alberta's orphan well problem was caused by a different security program that operated on the same asset-to-liability principle.

their mines.[5] This is not the result of 'bad actors', but the result of lenient regulation and the interaction of environmental obligations with bankruptcy law. This has encouraged coal-mining companies to mine for longer, and to construct larger mines because they understand that they can escape their regulatory obligations towards the environment and mine workers.

Alberta has similar problems in its regulatory environment, and CPAWS is concerned Albertans will end up with the same result. Alberta's regulatory approach to mine security, the Mine Financial Security Program (MFSP) has been the subject of reports from Alberta's Auditor General because:

> In the event that a mine operator cannot fulfill its reclamation obligations, and no other private operator assumes the liability, the province may have to pay a potentially substantial cost for this work to be completed. Thus, a robust and responsive system to calculate and collect security from mine operators is essential.[6]

CPAWS believes the MFSP is insufficient to protect the polluter pays principle and prevent mining that generates risks that environmental clean-up costs will not be borne by the mining company. In 2015, the Auditor General of Alberta found that "There is a significant risk that asset values calculated by the department are overstated within the MFSP asset calculation, which could result in security amounts inconsistent with the MFSP objectives."[7]

Alberta's MFSP uses an asset-to-liability approach that considers the resource value associated with an approved project as a financial asset that could be used to pay for mine clean up. This creates a vulnerability in the MFSP where Alberta will not have sufficient security for cleanup if the estimated assets are over-valued, or if the value of the asset fluctuates suddenly.[8] The asset-to-liability approach is generating the same problem 'self-bonding' did for coal mines in the United States: "When a company's financial position deteriorates and it is no longer eligible for self-bonding [or no longer deemed to have a sufficient asset-to-liability ratio, in the Albertan case] it also lacks the financial resources to post surety or collateral bonds."[9]

Coal is a resource known to have high price volatility even under ordinary conditions. Coal, metallurgical or not, is a very carbon intensive product that would experience a massive value crash in the event a low-carbon or carbon-neutral alternative becomes available. Canadians should not assume any risk of environmental clean-up not being completed because of a foreseeable crash in coal prices during the life of the GMCP.

Expert evidence will show the coal quality will rapidly decrease at the GMCP, and raises concerns about the financial stability of GMCP.

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[5] Joshua Macey & Jackson Salovaara, "Bankruptcy as Bailout: Coal Company Insolvency and the Erosion of Federal Law" (2019) 71:4 Stan L Rev 879, at 886-887 and 993. [Macey and Salovaara]

[6] Auditor General of Alberta, *Environment and Parks and the Alberta Energy Regulator – Systems to Ensure Sufficient Financial Security for Land Disturbances from Mining*, July 2015, page 26 (APPENDIX E).

[7] *Ibid*, at page 25

[8] *Ibid*, at page 27.

[9] Macey & Salovaara, at 897.

Expert evidence will show that adaptive management is not a cure-all that will fix the numerous foreseeable environmental problems. Many of the large number of adaptive management projects Benga proposes to undertake are not scientifically or financially feasible, and the complexity of the proposed adaptive management projects that would be necessary make it likely few, if any, of them are likely to be properly carried out.

Benga was formed specifically for the purposes of developing the GMCP. Benga has no corporate history, and no record of applying adaptive management. Evidence at the hearing will show that Benga has underestimated the environmental liabilities of the GMCP, and overestimated the economic stability of the GMCP. CPAWS is of the view that Benga has an unrealistic view of the benefits and effectiveness of adaptive management, and of the financial costs of implementing adaptive management.

PART IV: THE MANDATE OF THE JOINT REVIEW PANEL IS LIMITED IN RELATION TO CUMULATIVE IMPACTS

CPAWS asks the JRP to include in their final report a clear description of the scope of the cumulative impacts that have been considered, and not been considered, in this environmental assessment. Because Benga took so many years to provide sufficient information to advance to a hearing, this environmental assessment does not include the cumulative impacts of projects that became reasonably foreseeable after August 17, 2018, more than two years before the hearing will begin. This is particularly important given Alberta's decision to rescind their 1976 coal policy and encourage metallurgical coalmines in the Rocky Mountains.

This limitation means that the final report of the JRP will not account for the cumulative environmental impacts of other mines, including Elan South, a mine planned immediately north of GMCP. It also means the assessment of the economic need for GMCP did not account for the other coal projects advancing in Alberta. British Columbia overdeveloped their metallurgical coal resource for sale to Japanese suppliers in the 1980's, and took extraordinary losses during the Japanese recession and the consequent situation of oversupply in the late 1980's and 1990's. The ensuing bankruptcies interrupted environmental reclamation, despite reclamation bonds.[10] Whether Canada is recreating this situation by allowing the heavy development metallurgical coal projects in Alberta for export to China should be assessed. Because of the statutory limits on the scope of the JRP's mandate, these serious concerns are excluded from the environmental assessment. CPAWS believes Canada needs a strategic Coal Policy to control the environmental and economic impacts of coalmines

[10] Jamieson, Eric D. "CRUNCH MINING: The Logistics of Western Canadian Export Coal Supply." *Energy Exploration & Exploitation*, vol. 12, no. 5, 1994, pp. 393–417
403, 407.

CONCLUSION: CPAWS POSITION ON THE GRASSY MOUNTAIN COAL PROJECT

CPAWS believes the GMCP will cause serious adverse environmental effects Benga will be unable to mitigate, and that these adverse impacts cannot be justified. The GMCP should not be approved.

In order to protect the environment and the polluter pays principle, the JRP should recommend the following conditions and mitigation measures:

> (1) Benga should be required to post full security under the *Mine Financial Security Program Standard*. The security should be calculated to realistically account for all environmental liabilities of the GMCP, and should include a conservative estimate of the complete costs of:
>
> > (a) necessary water, air and soil monitoring,
> > (b) monitoring, improvements, repairs, and maintenance of the Saturated Backfill Zone, and
> > (c) other repairs and maintenance work.

Benga must not be permitted to rely on the asset-to-liability system of calculating liability, which is known to be unreliable, particularly when the value of metallurgical coal may collapse due to climate change action or international economic downturns. The price of coal is unlikely to be stable enough to keep the GMCP viable for the expected life of the mine. Without this condition, the foreseeable ongoing environmental costs of the GMCP will become a burden on the citizens of Canada and Alberta that will far outweigh the short-term economic benefits. CPAWS is concerned the economic case for mountain top removal coalmines in Alberta relies on the expectation that the mine operator will be able to avoid paying the full costs of environmental clean-up.

> (2) Benga must install and provide reliable infrastructure to enable timely public access complete sets of raw data from, and regularly publish the complete results of;
>
> > (a) water quality and quantity monitoring, and
> >
> > (b) consistent annual population surveys of the number of Westslope Cutthroat Trout, and their life stage in both Blairmore and Gold Creek.

Environmental monitoring data produced for the public benefit must be freely accessible to the public. This requirement is necessary to avoid one of the problems seen in the Elk Valley, where the regulator and the mining company were aware of a growing selenium problem, but did not raise the alarm with the public and allowed the problem to get worse for more than a decade.

> (3) The GMCP should be subject to a clearly defined water quality exceedance limit for selenium that forces mine closure.

Only a clear and credible red-line requiring total mine closure creates a strong enough incentive for a mining company to protect water quality. Without such a hard-line approach, companies pay fines as routine business expenses and issue rosy progress reports on their adaptive management progress while problems worsen for decades. If the water quality limits are left to be defined or changed in the future, future regulators will soften them in order to protect the financial viability of the project – exactly the process that has occurred in the Elk Valley. The JRP must consider the incentives that limit the future actions of regulatory bodies. Past Review Panels have been to optimistic about the actions regulators will be willing to take in the future.

(4) A *SARA* fine for the extirpation of the Gold Creek population of Westslope Cutthroat Trout should be calculated and agreed to by Benga as a condition of the license.

If the GMCP is approved, Benga will effectively become the keepers of the genetically pure population of Westslope Cutthroat Trout in Gold Creek. The consequences of Benga's failure to preserve the population should be established in advance as part of this public process. Without this condition, Benga may watch the population go extinct and then avoid a fine by arguing they took all due care to preserve the population. The burden of taking a genetically unique population of a species at risk into their care must be impressed on Benga, and for this purpose, money talks.

<Original signed by>

Drew Yewchuk
Staff lawyer, University of Calgary Public Interest Law Clinic
Counsel for CPAWS

APPENDICES TO CPAWS SUBMISSION

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August 3, 2020

To: Joint Review Panel for the Grassy Mountain Coal Project

From: A. Dennis Lemly, Ph.D.

Regarding: Environmental hazard of Benga Mining's proposed Grassy Mountain Coal Project

Dear members of the Joint Review Panel for the Grassy Mountain Coal Project,

The following statement and supporting documentation (peer-reviewed publication in an international scientific journal, attached) come to you without any monetary compensation or other commission to me for its preparation. I was not hired as a consultant. I received no fee-for-service from environmental charities, government agencies, law firms, universities, or other entities. My comments in this letter and my journal publication are based on over 40 years of experience and hands-on field and laboratory research on the environmental impacts of aquatic pollution from coal, both mining and utilization, and my personal and professional commitment to be a voice for protection of fish and wildlife from that pollution (see attached resume). I specialize in selenium ecotoxicology, which is the primary coal contaminant that poisons fish and wildlife. I closely examined the public information available in 2018, from Benga's voluminous proposal submissions and other documented polluted locations in Alberta, as well as the British Columbia issue (Teck Coal), and compiled a science-based evaluation of the environmental hazards of the Grassy Mountain Project. Since then, I have kept appraised of the additional information that Benga has brought forward, that is, the various Addenda, up to and including the "Twelfth Addendum Environmental Impact Assessment" dated June 19 2020, focusing on its proposed "selenium mitigation" plans. Tragically, for fish and wildlife health, there is nothing new or different in this proposed mitigation as compared to Benga's 2016 "Updated EIS" and everything that has ensued since. As I point out in Item 4 of my publication, adequate selenium mitigation (both from regulatory compliance and prevention of toxicity to fish and wildlife) from coal waste rock leachate using saturated backfill and surge ponds, which is all Benga is proposing, has not been demonstrated to work and it will not work at Grassy Mountain. Moreover, one can easily see the inherent flaw in Benga's proposal by virtue of the language that, in effect, "if saturated backfill and surge ponds don't work, we'll try something else". This is a gamble that cannot be allowed. Hard science tells both me and you what the reality is and what the result will be. History from other case examples in Alberta and British Columbia reveal what will happen. Fish will be poisoned and the high quality fisheries and aquatic habitats that now exist will be degraded and perhaps eliminated. Please take time to read my publication closely. I did not prepare it on a whim. It is credible science. The statements and warnings it makes are real. If you want to protect and preserve the aquatic environmental quality of the project area, Blairmore Creek, Crowsnest River, Oldman River Reservoir, etc., then take a very hard, objective look at what is being proposed. If you want to keep your trout, now is the time to take preemptive action. I trust you will reach the righteous decision. Don't approve the Grassy Mountain Project. I am available for further comment and correspondence at <email address removed> .

Sincerely,

<Original signed by>

A. Dennis Lemly, Ph.D.

Attachments

Publication: Environmental Hazard Assessment of Benga Mining's Proposed Grassy Mountain Coal Project

Resume of A. Dennis Lemly, Ph.D.

Environmental Science and Policy 96 (2019) 105–113

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Environmental hazard assessment of Benga Mining's proposed Grassy Mountain Coal Project

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A B S T R A C T

The Grassy Mountain Coal Project is a planned mountaintop open-pit development by Benga Mining Limited that would destroy 2,800 ha of scenic Rocky Mountain landscape in southwest Alberta, Canada. A scientific analysis of environmental hazards of the project reveals numerous flaws in both the projected environmental performance of the mine and its regulatory control. From both environmental and economic perspectives, the proposed mine will do far more damage than can be reasonably justified on any level. In this report, I present science-backed facts that show 6 specific, and grave, points of environmental hazard. If approved and made operational, the Grassy Mountain Coal Project will create a serious environmental threat from selenium pollution of high quality, high value aquatic habitats and culminate in poisoning of provincially and federally protected fish, coupled with substantial negative economic impacts. Prudent, timely, and decisive action by the Alberta Energy Regulator can eliminate the selenium risk and protect the environment.

1. Introduction

A plan to develop extensive open-pit mountaintop coal mining operations in the Crowsnest Pass area of southwest Alberta near the town of Blairmore, approximately 70 km north of the USA-Canada border (Fig. 1), has been submitted by Benga Mining Limited to the Alberta Energy Regulator (NRC, 2018; Riversdale, 2018). As part of the evaluation process for the proposed Grassy Mountain Coal Project (GMCP), AER required Benga to prepare an Environmental Impact Statement (EIS). That document was recently made available to the public (Government of Canada, 2018). Prior to its release, the Canadian Environmental Assessment Agency (CEAA) reviewed an earlier draft EIS and found several deficiencies, requiring additional information. According to CEAA, those deficiencies were addressed in the revision (CEAA, 2018a), and a formal government review of the final EIS is in progress. A public comment period was announced by CEAA to provide interested parties the opportunity to submit their thoughts on the proposed coal mining operations. CEAA's Joint Review Panel with AER will examine those comments and related information and make a determination as to whether a formal public hearing is warranted (CEAA, 2018b). I conducted a scientific review of the EIS, evaluated its merits, and compiled findings and conclusions in the present document. My report is an environmental hazard assessment that brings information from the EIS together with case examples from other open-pit mountaintop coal mines in Canada and the United States that have been in operation for as long as the projected life of the GMCP (25 years), and which utilize the same methods and techniques for handling solid and liquid residuals (surface disposal of waste rock, retention pond treatment of wastewater, etc.). The result is a revelation of what can be expected to occur if the Grassy Mountain Project is approved and put into motion.

2. Specific hazards of the Grassy Mountain Coal Project

(1) Exposure of waste rock to leaching

The process of open-pit mining requires surface disposal of residuals, that is, the waste rock removed to gain access to the desired coal seam. This creates a stockpile of material which has the potential to produce large volumes of contaminated wastewater due to precipitation-induced leaching of toxic heavy metals, trace elements and other materials from the mineral matrix of the rock. Of particular importance is the trace element selenium, which bioaccumulates in aquatic habitats and poisons fish and wildlife (Lemly, 2002b, 2008, Environment Canada, 2014). Leaching of selenium and resultant biological impacts is an undisputed fact of open-pit mountaintop coal mining, and has been demonstrated repeatedly in field case studies (Palmer et al., 2010; WVDEP, 2010; Lindberg et al., 2011; Environment Canada, 2014; Hendry et al., 2015). Case evidence clearly shows that this source of aquatic pollution will not, and cannot, be mitigated even with the application of advanced, high-cost treatment procedures (Linnett 2017, Scott, 2017a, 2017b). It will inevitably happen. The magnitude of pollution and its environmental impact depends on the extent of the waste rock stockpile. To date, there has been no demonstration of effective treatment of leachate wastewater to render it safe to aquatic life in receiving waters at the scale and flows emanating from

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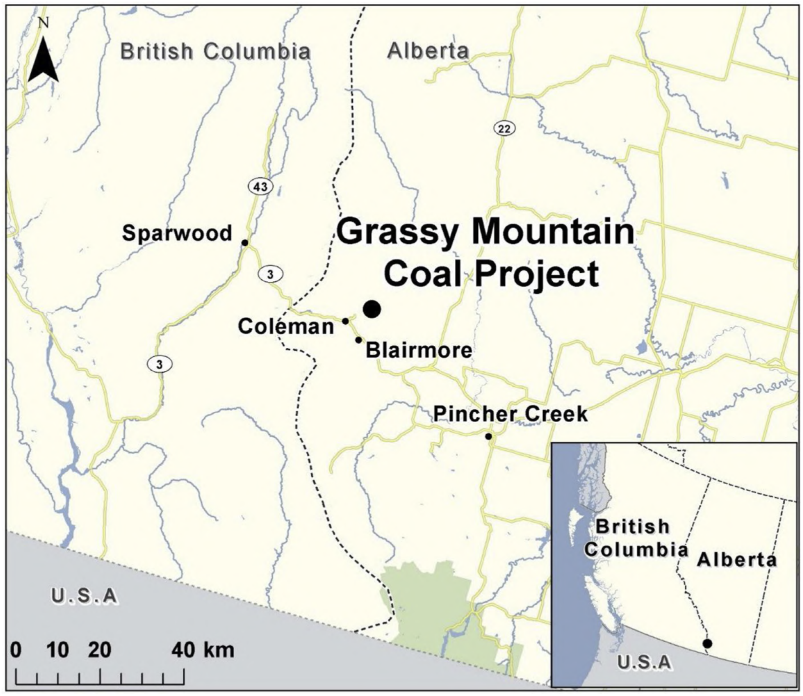

Fig. 1. Location of the proposed Grassy Mountain Coal Project in southwest Alberta, Canada (Graphic from Riversdale 2018).

coal mines. Pilot-scale experimental models of bioreactor treatment in Alberta (Luek et al., 2014) showed an ability to reduce selenium, but effluent concentrations remained above aquatic toxic levels (in excess of 5 ug/L, toxic threshold = 1.5 ug/L, USEPA, 2016, Alberta provincial and Canada federal guideline = 1 ug/L, CCME, 2018; Alberta Government, 2018b), and flows treated were a maximum of 2250 L/day, which is less than one-tenth of one percent of even a small waste stream tributary, thus offering little insight as to its practical application on the scale needed for coal mines. Moreover, there were also issues with release of fecal coliform bacteria in the bioreactor outflow that raised human health concerns. As a follow-up to the pilot model work, a field experiment was conducted on a 7.2 ha abandoned end-pit mine lake (Luek et al., 2017). It involved nutrient enrichment treatment using nitrogen and phosphorus fertilization to stimulate high primary productivity, create a eutrophic system, and maximize associated selenium uptake from water. Several critical weaknesses are evident in the conclusions of that study: (1) the pit lake was deep (45 m), anaerobic (absence of oxygen), and had no surface outflow (a stagnant system with retention time greater than 1 year), thus yielding results that are not transferable or applicable to the shallow (< 5 m), aerobic (oxygen-rich), flow-through retention ponds intended for Grassy Mountain (Hatfield, 2017); the selenium chemistry and cycling in those two systems are totally different, (2) waterborne selenium concentrations at the start were only 6.5 ug/L and, while elevated above background, were far lower than the 100–200 ug/L levels expected to be present in Grassy Mountain waste streams (Government of Canada, 2018), so the removal efficiency at those levels was not tested or demonstrated and, thus, remains unknown, (3) selenium speciation indicated a preponderance of selenate at the start (67%) with far less of the more highly toxic selenite form (13%), yet no speciation of selenium was reported for the rest of the study so it is unknown as to whether selenium was removed in equivalent amounts, or whether selenate was preferentially removed and the most toxic form remained, and at potentially elevated levels relative to what was present at the start, (4) end pit lakes having circumneutral pH, as was the case in the test, are known to be an attractive nuisance to wildlife, that is, they offer a desirable aquatic habitat for colonization, feeding and breeding of everything from insects to frogs and fish to ducks, raptors, and mammals, but their attractiveness belies the fact that they will be exposed to toxic levels of pollutants (USFWS, 2004). Aquatic birds are especially at risk, and migratory waterfowl are a primary concern, both for their own health, and because of the Canada-USA Migratory Bird Treaty Act (MBTA), which specifically prohibits "knowing take" due to environmental pollution (USFWS, 2017). These experiments, while interesting, mean little considering the scale of operations and wastewater stream hydrology that will result from the Grassy Mountain Project. If anything, they demonstrate why they won't work rather than why they will. Experimental selenium treatment through use of similar high primary productivity systems (eutrophic wetlands or lakes), has been shown to fail repeatedly, and, importantly, also infer MBTA liabilities (Lemly and Ohlendorf, 2002). Much can be learned by examining the case-example outcome of attempts to remove selenium on a mine-level scale through the installation of a $45 million dollar state-of-the-art treatment facility in British Columbia (Giffels Westpro, 2014). It failed, and to the contrary, this elaborate technology, which included both passive (bioreactor) and active (chemical) treatment, caused the release of a more toxic form of pollutants, resulting in the death of provincially and federally protected fish (westslope cutthroat trout and bull trout), and a $1.4 million dollar fine for violation of the Canadian Federal Fisheries Act (Linnitt, 2017; Scott, 2017a, 2017b). In addition to the waste rock leaching source of selenium, there is also the "leachate" that will result from the preparation of "clean coal" as the final product of the mine that would be exported to Asia for use as coking coal to make steel. According to the EIS, Grassy Mountain would produce millions of tons of "clean coal" per year. The cleaning process will be done on-site at the mine, and entails washing to remove soil and extraneous rock, crushing, screening and gravity separation, and dewatering (Riversdale, 2016; Wikipedia, 2017; RPM, 2018). There may also be application of various chemicals, notably MCHM (4-methylcyclohexane methanol), to enhance the cleaning process (Biello, 2014; Riversdale, 2016; RPM, 2018). The addition of chemicals escalates the toxic risk of wastewater to humans as well as aquatic life (Biello, 2014; WVU, 2015). There is also the major problem of calcite deposition in receiving waters as a by-product of coal cleaning, which coats the stream bottom and, in effect, turns it into concrete that is uninhabitable to invertebrates that form the base of the aquatic food chain, and also

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eliminates the loose gravels necessary for successful fish spawning (Environment Canada, 2014). The sum total of cleaning results in an additional "leachate" wastewater stream that finds its way into aquatic systems and is a significant, yet relatively unknown, source of coal mining-related pollution.

(2) Fish and wildlife poisoning

Leachate wastewater from coal mines contains numerous pollutants that pose a threat to aquatic life, including various salts and acid-forming materials, heavy metals, and trace elements (USEPA, 2010, 2017, Lindberg et al., 2011; Lemly, 2008, 2013). Key among these contaminants is the trace element selenium. It has a strong ability to bioaccumulate and biomagnify, that is, to progressively increase in concentration as it is absorbed from water by primary producers (plankton and algae) and passed up the food chain through successive trophic levels, culminating in greatest concentrations in the tissues of fish and wildlife. This leads to a highly dangerous situation because even very low, seemingly innocuous levels of waterborne selenium can result in toxic amounts in fish and wildlife. The end result is selenium poisoning, which consists of a variety of developmental deformities and death in offspring, and ultimately, complete reproductive failure if concentrations reach sufficient levels. Fish and aquatic birds are especially at risk of poisoning (Ohlendorf et al., 1988; Lemly, 1993, 1996, 1998, 2002a, 2002b, 2014, 2018b). Even at minimal toxic threshold levels, migratory aquatic birds (spotted sandpiper, *Actitis macularius*) experienced reduced hatchability of eggs downstream of mountaintop open-pit coal mines in British Columbia (Harding et al., 2005). Anything above that threshold just escalates the magnitude and severity of impacts. Moreover, such poisoning of migratory birds invokes the Canada-USA Migratory Bird Treaty Act, which carries strict penalties for any "take" due to pollution (USFWS, 2017). Fig. 2, Fig. 3, Fig. 4, Fig. 5 show examples of selenium poisoning deformities in fish that were caused by coal waste. Selenium poisoning can be insidious, that is, not readily apparent, due to the fact that it can cause reproductive failure and death of larval fish and embryonic birds while adults remain relatively unaffected. This is because selenium is consumed in the diet, then passed from parents to offspring in eggs, where its toxicity is expressed during development or just after hatching. At first glance, things may appear fine, with adults seemingly healthy and numerous, yet, reproductive failure can be taking place without visual evidence, that is, a massive die-off of fish or birds. Things can get very bad at a population level with little or no overt, outward indication. This has happened repeatedly, as evidenced by such landmark cases as the Belews Lake fish poisoning, and the Kesterson Reservoir waterfowl poisoning (Lemly, 1985, 2002a, Ohlendorf et al., 1988). Just because

Fig. 2. An abnormal bluegill (*Lepomis macrochirus*, top) from Lake Sutton, North Carolina, USA, with deformities that resulted from teratogenic effects of selenium poisoning due to coal waste. This individual has multiple defects of the mouth (which is less than 20 percent of its normal size and permanently distended) and other craniofacial structures including "gaping" permanently deformed gill cover. Bottom individual is normal. (Photo from Lemly, 2014).

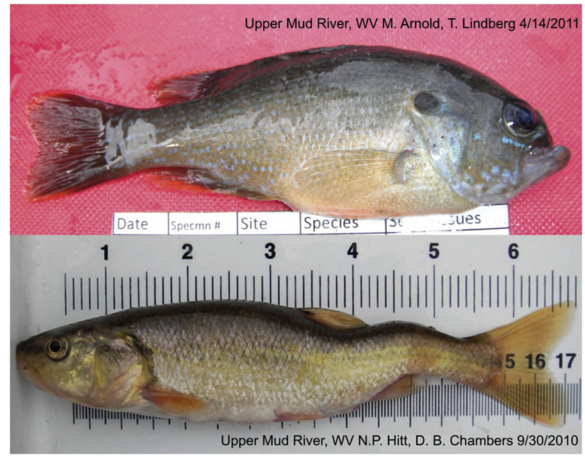

Fig. 3. Effects of selenium toxicity on two species of fish collected from the Upper Mud River, which is impacted by mountaintop coal mines in West Virginia, USA. (Upper) A sunfish (*Lepomis* sp,) showing cranial-facial deformities typical of selenium toxicity. This individual is missing its entire upper jaw and also exhibits compressed front head, a condition known as "pugnose". (Lower) Female creek chub (*Semolitus atromaculatus*) with lordosis deformity of the spine (dorso-ventral curvature), also a typical teratogenic deformity caused by selenium poisoning. (Photo from Lindberg et al., 2011).

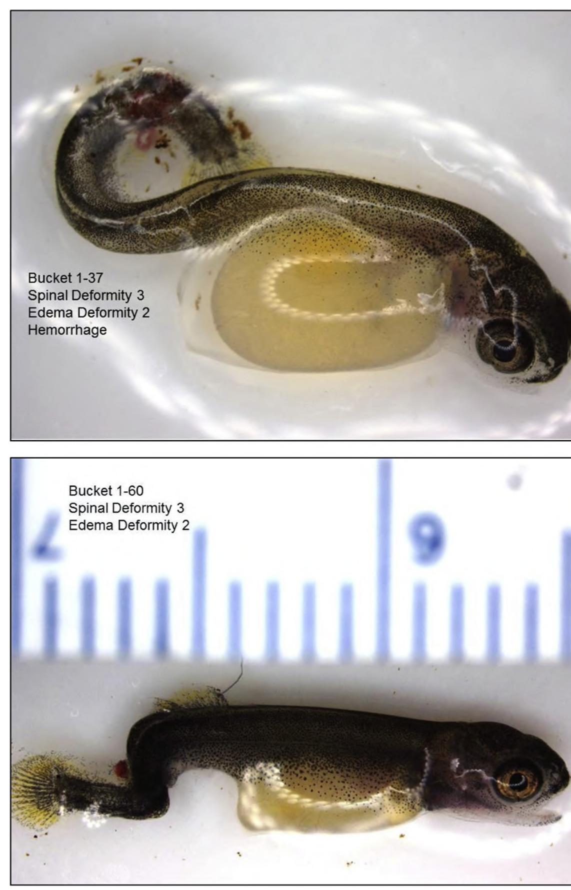

Fig. 4. Recently hatched westslope cutthroat trout (*Oncorhynchus clarki lewisi*) from the Upper Fording River, British Columbia, Canada, showing marked spinal deformities expressed as lordosis, kyphosis, and scoliosis. These deformities are reliable biomarkers of selenium poisoning. (Photo from Environment Canada, 2014).

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Fig. 5. Deformity (missing gill cover) in a westslope cutthroat trout (*Oncorhynchus clarki lewisi*) captured in Coal Creek, a tributary stream polluted by selenium from an open-pit mountaintop coal mine in British Columbia, and discharging to the Elk River. Gill cover deformities are a common type of craniofacial abnormality that is caused by selenium poisoning (Photo from Environment Canada, 2014).

adults are present doesn't mean there is no selenium poisoning taking place. One has to look closely at the base source of poisoning – death and deformities in developing and newly hatched fish and birds – to determine actual toxic impacts. Because of the nature of the selenium cycle – low water concentration, bioaccumulation, and insidious mode of toxicity – selenium is a "ticking time-bomb" (Lemly, 1999b). Once waterborne concentrations reach levels that begin to bioaccumulate, the fuse is lit. Then, a cascade of events is set in motion, ultimately resulting in reproductive failure and population-level impacts (Ohlendorf et al., 1988; Lemly, 1997, 1999b). Even if selenium sources are curtailed and waterborne selenium levels eventually reverse, the time-bomb explosion results in long-term impacts – on the order of decades – due to the retention of selenium residues in aquatic sediments, where it can be cycled back into the ecosystem and food chain (Lemly and Smith, 1987; Lemly, 2002b). Some major regulatory authorities have responded to the field case study evidence of the selenium threat. For example, the US Environmental Protection Agency conducted an in-depth review of its national selenium criteria and issued revised levels in 2016. Those criteria reduced the maximum waterborne selenium concentration by 70% over the previously permissible level for lentic – or passive – waters (5.0 ug/L reduced to 1.5 ug/L), and by 38% for lotic – or flowing – waters (5 ug/L reduced to 3.1 ug/L). The Agency also issued a first-ever tissue criterion for fish as an attempt to prevent bioaccumulative poisoning and associated reproductive impacts (USEPA, 2016). The waterborne selenium criteria in Canada are even more restrictive, as reflected by the 1 ug/L federal and Alberta provincial guideline (CCME, 2018; Alberta Government, 2018b). In addition to toxicity risks for fish and wildlife, there are also concerns for human health due to the accumulated selenium in edible fish and bird tissues. There are numerous examples of consumption advisories issued by state and federal authorities to limit intake of fish due to selenium contamination from coal waste (SNC, 2000; ATSDR, 2009a, 2009b, WVDNR, 2012).

(3) Pollution of aquatic habitats

Receiving waters for liquid waste that would be released from the Grassy Mountain Project are high quality, high value aquatic ecosystems in the Crowsnest Pass area. These include Gold Creek and its tributaries, Blairmore Creek and its tributaries, and the Crowsnest River. These waters are teeming with fish and other aquatic life, and are designated critical habitat for westslope cutthroat trout (*Oncorhynchus clarki lewisi*), which is a provincially and federally listed threatened species (Fisheries and Oceans Canada, 2013; ECCC, 2017; AEP, 2018). Westslope cutthroat trout have been shown in both field and laboratory studies to be highly sensitive to selenium pollution from coal mining. Teratogenic deformities and reproductive failure develop quickly, and without warning once an aquatic habitat is polluted (Rudolph et al., 2008; Elphick et al., 2011; Environment Canada, 2014; Soloway, 2014). Because of their sensitivity and status as a threatened species, these trout require special attention if they are to be maintained and preserved as a thriving, not just persisting, component of the Alberta fauna. There are major steps already underway to this end; the Alberta Recovery Plan (Cove et al., 2013) and the federal Recovery Strategy for this fish (DFO, 2014), which are two significant documents describing the problems it faces and the general approach to recovering the species. Substantial employee hours and funds have been expended preparing them, and much more is earmarked for carrying them out. Expanded industrial damage to critical habitat, as would occur if the Grassy Mountain Project proceeds, would impede the success of recovery, resulting in a serious setback for the fish and also a tragic waste of effort and taxpayer money. In fact, elaborate recovery efforts have already been undertaken in Alberta, involving helicopter transport of fish, in an attempt to rescue some of the remaining fish and establish new populations (Derworiz, 2015). Moreover, it is expected that numerous other fish and aquatic-dependent species would be poisoned as well, including migratory waterfowl and shorebirds (Ohlendorf et al., 1988; Harding et al., 2005), which would bring the Canada-USA Migratory Bird Treaty Act into play (USFWS, 2017). Degradation of these waters by selenium and other pollutants would result in poisoning and loss of valuable fishery resources – valuable from several perspectives, including the direct ecological cost of habitat and fish replacement value (possibly including fines of up to $1 million for each count of habitat destruction or poisoning of a threatened species, Government of Canada, 2018b), recreation and sport fishing value, real estate value, human health value, and aesthetic value (Lemly and Skorupa, 2012a, 2012b, Lemly, 2014, 2015b). Based on numerous case examples of coal waste aquatic pollution and resultant fish and wildlife poisoning and associated losses, the aggregate economic impact of these costs could easily exceed $30 million dollars per year, and deal a devastating blow to the local and regional economy. A cost analysis of the projected 100–250 digging/hauling/production jobs that would be gained from the Grassy Mountain mining operation at its peak (Nichols, 2016; Government of Canada, 2018), at an average pay rate of $38 per hour ($78,000 per year, Payscale, 2018), translates to a total annual employee payout of between $7 and $19 million – which is completely offset by the economic losses resulting from environmental impacts of the project. Moreover, most of those jobs are expected to be filled by immigrant workers, not by existing local permanent residents (Nichols, 2016). Thus, claims made by Benga Mining that it needs to gain quick approval and start mining because of the anticipated value of overseas investment to the Alberta economy and local residents (Stephenson, 2018) are, at best, misleading.

(4) Lack of proven mitigation measures and regulatory compliance

Selenium pollution from coal mine waste is a global environmental safety issue (Lemly, 2004, Lemly, 2007; 2008, 2013, 2014, 2018a). The methods and techniques proposed for waste management at Grassy Mountain pose grave environmental hazard and have been demonstrated to fail to protect the environment. This is especially true because of a lack of proven mitigation that would effectively eliminate those risks. For example, no treatment precautions or post-mining reclamation steps specified in the Waste Management Plan (WMP), the EIS or Addenda sufficiently address selenium pollution. How does Benga mitigate this risk? It doesn't, and can't. This is a critical weakness and literally a fatal flaw with respect to fish and wildlife health. As was mentioned in Item 1, exposure of waste rock to leaching will take place consistently during active mining, and continue indefinitely after mining ceases. This source of selenium cannot be effectively stopped. Statements in the EIS, WMP, and Addenda offer no realistic hope of success and reveal a shallow understanding of selenium cycling in the aquatic environment. They are not backed up by case examples demonstrating that the proposed waste management methods have resulted in effective control of selenium. That is because there are no case examples. Effective treatment doesn't exist, only case after case of selenium pollution and resultant poisoning of fish and wildlife. The "treatment" discussed in the WMP is focused is on physical habitat quality, that is, stream sedimentation, not remediation of changes in water chemistry from selenium and other chemical pollutants. Even the habitat statements are contradictory and highly suspect. For example, Addendum Consultant Report #6, Aquatic Ecology Effects Assessment (Hatfield, 2017, page 57) states "Gravel deposition [sedimentation] will likely be enhanced in some locations", and following," the likelihood and extent of physical habitat to be altered in terms of quantity and suitability is considered negligible". Both of these cannot be true, that is, a dual contention that on the one hand Benga Mining is going to sediment the streams but on the other hand there won't be any effects. By Canadian law under Section 58(1) of the Species at Risk Act, (Government of Canada, 2018b), destruction of any part of habitat that supports a listed threatened species, in this instance westslope cutthroat trout, is strictly prohibited and, therefore, cannot simply be decreed "negligible" and dismissed by a consulting firm. With absolutely no case study evidence to support their claim, it seems clear that the consultant reports have simply "wished away" detrimental, and illegal, impacts by invoking unverified model projections, not actual documentary data, in order to draw the conclusion that likely effects are "considered negligible". SARA does not allow *any* habitat destruction. Quote "No person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species if (b) the listed species is an aquatic species". The only mention of selenium "treatment" in the EIS refers to the use of rudimentary methods for passive removal. Quote "All process water with elevated selenium will be treated in surge ponds and saturated zones with sufficient water residence time" (Hatfield, 2017, page 57). This is simply use of retention ponds, with the hopes that selenium will either settle out or be biologically removed. It won't, as has been shown repeatedly in case examples. Moreover, these ponds are notorious for breaching, which is not acknowledged as a possibility or accounted for in the EIS. With no contingency plan, this is analogous to allowing a speeding car to proceed with no brakes. The equivalent of an accident waiting to happen. Retention ponds, even when coupled with enhanced active treatment steps (Giffels Westpro, 2014), have not been demonstrated to work and will not work in this instance either. In fact, documented evidence shows that the contrary will happen. Selenium will not be removed, but will be altered into a chemical form that is even more toxic to westslope cutthroat trout (Environment Canada, 2014; Linnitt, 2017; Scott, 2017a, 2017b). In addition to fatal flaws in the proposed treatment methods, there is a serious regulatory issue as well. There are no specifications for selenium monitoring, selenium treatment and removal, or selenium water quality criteria, in the Alberta Coal Mining Wastewater Guidelines (AER, 2014; Alberta Government, 2018), despite the fact that there is a well-established and defined limit for selenium (1 ug/L) in both federal and provincial water quality regulations (CCME, 2018; Alberta Government, 2018b). This limit was established as a result of extensive case study evidence from Canada and elsewhere over the past four decades showing how dangerous selenium is to aquatic life. Current policy by AER reveals an extremely poor understanding and recognition of the key aquatic pollutant emanating from coal mines, and reflects very poorly on the credibility and performance of AER. This lack of adequate regulatory oversight and enforcement will lead to pollution that is seemingly "legal" in the sense that AER guidelines were being met, at the same time that fish and wildlife are being poisoned. Even if regulations are in place, past and current performance of the mining industry in Canada strongly suggests that there is little hope that Benga Mining will comply. For example, a recent government-conducted environmental audit of the mining sector in British Columbia revealed that surface open-pit mountaintop coal mines are almost never in compliance with regulations. Quote "We conducted this audit to determine whether the regulatory compliance and enforcement activities of the Ministry of Energy and Mines (MEM) and the Ministry of Environment (MoE), pertaining to mining, are protecting the province from significant environmental risks. We found almost every one of our expectations for a robust compliance and enforcement program within MEM and the MoE were not met" (Bellringer, 2016). The mining sector was essentially getting a "free pass" to do as it pleased while the regulatory community consistently failed in their responsibility to enforce the law, year after year. This seems to be a clear case of regulatory capture, that is, "A form of government failure which occurs when a regulatory agency, created to act in the public interest, instead advances the commercial or political concerns of special interest groups that dominate the industry or sector it is charged with regulating" (Carpenter and Moss, 2014; Wikipedia, 2018). Regulatory capture was identified as an evident government flaw in the first recommendation for needed reform offered by the British Columbia audit (Bellringer, 2016), and was exposed as a pervasive problem influencing regulatory decisions made by the National Energy Board of Canada, as stated by its own deputy energy minister (Wilt, 2017). Moreover, despite a wealth of scientific evidence showing the poisoning impacts of coal mining in BC, all of the requests for mine expansion were granted permits by government regulators. Although this documented regulatory collapse in BC is a tragic, landmark example, there are similar cases of coal-mine selenium pollution impacts on aquatic life in Alberta with no indication of adequate regulatory intervention by AER. Clear evidence of this regulatory failure can be found by examining the scientific literature regarding impacts in the McLeod River headwaters and Grande Cache area, and subsequent lack of regulatory action. For example, research studies by Holm et al. (2003, 2005), Kuchapski and Rasmussen (2015a, 2015b), Mackay (2006); Palace et al. (2004); Wayland et al. (2006, 2007), and Wayland and Crosley (2006) all show selenium bioaccumulation, high risk, and toxic effects to fish and aquatic invertebrates, including the provincially and federally listed threatened bull trout (*Salvelinus confluentus*). Yet, no regulatory intervention was undertaken in response to these documented risks and impacts. Coal mining remained unimpeded and was issued permits for expansion. Despite the scientific documentation of detrimental pollution impacts, it seems that this has been a long-running case of "don't ask, don't tell" by government regulators in Alberta. In effect, we won't go looking for problems, therefore, we won't find any, so continue mining. It's not that there is a lack of regulations promulgated under statutory authority *of* government, there is a lack of enforcement of those statutory laws *by* government. Today, with the large body of scientific information and case study evidence available demonstrating the selenium threat from coal mining in Alberta and elsewhere, there is no longer plausible deniability. There is no legitimate basis for the claim" we didn't know better", either on the part of the mining industry or the regulatory community in which it operates. Benga's consultant models and resultant conclusions of "negligible" impacts have no basis in fact. This is simply a ploy to gain AER approval and make money for Benga and its investors, without commensurate benefits to Albertans. Case evidence from Canada and elsewhere, over and over, time and time again, reveals the truth about pollution and impacts from open-pit coal mines. The tragedy that took place in BC and, in fact, already in Alberta, should not, and need not, be repeated with the Grassy Mountain Project.

(5) Downsteam transport of contaminants

One of the greatest hazards resulting from selenium pollution of flowing waters is downstream transport. Not only can aquatic life in the immediate vicinity of the input source be poisoned, but also in habitats far from it, perhaps hundreds of kilometers away. Selenium is a chemical element. It doesn't biodegrade and magically disappear. It travels intact and unaffected. This aspect of selenium cycling is known as the Hydrological Unit Principle (HUP, Lemly, 1999a, 2002b). The HUP is quite simple, low concentrations of waterborne selenium that are seemingly innocuous can be transported to aquatic systems where the propensity for bioaccumulation and risk of poisoning is even greater,

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that is, into lentic, or standing/impounded waters. The greater risk is due to generally greater primary productivity in lentic systems (growth of algae and other microorganisms that accumulate selenium directly from water) which “fuels” the base of the aquatic food chain and then subsequent trophic-level increases in tissue concentrations result in toxicity to fish and wildlife. A Hydrological Unit is the segment of aquatic habitat that experiences elevated waterborne selenium sufficient to cause bioaccumulation to hazardous levels. It is determined by the input source selenium concentration and the magnitude and spatial distribution of downstream inputs of low-selenium water. Thus, the length of a HU can be quite short, if dilution is sufficient and quick, or very long, if the volume and selenium concentration of wastewater discharge are large relative to the receiving waters. The latter case occurred from open-pit mountaintop coal mining in the Fording River area of British Columbia, resulting in downstream transport from the Fording River into the Elk River and ultimately, deposition of toxic levels of selenium into Lake Koocanusa, some 165 km away (Scott, 2014, 2015a, 2015b, 2016, Selch, 2014; Lavoie, 2018; Pollack and Moy, 2018). The HUP has particular importance for the Grassy Mountain Project because the scale of mining and amount of waste rock subjected to selenium leaching (2,800 ha, billions of tons), and the relatively small size of receiving waters (Gold Creek and Blairmore Creek), the flow of these streams will be overwhelmed by wastewater flow. This means there will be little dilution afforded by the immediate receiving waters, thus, downstream transport will come into play and be a big factor in cumulative impacts. Aquatic systems that would be affected include the Crowsnest River and Oldman River Reservoir, which support a world-class rainbow and brown trout sport fishery. Importantly, long-term risks exist, even decades after mine closure, because of the fact that waste rock piles cannot be effectively mitigated or reclaimed, as shown in the BC case studies (Environment Canada, 2014), and the reservoir of waste rock selenium prone to leaching is huge (Hendry et al., 2015).

(6) Compelling evidence from British Columbia shows how dangerous the Grassy Mountain Project will be

Teck Coal Limited has five open-pit mountaintop mines in the Elk River Valley of southern British Columbia in fairly close proximity to the proposed Grassy Mountain Project, only about 30 km away (Riversdale, 2018). The mining techniques and basic waste disposal methods used by Teck are the same as proposed by Benga for Grassy Mountain, although advanced treatment for selenium removal was attempted by Teck, but failed. The BC mines produce metallurgical-grade coal that is shipped to Asia for use as coking coal to make steel. This is the same end-product and marketing that is proposed for coal coming out of Grassy Mountain. The mines are located along the Fording River and its tributaries (Environment Canada, 2014; Teck, 2018). Selenium-laden leachate from waste rock piles and coal processing wastewater are discharged into the Fording River, which flows into the Elk River near Fernie. Water quality in both of these rivers has steadily declined over the past 4 decades. Selenium levels increased to the point that significant bioaccumulation began to occur in fish and the aquatic ecosystem of the Fording, such that by the 1990′s selenium poisoning of fish was evident, including the listed as special concern westslope cutthroat trout and listed as threatened bull trout (*Salvelinus confluentis*, Wood and Berdusco, 1999; McDonald, 2013; Environment Canada, 2014; British Columbia, 2018). Toxic impacts steadily escalated to the point that most of the historic westslope cutthroat trout population in the Upper Fording River (above Josephine Falls) was eliminated (Environment Canada, 2014). The remnant population that remained was, and still is, severely impacted. Estimates indicate that at least 180,000 newly hatched trout perish each year due to selenium poisoning, and even adults carry the scars of selenium toxicity they incurred as hatchlings (Lemly, 2015a, Fig. 5). Toxic impacts are not confined to the Upper Fording, they extend far downstream, including the Lower Fording and Elk. Figs. 4 and 5 illustrate these toxic effects. Recent evidence has emerged showing that not only are fish being affected, but also aquatic invertebrates are being poisoned, which deals a death blow to the aquatic food chain, upon which westslope cutthroat trout and other species depend to survive (Pollack and Moy, 2018).

Teck Coal attempted to reduce selenium levels in the Fording River by constructing a $45 million dollar wastewater treatment plant on West Line Creek, a primary selenium-releasing tributary (Giffels Westpro, 2014). The facility was promoted as state-of-the-art, and was designed to utilize both biological and chemical treatment steps. Long-term plans were to construct several of these facilities within the Fording-Elk River mining footprint in the hopes of providing an effective remedy to the selenium problem. However, within 6 months after the Line Creek Plant became operational, a fish kill was detected, consisting of both westslope cutthroat trout and bull trout, the former of which is a listed species of special concern under Canadian federal law (Government of Canada, 2018b). Investigations revealed that the plant had not only failed to achieve the desired water quality in its effluent discharge, but also had actually made things worse by producing and releasing a more toxic selenite form of selenium (Linnitt, 2017; Scott, 2017a, 2017b, Lavoie, 2018; Pollack and Moy, 2018). Although fines were levied against the mining company for violating the Canadian Federal Fisheries Act, the magnitude of fines ($1.4 million total) was nothing more than a slap-on-the-wrist compared to the multi-billion dollar annual profit made by the coal mines ($12 billion in 2017, Teck, 2017). Moreover, permits for mine expansion were always granted by government regulators despite the overwhelming scientific evidence of significant environmental impacts and concurrent legal violations. Even more tragically, there has been no resolution of the selenium pollution issue. It continues unabated and poisoning of fish continues. This case example shows that available treatment measures to protect water quality from selenium in coal mining waste are ineffective, despite their elaborate technical design and high cost. There has been no demonstrated success for selenium removal on the scale needed to treat mountaintop open-pit coal mine waste. There is also a grave environmental danger due to the legacy effects of pollution, that is, continued contamination and poisoning long after mining operations stop. For example, it is estimated that the reservoir of selenium in waste rock piles will release toxic levels of selenium in leachate for centuries (Hendry et al., 2015; Pollack and Moy, 2018). To date, there has been no demonstrated effective mitigation measure, physical or chemical, for eliminating this pollution threat. Another compelling piece of evidence as to how dangerous Grassy Mountain will be is the downstream transport of selenium and bioaccumulation in aquatic systems far from its source. For many years, research has documented increasing levels of selenium in waters and fish in Lake Koocanusa, an impoundment of the Kootenai River that straddles the USA-Canada border between BC and Montana (Selch, 2014; Scott, 2014, 2015a, 2015b). Downstream transport of pollution from coal mines 165 km away is responsible for these increases. Concentrations of selenium in Koocanusa water now exceed USEPA criteria for the protection of aquatic life (Scott, 2016; Pollack and Moy, 2018) and fish tissue amounts are at toxic levels (Selch, 2014; Lavoie, 2018). The Hydrological Unit Principle is clearly in play, that is, downstream transport of relatively low levels of waterborne selenium that become hazardous due to bioaccumulation in a lentic ecosystem. With respect to the proposed Grassy Mountain Project, this would mean that severe downstream effects would be expected in Oldman River Reservoir due to transport of selenium by the Crowsnest River. The reservoir is only some 40 km away from the mine site, far less than the 165 km between the BC coal mines and the “impact zone” of Lake Koocanusa. Moreover, fisheries that would be impacted include threatened westslope cutthroat trout and the internationally recognized rainbow and brown trout sport fishery in the Crowsnest River. Ecosystem values that would be affected run the full range of potential damage costs involving habitat and fish replacement value, recreation and sport fishing value, real estate value, human

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health value, and aesthetic value (Lemly and Skorupa, 2012a, 2012b). These costs could easily run into the tens of millions per year, and deal a substantial blow to the local and regional economy.

3. Conclusions

If approved and made operational, the Grassy Mountain Coal Project will create a grave environmental threat from selenium pollution of high quality, high value aquatic habitats in a scenic Rocky Mountain landscape. The magnitude of impact will depend on extent and duration of mining, amount of waste produced, and exposure of fish and wildlife in the surrounding area and downstream, including Crowsnest River and Oldman River Reservoir, and perhaps beyond. Aquatic species that would be poisoned include the westslope cutthroat trout, which is a provincially and federally listed threatened species. Beyond its protected status, the cutthroat it is a sentinel species that reflects the high environmental quality that now exists in the Crowsnest Pass area. Case studies from coal mining in the McLeod River and Grand Cache area of Alberta and the Elk River Valley of nearby British Columbia clearly show the environmental hazard of Grassy Mountain. There is no need for history to repeat itself. The proposed methods and techniques to protect water quality are simply hollow promises that carry no legitimate demonstration of prior success. A large body of scientific evidence clearly shows the high degree of environmental hazard which will accompany the Grassy Mountain Project. Moreover, the metallurgic coal produced will be sold to Asia. Resultant monetary benefits will accrue to Benga Mining and Asian investors, yet, apart from a few local jobs, the vast majority of Albertans will see no financial benefit but will collectively bear the cost of environmental damage and chronic pollution. The risk trade-off is unacceptable to maintain the high environmental quality that now exists in the Crowsnest Pass area. It would be an environmental, public, and political nightmare if the coal mining tragedy that has unfolded in British Columbia, and already in Alberta, were to repeat itself. The overwhelming weight of scientific information and case study evidence indicates that this outcome is inevitable if the mining takes place. Perhaps most importantly, there is a definite, dangerous risk of corporate regulatory capture coming into play which would control policy and prevent decisions necessary to protect the environment. Prudent, timely, and decisive action by Alberta Energy Regulator and CEAA is needed in order to eliminate the selenium threat.

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Resume of Alton Dennis Lemly

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Professional Preparation

Haywood Technical Institute	Fish and Wildlife Management	A.A.S. 1975
Western Carolina University	Biology	B.S. Ed. 1978
Wake Forest University	Biology	M.A. Ed. 1979, Ph.D. 1983
University of Saskatchewan	Fish Toxicology	Post-Doc 1983-1986

Appointments

2006-2016 Research Associate Professor of Biology, Wake Forest University
1991-2016 Research Fisheries Biologist, USDA-Forest Service
1986-1991 Research Fisheries Biologist, U.S. Fish and Wildlife Service

Applicable Experience

My work centers on aquatic pollution issues related to fossil fuel procurement and utilization. I have investigated environmental risks and aquatic impacts of the coal mining and coal-fired electric utility industries for over 40 years, dating back to 1977. I specialize in the ecotoxicology of selenium, a trace element pollutant that results from coal mining and coal combustion wastes, i.e., coal ash. Selenium bioaccumulates and causes developmental deformities and reproductive failure in fish and wildlife. I have conducted intensive investigations of numerous cases of selenium pollution, including Belews Lake, North Carolina, where 19 species of fish were eliminated, and Kesterson National Wildlife Refuge, California, where many thousands of aquatic birds were poisoned. I have published 48 research articles on selenium toxicity to fish and wildlife, as well as the professional reference book *Selenium Assessment in Aquatic Ecosystems*. I have consulted on selenium pollution issues ranging from power plant coal ash waste at numerous US and international locations from Russia to Australia, to mountaintop removal coal mining impacts in West Virginia, to Canada-US transboundary pollution from open-pit coal mining in the Elk Valley, British Columbia. From 2006-2016 I had dual federal-university appointments that provided a unique mechanism for conducting integrated, collaborative research on coal mining and coal ash pollution issues around the world.

Pertinent Publications (PDFs are available for many of these upon request)

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3. **Lemly, A.D.** 1985. Ecological basis for regulating aquatic emissions from the power industry: The case with selenium. *Regulatory Toxicology and Pharmacology* 5: 465-486.

4. **Lemly, A.D.** 1985. Toxicology of selenium in a freshwater reservoir: Implications for environmental hazard evaluation and safety. *Ecotoxicology and Environmental Safety* 10: 314-338.

5. **Lemly, A.D.**, and G.J. Smith. 1987. Aquatic cycling of selenium: Implications for fish and wildlife. Fish and Wildlife Leaflet 12. U.S. Fish and Wildlife Service, Washington, DC.

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12. **Lemly, A.D.** 1994. Agriculture and wildlife: Ecological implications of subsurface irrigation drainage. *Journal of Arid Environments* 28: 85-94.

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21. **Lemly, A.D.** 1997. Role of season in aquatic hazard assessment. *Environmental Monitoring and Assessment* 45: 89-98.

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Key Data and Information Contributions to US Federal Regulatory Policy for Selenium

1. Development and transfer of guidance for aligning federal activities under National Environmental Policy Act requirements for mining activities that generate selenium in wastewater.
2. Preparation of a reference guidebook for selenium assessment and associated water quality criteria in aquatic ecosystems.
3. Development and transfer of implementation guidance for US EPA fish tissue standards for selenium.
4. Development and transfer of damage assessment valuations for use by US EPA in planning for national coal ash disposal regulations.

APPENDIX B

CPAWS
CANADIAN PARKS AND WILDERNESS SOCIETY
SOUTHERN ALBERTA CHAPTER

c/o Canada Olympic Park
88 Canada Olympic Way SW
Calgary, AB, T3B 5R5

June 16, 2020

SENT ELECTRONICALLY

Osler, Hoskin & Harcourt LLP
Suite 2500, TransCanada Tower
450 – 1st Street S.W.
Calgary, Alberta, Canada T2P 5H1

Re: CPAWS Request for information relating to the Grassy Mountain Coal Project (80101) to prepare for hearing

As you recommended in your letter of November 14, 2019, I am requesting information directly from Benga for CPAWS to use in preparation for the hearing for the Grassy Mountain Coal Project.

(1) The complete results of the coal quality tests generated in relation to the Grassy Mountain Coal Project. This includes, but is not limited to, the results of the 9 pilot scale carbonization runs done at ALS Riverview facility in Queensland Australia, the bulk sampling programs undertaken by Hazen and ALS, the coal quality review report completed by the Bob Leach Pty Ltd, the results of the historical sample testing described in section B.4.2 of the Environmental Assessment, and any documents not already in the EIA that show how the indicative product specification for the coal was calculated.

(2) The complete set of results of the spring spawning surveys, genetic sampling, condition factor (K), and summer population assessments for the WSCT that was done in 2016, and any other data produced from work authorized by *SARA* permit DFO-16-PCAA-00026.

The complete results of all snorkel surveys for WSCT done since 2016, and any other genetic sampling data or analysis that was done on WSCT for the project. (Including, but not limited to the work described in section 6.6.2.1 of Package 5 to Tenth Addendum to the Environmental Impact Assessment).

If this information is already included or available in the EIA, please identify where. If you dispute the relevance of any of this material, or are otherwise unable to provide it to CPAWS, let me know promptly so that we can have the issue considered and decided by the JRP without delay.

Sincerely,

<Original signed by>

Drew Yewchuk
Staff Lawyer
Public Interest Law Clinic

Osler, Hoskin & Harcourt LLP
Suite 2500, TransCanada Tower
450 – 1st Street S.W.
Calgary, Alberta, Canada T2P 5H1
403.260.7000 MAIN
403.260.7024 FACSIMILE

OSLER

Calgary
Toronto
Montréal
Ottawa
Vancouver
New York

July 3, 2020

Martin Ignasiak
<contact information removed>

SENT BY ELECTRONIC MAIL

Canadian Parks and Wilderness Society (CPAWS)
Southern Alberta Chapter
c/o Canada Olympic Park
88 Canada Olympic Way SW
Calgary AB T3B 5R5

Attention: Drew Yewchuk, Staff Lawyer, Public Interest Law Clinic

Dear Mr. Yewchuk:

Re: Benga Mining Limited ("Benga")
CEAA Reference 80101
Grassy Mountain Coal Project ("Project")
Response to Information Request ("IR")

We are writing in response to your letter dated June 16, 2020, in which you requested further information from Benga on behalf of CPAWS. This letter provides Benga's response to the two IRs contained within your letter.

IR #1: Results of the Coal Quality Tests in relation to the Project

You requested the complete results of the coal quality tests generated in relation to the Project. We are unable to provide this information because it is confidential, irrelevant to the Joint Review Panel's Terms of Reference, and redundant of information already included in the environmental impact assessment ("EIA").

The results of the coal quality tests generated in relation to the Project is information that is scientific and technical in nature, has been consistently treated as confidential, is commercially sensitive about the quality of the resource (and thus the value of Benga's assets in the area), and would cause harm to Benga's competitive position through its disclosure. Similar resource quality information has been treated as confidential during regulatory proceedings such as this.[1] Samples were sent to Australia for testing precisely to ensure that the results would remain confidential and to avoid this sort of harm to Benga.

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[1] See, for example: *Ridgeback Resources Inc. and Westbrick Energy Ltd., Well Licence Applications near the Brazeau Dam, Panel Decision on Cenovus Request for Confidentiality* (March 26, 2020), AER Proceeding 379, available online: https://www.aer.ca/documents/decisions/Participatory_Procedural/1922830_20200326.pdf. Regarding analogous seismic information, see: *Polaris Resources Ltd., Applications for a Well Licence, Special Gas Well Spacing, Compulsory Pooling, and Flaring Permit,*

The disclosure of this confidential information is not necessary for this proceeding. The only element of the Joint Review Panel's Terms of Reference to which the coal quality test results might be relevant is the economics of the Project. To the extent that it might be relevant for this purpose, the requested confidential information is redundant of the socio-economic information that is already included in Addendum 11 of the EIA regarding the economic scenarios presented based on different coal prices.[2]

The information that is already included in the EIA is sufficient to allow a review that complies with the Joint Review Panel's Terms of Reference, including as it pertains to the economics of the Project. It is not the role of a joint review panel to second guess a company's analysis of the quality of a resource and the value of its assets. A company assumes any risk related to quality and value when it decides to proceed with a project.

IR #2: Results of Surveys, Genetic Sampling and Data from *SARA*-permitted Work

Identified in the table below is where information responsive to this IR is already included in Addendum 1 of the EIA[3]:

Results Requested	Location in Addendum 1 of the EIA
Spawning surveys and population assessments (2016 results)	• Section 3.1.4 WSCT Spawning Survey (Methods) • Section 3.1.5 Fish Population (Methods) • Section 4.1.2.2 Tributary Assessments (Results) • Section 4.1.4 WSCT Spawning Survey (Results) • Section 4.1.5 Fish Population (Results) • Section 5.4 WSCT Spawning Survey (Summary of Findings) • Section 5.5 Fish Population (Summary of Findings) • Appendix A1 Fisheries and Aquatics Technical Baseline Report: Appendix A5 Fish Survey Data (Detailed Results)
Genetic sampling (2016 results)	• Section 3.1.2 Fish Inventory (Methods) • Section 4.1.2.2 Tributary Assessments (Results) • Appendix A1: Appendix A5, Table A5.2

Livingstone Field (December 16, 2003), p. 5, available online: https://www.aer.ca/documents/decisions/2003/2003-101.pdf; AER, "EnerFAQs" (January 2020), available online: https://www.aer.ca/providing-information/news-and-resources/enerfaqs-and-fact-sheets/enerfaqs-landowner.html: "A company will normally select the location of a well based on the geology of nearby wells or on seismic information. Some of this information may be confidential."

[2] Registry No. 313, pp. 13-19.

[3] Registry No. 44.

Results Requested	Location in Addendum 1 of the EIA

	• Appendix A4 Preliminary Habitat Offsetting Plan
	  ○ Section 3.1 Critical Habitat
	  ○ Table 3.1 Watercourses in the Local Study Area designated as critical habitat (greater than 99% genetically pure) and near-pure (95% to 99% genetically pure) westslope cutthroat trout

Condition factor (2016 results)	• Section 3.1.5.5 Fish Condition (Methods) • Table 3.3 Fulton Condition Factor (K) assignment to fish condition • Section 4.1.5.3 Condition (Results) • Figure 4.13 The percentage of the population of WSCT in Gold Creek and Blairmore Creek by K Factor as a measure of fish condition • Section 5.5 Fish Population (Summary of Findings)

In addition, please find enclosed a memorandum from Hatfield Consultants LLP dated June 29, 2020, which contains a preliminary characterization and analysis of supplemental fish monitoring data collected on Gold and Blairmore creeks covering 2017 to 2019.

Conclusion

We trust that these responses are satisfactory. Benga looks forward to continuing to work with CPAWS to ensure that the JRP has all the necessary and relevant information before it to make a public interest decision with respect to the Project.

Yours truly,

<Original signed by>

Martin Ignasiak

Encl.

Hatfield Ref #: MEMS9950-NV

June 29, 2020

Gary Houston
Vice President, External Affairs
Benga Mining Ltd.
P.O. Box 660
12331 – 20th Ave
Blairmore, AB, T0K 0E0

Re: Preliminary Analysis of Westslope Cutthroat Trout Monitoring Data (2017 – 2019) for Gold and Blairmore creeks

Dear Gary:

Included herein, please find a preliminary characterization and analysis of supplemental fish monitoring data collected on Gold and Blairmore creeks covering 2017 to 2019 as part of the Grassy Mountain Coal project. Analyses include results from 2016 for comparison, where appropriate. Please note that these analyses are draft with more detailed analysis and interpretation ongoing.

If there are any additional requests, please let me know.

Sincerely,

<Original signed by>

Cory Bettles, MSc, RPBio, FP-C
Senior Manager, Fisheries Resources
HATFIELD CONSULTANTS LLP

1.0 INTRODUCTION

This letter provides a high-level analysis of fish inventory monitoring data collected between 2017 and 2019 (post-EA Addendum submission). The monitoring builds on the data collected up to 2016 and aims to track spatial and temporal population variability metrics of Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) inhabiting Gold and Blairmore creeks. Non-invasive survey techniques (snorkel surveys) have been deployed to avoid causing undue stress on fish, which is a continuation of the surveys initiated in 2016. The set of data (tables and graphs) summarizes preliminary findings from surveys performed from 2017 to 2019 and compared with findings from 2016 surveys.

1.1 STUDY AREA

Fish inventory monitoring focused on the defined aquatic Local Study Area (LSA), specifically Gold Creek and Blairmore Creek mainstems.

Other fisheries and aquatics information prior and up to 2016 is provided in the Fisheries and Aquatics Technical Baseline Report dated December 2016 (Hatfield, 2016).

2.0 METHODS

Fish inventory surveys were performed to monitor WSCT: (1) presence and distribution, (2) seasonal habitat use, and (3) relative abundance. All surveys were conducted by way of direct visual observation (i.e., snorkel surveys) and occurred during three time periods: WSCT spring spawning, summer rearing, and overwintering seasons.

2.1.1 Snorkel Surveys

Where habitat conditions permitted, snorkel surveys were conducted throughout Gold Creek and Blairmore Creek mainstems, following the methodology described by O'Neal (2007). In reaches where depths were greater than 40 cm, a snorkeler swam in an upstream direction against the current counting the fish as they swam by to avoid double counting. The snorkeler swam in a zigzag pattern across the margins of the stream, paying particular attention to potential hiding places, such as large boulders or woody debris. All the fish observed were tallied and assigned a fork length class at 10 cm intervals. Data were recorded by a stream bank assistant, who also monitored the swimmer's safety. Snorkel surveys were repeated 2016 to 2019, focusing on multiple seasons and life-history strategies including: spring spawning surveys, summer rearing/population surveys, and overwintering surveys conducted in October.

2.1.2 WSCT Spring Spawning Surveys

The objectives of the spring spawning surveys were to: (1) monitor WSCT spawning activity during two periods targeting elevational changes in conjunction with the descending limb of the hydrograph and optimal temperature when WSCT are known to reproduce, and (2) document spawning habitat and activities based on observations of mature individuals displaying spawning morphological and colour characteristics. Other WSCT observed that were not involved in reproductive activity were noted. No spawning surveys were completed in 2017.

Spawning surveys can prove challenging due to timing fluctuation of the spawning event between streams and between years within the same stream based on the variation of environmental conditions. Complexities are compounded by the potential short duration of the event and in turbid watercourses where redds can be covered with sediment shortly post-spawn. Streambank observations can be inaccurate, especially for WSCT, as they will often spawn in areas under cover, including deep undercut banks and large woody debris (LWD). Therefore, snorkel surveys were conducted within select macrohabitat reaches to verify location, timing, and elevational extent of WSCT spawning. Number of fish in spawning condition as well as numbers of paired fish were recorded. Surveyed stream lengths were recorded so that estimated spawning densities could be calculated, and spawning areas identified, where possible. Redds were not counted, given the challenges associated with their identification with any confidence. A mature WSCT was an individual displaying morphological and colour characteristics associated with spawning WSCT (e.g., intense colouration, rose-tinted belly). Two mature adults together and over top of spawning gravels were classified as a pair. Reach selection was based on access or availability of suitable habitat. Reaches were excluded in some cases due to poor spawning habitat, low fish densities, or was outside of the designated federal critical habitat or provincial conservation designation for WSCT.

2.1.3 WSCT Summer Population Surveys

Following 2016, relative abundance estimates were compiled through ongoing snorkel surveys, per described.

Snorkeling was conducted in an upstream direction, documenting all WSCT and assigning fork-length. In areas with high fish counts, the snorkeler revisited the site multiple times to verify count estimates and size-bin accuracy. Using a Garmin GPS, the boundaries of each sample site were recorded enabling stream length to be used to calculate fish density (not yet completed).

2.1.4 WSCT Overwintering Surveys

Overwintering surveys have presented many challenges to biologists, especially in the region of this project where winter temperatures and snowfall keep streams frozen and covered in deep snow throughout the winter months (Lotic Environmental 2015). These conditions make streambank observations ineffective. To address sampling limitations, surveys were scheduled at the earliest possible date prior to ice up and snow accumulations (October) following the assumption that water temperatures and stream flows would be sufficiently reduced to induce movement of fish into winter habitats (Jakober et al. 1998). We employed snorkel survey methods to collect quantifiable data with respect to fish abundance, size class, distribution, and overall overwinter habitat quality and quantity in both Blairmore and Gold creeks. For overwintering habitat with high fish abundance (i.e., pools), surveys were repeated to confirm accuracy of fish counts.

Overwintering surveys were completed in 2017, 2018 and 2019. In contrast to spawning and summer population surveys, overwintering surveys targeted pools deep enough to be classified as overwintering habitat. Overwintering pools were surveyed each year; additional reaches in both watercourses were included to the surveys commencing in 2018.

3.0 RESULTS

Preliminary analysis of snorkel survey data is provided in the following section. Data collected in 2016 has been included (where applicable) for comparison.

3.1 SPRING SPAWNING SURVEYS

Fish were characterized as mature when they displayed morphological characteristics associated with spawning fish and/or spawning behaviours. The late spawning window surveys targeted the smaller WSCT in the upper headwaters populations, as WSCT have been found to be sexually mature at 11 cm and 15 cm fork-length (FL), male and female, respectively (Downs, White and Shepard 1997).

During spawning surveys all WSCT observed were recorded, in addition to mature spawning individuals. The ratios of mature WSCT were calculated (Table 1) and visually presented in Figure 1 and Figure 2 per survey, per year, and per watercourse.

Table 1 WSCT observed during snorkel surveys comparing total WSCT and mature fish observations during early and late spring spawning windows.

Stream	Year	Timing	Total WSCT	Total Mature*	% Mature
Blairmore	2016	early	255	55	22
		late	428	27	6
	2017	no data	n/a	n/a	n/a
		no data	n/a	n/a	n/a
	2018	early	235	15	6
		late	153	2	1
	2019	early	125	14	11
		late	154	10	6
Gold	2016	early	64	35	55
		late	151	21	14
	2017	no data	n/a	n/a	n/a
		no data	n/a	n/a	n/a
	2018	early	48	6	13
		late	10	2	20
	2019	early	17	3	18
		late	6	3	50

*Note: Fish larger than 11 cm were considered mature fish, depending upon morphological characteristics.

Figure 1 Mature WSCT observed in Gold Creek during spring spawning (early and later spring) by year. No surveys were conducted in 2017.

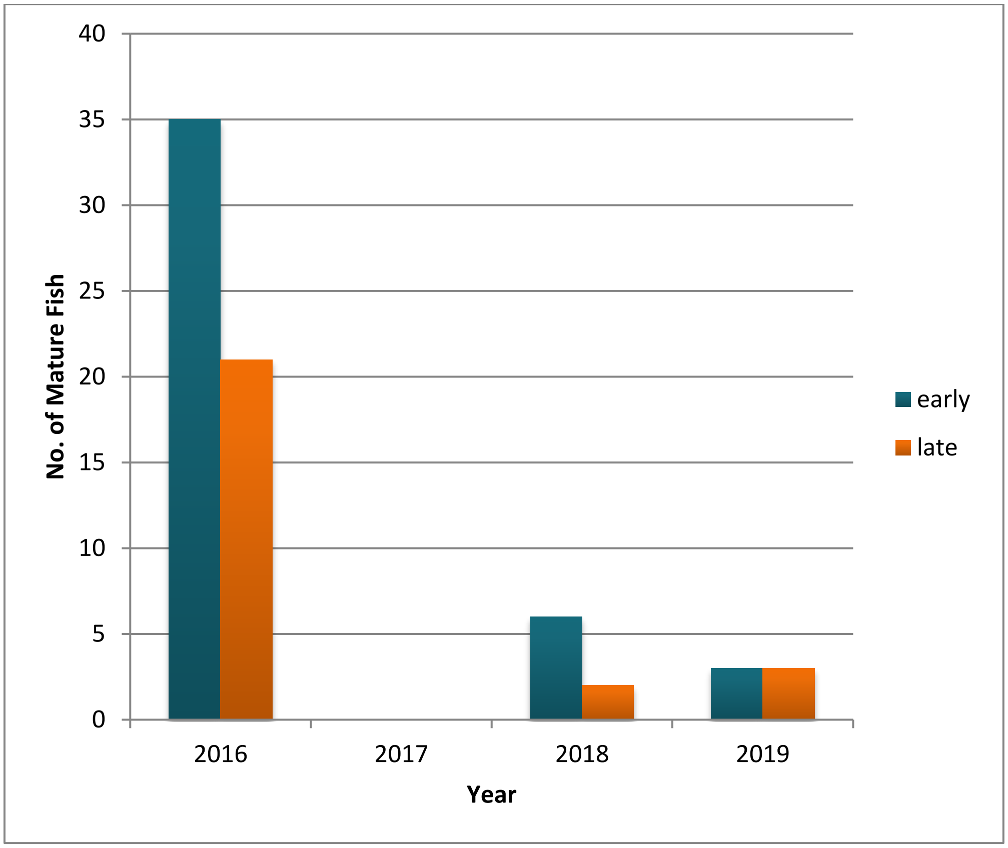
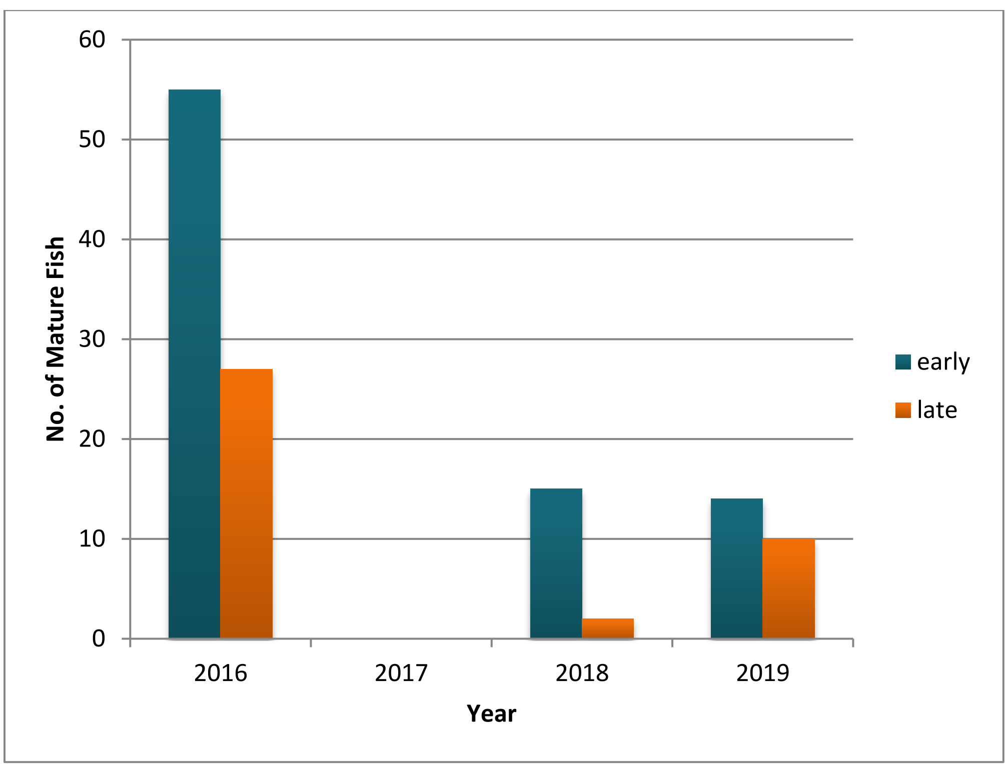


Figure 2 Mature WSCT observed in Blairmore Creek during spring spawning (early and later spring) by year. No surveys were conducted in 2017.



3.2 SUMMER POPULATION SURVEYS

Relative abundance of WSCT observed during summer rearing snorkel surveys per year is presented in Table 2, Figure 3, and Figure 4, below.

Table 2 Relative abundance of WSCT by fork-length (FL) enumerated through summer snorkel surveys in Gold and Blairmore creeks: 2016–2019.

Stream	Year	Fork Length (cm)				
		<20	20+	30+	40+	Total
Gold	2016	160	230	102	6	498
	2017	12	34	7	1	54
	2018	24	18	2	1	45
	2019	33	10	1	0	44
Blairmore	2016	645	230	42	5	922
	2017	323	32	6	2	363
	2018	147	19	1	0	167
	2019	169	117	4	1	291

In 2017, a decline in WSCT abundance was observed in both Blairmore and Gold creeks. In Gold Creek, the stock has declined further post-2017 (see Figure 3) where the stock in Blairmore Creek appears to be recovering since the lowest relative abundance observed in 2018 (see Figure 4 and Figure 5).

The cause of the observed decline is unknown at this time; however, these observations were made following an extended and atypical low flow period in 2016.

Figure 3 Relative abundance of WSCT observed during index site snorkel surveys by fork-length class (cm) for Gold Creek: 2016–2019.

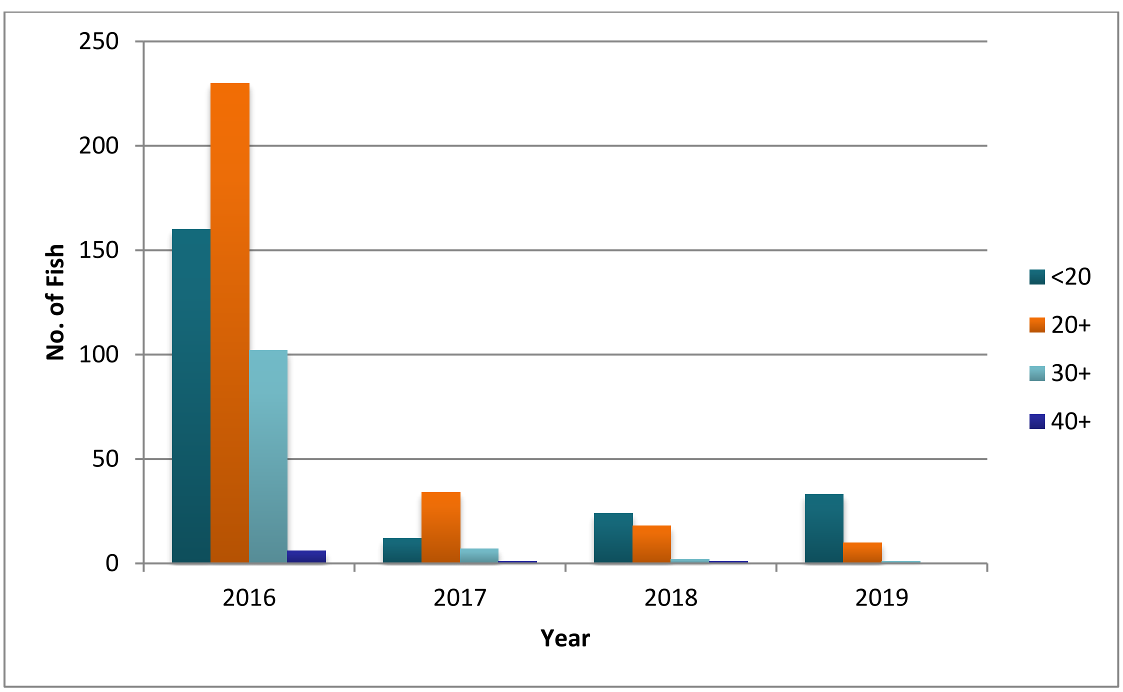


Figure 4 Relative abundance of WSCT observed during index site snorkel surveys by fork-length class (cm) for Blairmore Creek: 2016–2019.

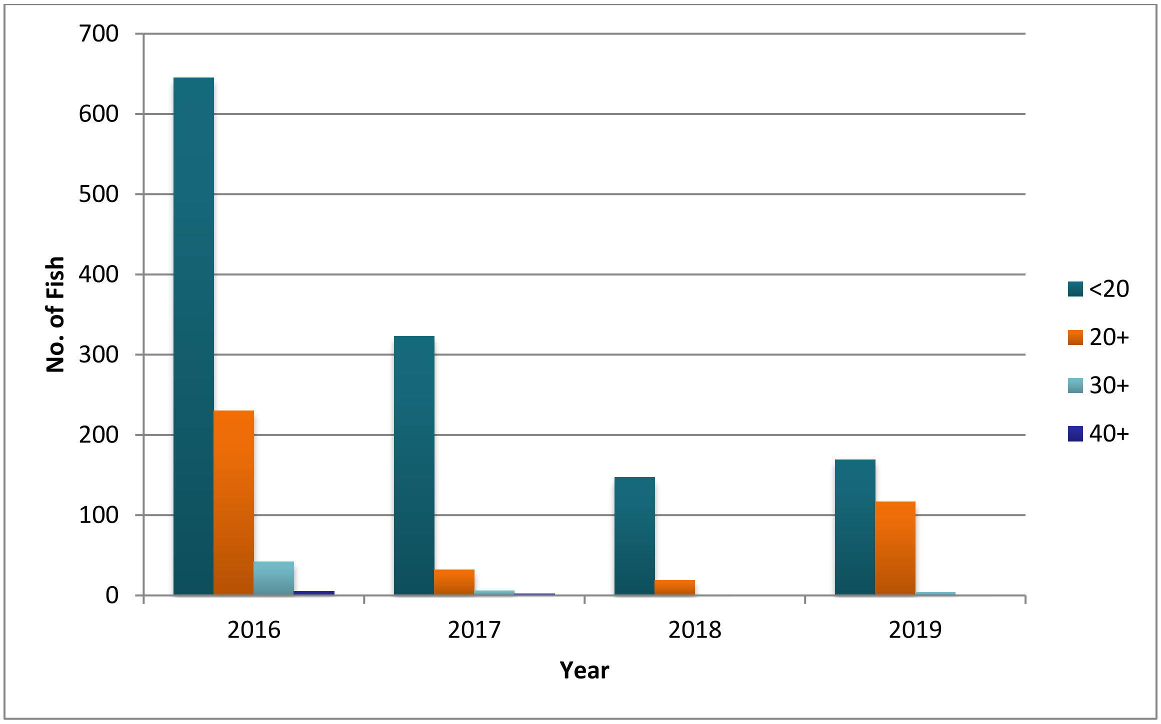
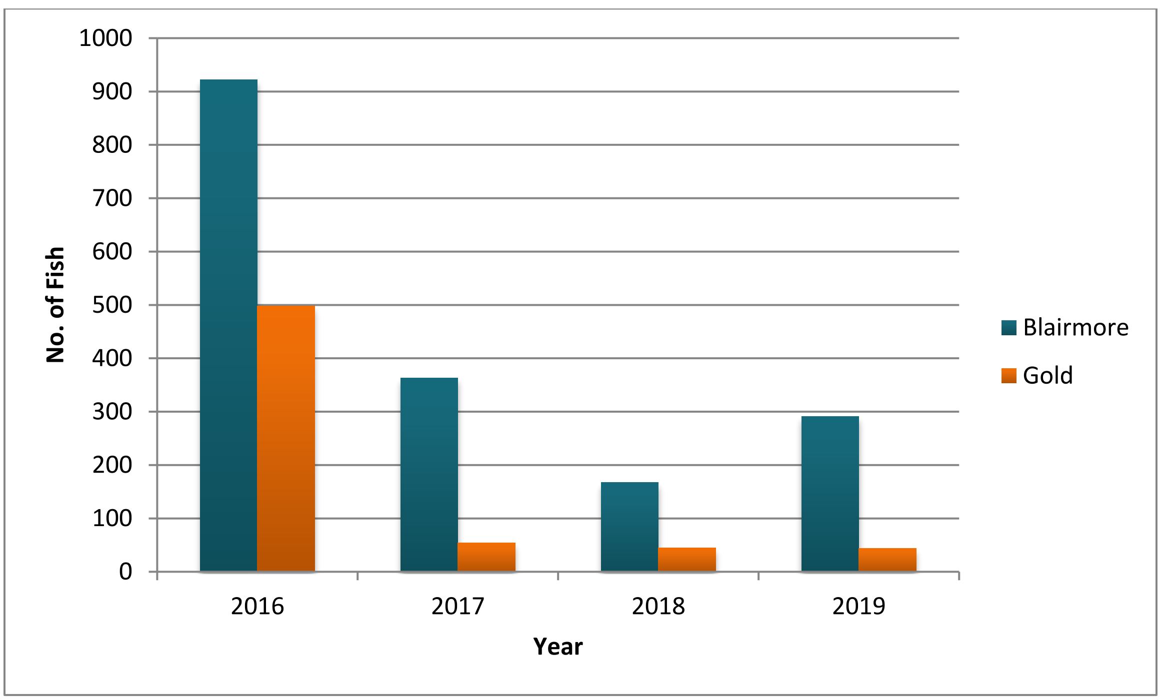


Figure 5 Comparison of relative abundance of WSCT observed in Blairmore and Gold creeks during index site snorkel surveys, 2016–2019.



3.3 OVERWINTER SURVEYS

Overwintering surveys were conducted in 2016-2019 in October each year. These surveys were expanded upon in 2018 and 2019 in response to the observed population decline. Locations and names of all overwintering pools were documented (see Table 3), however, due to weather conditions and accessibility issues overwintering index sites (see Table 4 and Table 5) were chosen for annual repeat surveys.

Table 3 Identified overwintering pools in Gold and Blairmore creeks, 2016–2019.

Gold		
Name	Easting	Northing
Lower-1	688474	5502281
Lower-2	688610	5502288
Lower-3	688562	5502185
Lower-4	688834	5501862
Green-1	688601	5501078
Green-2	688586	5501121
Green-3	688616	5501232
Green-4	688642	5501239
above green	688474	5502281
above green	688562	5502185
above green	688834	5501862
above green	688610	5502288
below faery-morin	688556	5502180
EB pond	688481	5502252
above foot bridge	688402	5502336
Faery	688193	5502564
OH spruce	687791	5502851
Braid-1	687521	5503312
Braid-2	687488	5503540
Braid-3	687478	5503771
Braid-4	687487	5503794
Cory's	687388	5504402
Picnic	687625	5504849
Bedrock 1	687682	5504970
Bedrock 2	687508	5503994
Bridge	687827	5506062
100 fish pool	687869	5506458

Blairmore		
Name	Easting	Northing
Bedrock I	684743	5504070
Bedrock II	684776	5504262
root wad	684883	5504707
Ford	684930	5504917
Bone	684910	5505504
Pocket	684908	5505510
above Ex to RR	684658	5506905
PBR	684524	5507194
upper 01	684504	5507761
upper 02	684249	5508254
upper 03	684247	5508327
upper 04	684197	5508497
upper 05	684156	550857
upper 06	683906	5508680
upper 07	683558	5509001
double log pool	683502	5509046
BCT09	682892	5509234
below blue bridge	683013	5509765

Table 4 WSCT observed in Blairmore Creek at overwintering index sites. Where n/d = not surveyed and therefore no data available. Surveys were conducted October 20-23 2016, October 21-24 2017, October 19-24 2018, October 5-7, 16 2019.

Blairmore				
Name	2016	2017	2018	2019
Bedrock 2	130	54	32	56
Ford	23	n/d	n/d	38
Pocket	0	65	n/d	n/d
Bone	74	31	41	65
PBR	n/d	n/d	80	58

Table 5 WSCT observed annually in Gold Creek across overwintering index sites. Where noted n/d = not surveyed. Surveys were conducted October 20-23 2016, October 21-24 2017, October 19-24 2018, October 5-7 & 16 2019.

	Gold			
Name	**2016**	**2017**	**2018**	**2019**
Green-1	0	n/d	0	0
Green-2	0	n/d	2	1
Green-3	0	n/d	0	0
Green-4	0	n/d	0	0
Faery	0	1	0	0
OH spruce	n/d	n/d	53	32
Cory's	28	0	0	0
Picnic	26	1	0	1
Bedrock 1	5	0	0	0
Bedrock 2	23	0	0	0
Bridge	2	0	n/d	n/d
100 fish pool	110	15	49	21

n/d = not determined

In 2017, a decline in overwintering WSCT was observed in Gold Creek (Figure 6). As of 2017, mature fish over 40 cm in fork-length (FL) were not observed in overwintering sites in Gold Creek (Figure 7). A modest increase of WSCT was observed in 2018, reflecting the increase observed in the overall relative abundance in 2018. In 2019, the number of observed WSCT was lower than 2018 abundance estimates.

Figure 6 Total WSCT observed in Gold Creek during overwintering surveys, 2016–2019.

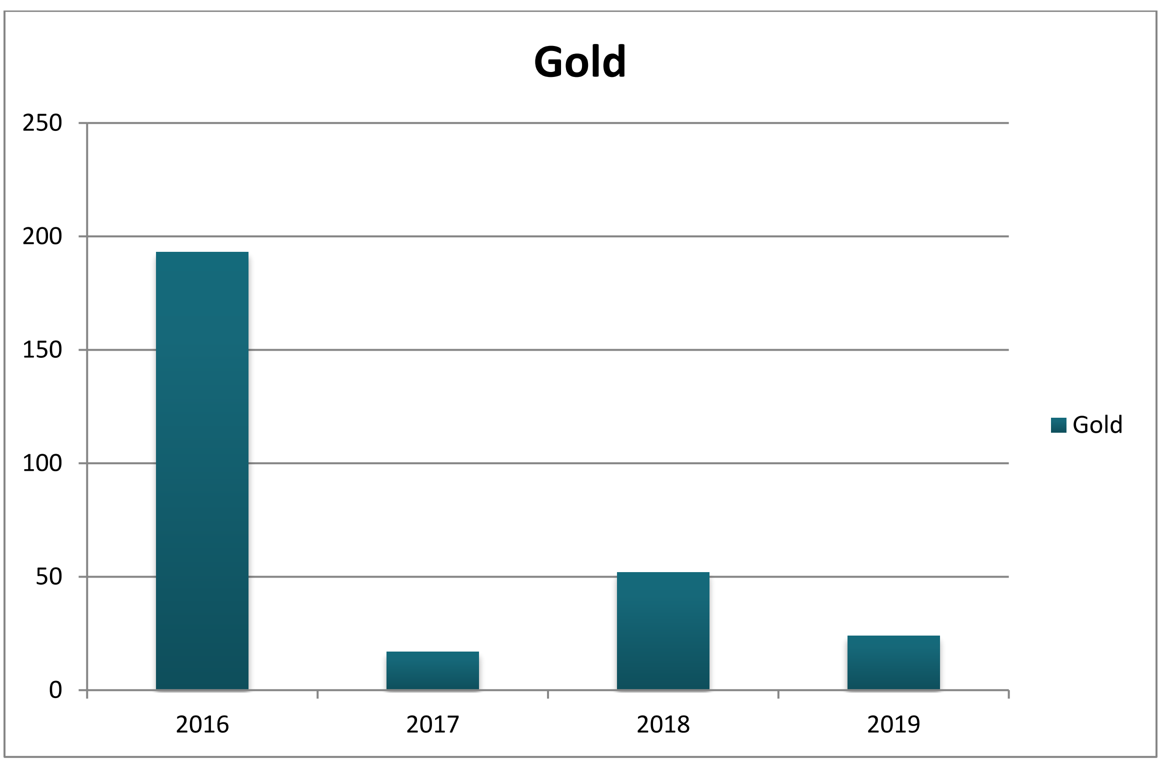
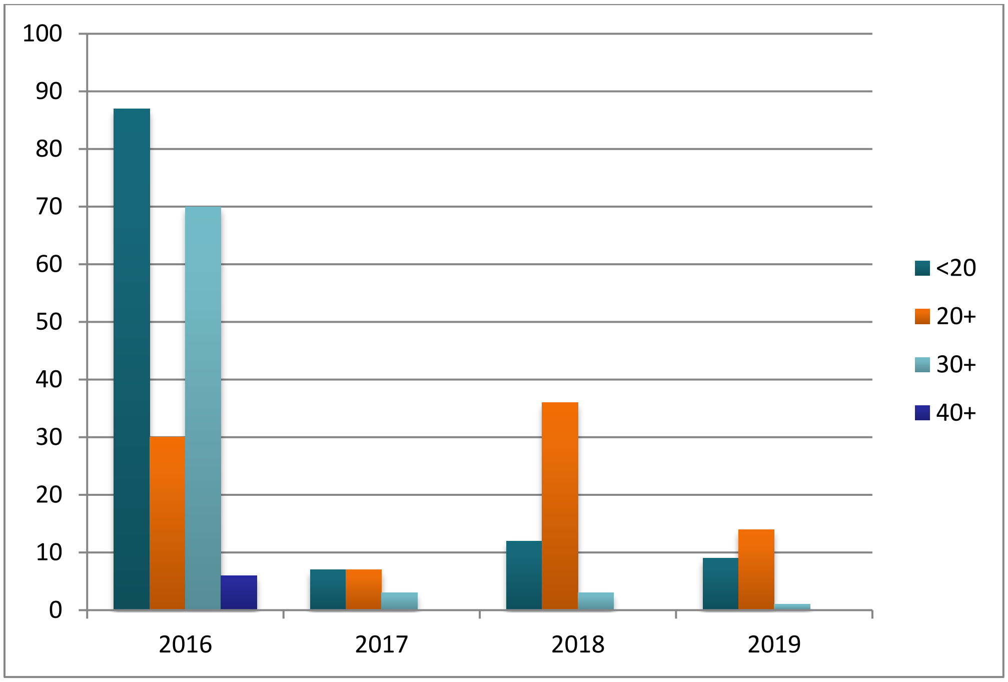


Figure 7 Total WSCT observed in Gold Creek during overwinter surveys based on fork-length (FL), 2016–2019.



In Blairmore Creek, WSCT observed during overwintering surveys declined in 2017, and 2018 (Figure 8). In 2019, abundance of WSCT appears to have increased, which aligns with summer abundance estimates/observations (Table 2; Figure 3 and Figure 4). The sharpest demographic decline was observed in mature 30+ and 40 cm (FL) WSCT in 2017 and continued throughout surveys in 2018 and 2019. After 2016, 40cm+ WSCT were not observed in Blairmore Creek (Figure 9).

Figure 8 Total WSCT observed in Blairmore Creek during overwintering surveys, 2016–2019.

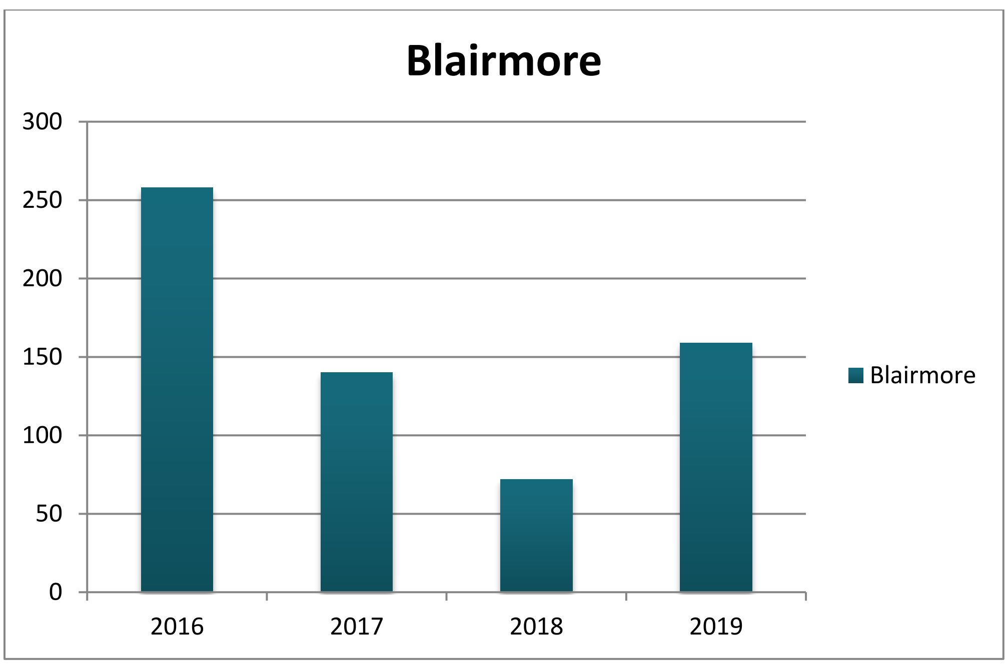
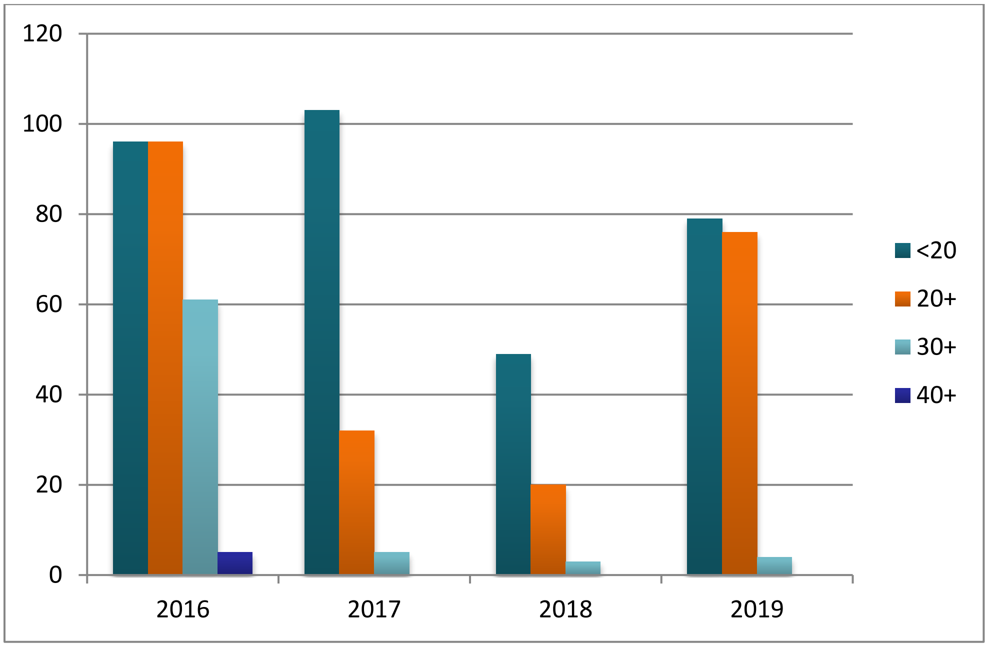
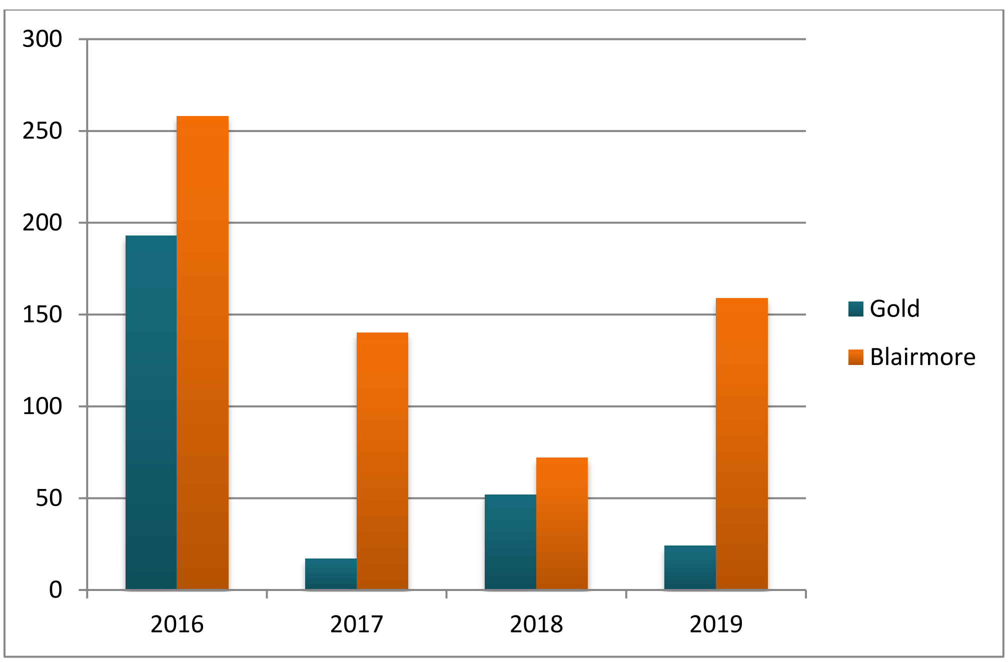


Figure 9 WSCT observed in Blairmore Creek during overwintering surveys annually and by fork-length (FL), 2016–2019.



A comparison of overwintering survey results in Blairmore and Gold creeks is further suggestive of the struggles WSCT experience in Gold Creek (Figure 10), likely due to a number of underlying local/limiting factors (e.g., cold water temperatures, habitat disturbance, movement obstructions etc.).

Figure 10 Comparison of WSCT observed in Blairmore Creek and Gold Creek during overwintering surveys, 2016–2019.



4.0 REFERENCES

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CANADIAN PARKS AND WILDERNESS SOCIETY
SOUTHERN ALBERTA CHAPTER

c/o Canada Olympic Park
88 Canada Olympic Way SW
Calgary, AB, T3B 5R5

July 30, 2020

SENT ELECTRONICALLY

Osler, Hoskin & Harcourt LLP
Suite 2500, TransCanada Tower
450 – 1st Street S.W.
Calgary, Alberta, Canada T2P 5H1

Re: CPAWS Request for information relating to the Grassy Mountain Coal Project (80101) to prepare for hearing

This is a request for information pursuant to the *Alberta Energy Regulator Rules of Practice* to use in preparation for the hearing for the Grassy Mountain Coal Project.

(1) In Addendum 8, in response to Information Request 13. AER-R2-13 (b) (Addendum 8, page 171-173) Benga wrote "In 2017, Benga launched the first of a planned series of selenium and nitrate attenuation trials aimed at proving the proposed treatment concept and informing engineering design of the fullscale system."
Benga provided the results of the first trial in Addendum 8, Appendix C-2. In Addendum 10 (Package 5, IR 5.5 and 5.8) Benga referred to an on-going column test for selenium and nitrate attenuation.

- Please provide the results of the column test and any further selenium and nitrate attenuation trials that have been undertaken, or descriptions of the further selenium and nitrate attenuation trials Benga has not yet carried out but has already planned.

(2) In Addendum 11, pages 13-19. In responding to Information request 6.3, Benga provided Table 6.3-1 providing estimates of provincial and federal income tax for metallurgical coal prices of 100$, $140, and $200 USD/Tonne.

- Please provide the spreadsheet or other document that shows how Benga calculated these estimates.

(3) Also in Addendum 11, on page 14 and Figure 6.31, Benga relied on a Wood Mackenzie report to estimate the future price of hard coking coal. Benga specified that they are not able to provide a copy of the Wood Mackenzie report due to confidentiality and copyright restrictions.

- Please provide information from the Wood Mackenzie report that sets out the required coal quality attributes for the hard coking coal that is the subject of Wood Mackenzie's benchmarking and price estimate, and any discount levels for coal quality attributes below the benchmark.

If this information is already included or available in the EIA, please identify where. If you dispute the relevance of any of this material, or are otherwise unable to provide it to CPAWS, let me know promptly so that CPAWS can determine if the issue should be considered and decided by the Joint Review Panel.

In order to comply with the *Alberta Energy Regulator Rules of Practice* requirement to file and serve information requests and responses to them and preserve the public nature of the hearing process, CPAWS intends to have this letter placed on the IAA registry. CPAWS proposes that Benga post their replies to information requests (including CPAWS's previous information request) on the public registry as well.

Sincerely,

<Original signed by>

Drew Yewchuk
Staff Lawyer
Public Interest Law Clinic

Osler, Hoskin & Harcourt LLP
Suite 2500, TransCanada Tower
450 – 1st Street S.W.
Calgary, Alberta, Canada T2P 5H1
403.260.7000 MAIN
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OSLER

Calgary
Toronto
Montréal
Ottawa
Vancouver
New York

August 13, 2020

Martin Ignasiak
<contact information removed>

SENT BY ELECTRONIC MAIL

Canadian Parks and Wilderness Society (CPAWS)
Southern Alberta Chapter
c/o Canada Olympic Park
88 Canada Olympic Way SW
Calgary AB T3B 5R5

Attention: Drew Yewchuk, Staff Lawyer, Public Interest Law Clinic

Dear Mr. Yewchuk:

Re: Benga Mining Limited ("Benga")
CEAA Reference 80101
Grassy Mountain Coal Project ("Project")
Response to CPAWS July 30, 2020 Information Request

We write in response to your Information Request ("IR") dated July 30, 2020.

<u>CPAWS IR #1:</u>

> Please provide the results of the column test and any further selenium and nitrate attenuation trials that have been undertaken, or descriptions of the further selenium and nitrate attenuation trials Benga has not yet carried out but has already planned.

Benga Response to IR #1

Please find attached a report prepared by Geosyntec Consultants International, Inc. dated May 2020 entitled "Laboratory Study Report Column Study to Evaluate Treatment of Nitrate and Selenium in Mine Water Using Gravel Bed Reactor Grassy Mountain Project, Alberta".

<u>CPAWS IR #2:</u>

> Please provide the spreadsheet or other document that shows how Benga calculated these estimates.

Benga Response to IR #2

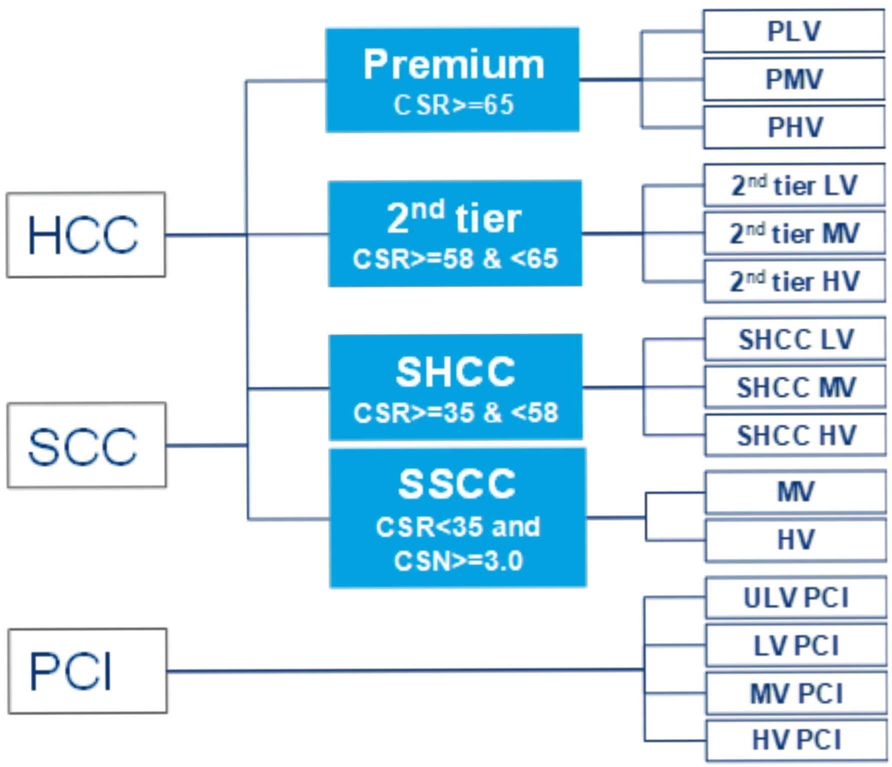
In IR Response 6.3 Benga provided many of the key assumptions it relied on to calculate the values shown in Table 6.3-1, including capital expenditures, annual operating expenses, Alberta coal royalty structure, federal and Alberta tax structure and exchange rate. These assumptions are all in the public domain or already identified as part of the Project Application. In addition to these assumptions, the spreadsheet Benga used to calculate the values shown in Table 6.3-1 contains proprietary and confidential information that is commercially sensitive, including but not limited to assumptions regarding costs of equipment and labour. Disclosure of this information, which Benga has historically treated as confidential, will harm Benga's competitive position. Therefore, Benga is not willing to provide its internal and confidential working model. However, to the extent that CPAWS has specific questions regarding any of the assumptions used by Benga in calculating the values shown in Table 6.3-1, Benga will consider its ability to respond to those questions upon receipt of them.

CPAWS IR #3:

> Please provide information from the Wood Mackenzie report that sets out the required coal quality attributes for the hard coking coal that is the subject of Wood Mackenzie's benchmarking and price estimate, and any discount levels for coal quality attributes below the benchmark.

Benga Response to IR #3

Benga has contacted Wood Mackenzie which has confirmed that the specification used for their premium hard coking coal benchmark price is primarily based on a CSR (coke strength after reaction) greater than 65. Benga expects the Grassy Mountain Project product to meet this criterion and to be low to medium volatility (between PLV and PMV). Any discount to this price for differences in coal and coke quality, would be subject to specific and confidential commercial negotiations between customers and suppliers. The following diagram better describes the different qualities of coking coal used by Wood Mackenzie.



CONCLUSION

Benga is not relying on any of these responses in support of its application and will therefore not be posting this letter on the registry. To the extent your client seeks to rely on any of these responses, it may refer to them in its evidence.

Yours truly,

<Original signed by>

Martin Ignasiak

Attachment

c: Mr. Gary Houston

engineers | scientists | innovators

Laboratory Study Report

Column Study to Evaluate Treatment of Nitrate and Selenium in Mine Water Using Gravel Bed Reactor

Grassy Mountain Project, Alberta

Prepared for:

Benga Mining Limited
PO Box 660
12331 20th Avenue,
Blairmore AB T0K 0E0

Prepared by:

Geosyntec Consultants International, Inc.
1243 Islington Avenue, Suite 1201
Toronto, Ontario M8X

Ref: TR0778B
May 2020
Rev. 1

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<	less than
%	percent
BAL	Brooks Applied Labs
°C	degrees Celsius
$CaCO_3$	calcium carbonate
CO_2	carbon dioxide
cm	centimetres
DO	dissolved oxygen
ft	feet
ft/day	feet per day
g	grams
g/L	grams per litre
GC	gas chromatography
Geosyntec	Geosyntec Consultants International, Inc.
GBR	gravel bed reactor
h	hours
IC	ion chromatograph
k	rate constant
L	litre
µL	microlitres
mg/L	milligrams per litre
mg $CaCO_3$/L	milligrams of calcium carbonate per litre
mM	millimolar
min	minute
mL	millilitres
mL/min	millilitres per minute
mV	millivolts
N_2	nitrogen gas
NGS	Next Generation Sequencing
NO_3	nitrate
ORP	oxidation reduction potential
PO_4	phosphate
PV	pore volume
QL	quantitation limits
RO	reverse osmosis
RPM	rotations per minute
Se	selenium
SGS	SGS Laboratory
SiREM	SiREM Laboratories
VFA	volatile fatty acids

1 Introduction

Geosyntec Consultants International Inc. (Geosyntec) was retained by Benga Mining Limited (Benga) o/a Riversdale Resources Ltd. to complete a laboratory treatability study to assess the potential use of a gravel bed bioreactor (GBR) to treat nitrate and selenium (Se) in water at the Grassy Mountain Project, Alberta (the Site). The study was performed by SiREM Laboratory (SiREM), a division of Geosyntec, under guidance and supervision from Geosyntec.

A GBR is a fixed-film bioreactor, whereby an engineered bed of gravel or crushed rock media is placed in a lined cell or container to support the growth and activity of microbes and biofilms that possess the ability to biodegrade or immobilize contaminants that may be present in surface water and/or groundwater. To treat nitrate and selenium in water, carbon-based electron donors and nutrients are added to the water to promote biological reduction of the nitrate and selenium within the GBR. Nitrate is reduced via nitrite to dinitrogen gas, a process referred to as nitrate reduction or denitrification. Selenate [Se(VI)] and selenite [Se(IV)], the predominant forms of selenium present in mine-impacted waters, are reduced to elemental selenium [Se(0)], which is generally immobile. Elemental selenium is expected to precipitate within the GBR media and is retained within the biomass and as solid surface precipitates.

The biological reduction reactions for nitrate and selenium are well documented (Rivett et al., 2008; Zhang et al., 2008), however, site specific GBR design parameters such as degradation rates need to be optimized for site conditions, including the type of crushed rock used in the GBR, influent concentrations of nitrate and selenium, geochemical composition of the treated water, operating temperatures and type and dosing of the electron donor. This study was designed to evaluate several variables related to site-specific conditions to inform a well-defined GBR field design specification, limit the uncertainty and streamline the subsequent field testing.

The remainder of this report summarizes:

- Study objectives (Section 2);
- Experimental methods (Section 3);
- Study results (Section 4);
- Study conclusions (Section 5); and
- Report references (Section 6).

2 Study Objectives

The primary objectives of the study were:

- Establishment of optimal electron donor form/dose and residence time for stimulation of denitrification and Se reduction;
- Assessment of treatment performance at operating temperatures of 8°C and 4°C.
- Evaluation of the effect of underdosing and overdosing electron donor on the nitrate and Se treatment efficacy;
- Evaluation of performance under ranging influent concentration scenarios, including 40 to 200 mg/L of nitrate and 150 ug/L to 1,000 µg/L of Se; and
- Evaluation of biofouling and mitigation techniques on the performance of the column.

3 Experimental Methods

The scope of work completed to satisfy the project objectives is described in this section.

3.1 Column Test Set-up

3.1.1 Rock Material Collection and Preparation

On 17 September 2018, rock material from the Site was collected by Benga. Waste rock samples of weathered rock at the surface were collected from the following lithologies: conglomerate, sandstone, and mudstone of the Cadomin and Kootenay formations. The material was received by SiREM on 21 September 2018. The Chain of Custody for the geological material received from the Site is provided in **Appendix A**.

The site rock material consisted of fragments approximately 17 cm x 7 cm x 2.5 cm in size. The material was crushed to a uniform size ranging from 1.5 to 2.5 cm, which is in the range of size recommended for GBR matrix material. The crushing was performed at Peto MacCallum Ltd. (Kitchener, ON) using a hydraulic press. The crushed rock material was rinsed with reverse osmosis (RO) water for 30 minutes (min) to remove dust particles that could clog the column, and air dried for 48 hours.

3.1.2 GBR Column Construction

Figure 1 provides a schematic of the column setup. The column was constructed of Plexiglas™ with a length of 50 centimeters (cm) and an internal diameter of 10 cm. Two sampling ports were positioned vertically along the central axis of the column at distances of 16.7 cm (A) and 33.3 cm (B) from the inlet end of the column.

The sampling ports within the column were constructed using a nylon Swagelok compression fitting tapped into the column. 19-gauge needles that reached the center of the column were positioned through the fitting and secured by tightening the ferrules. Glass wool was threaded through the needles to ensure minimal particulates from entering the samples. Each sample port was then fitted with a Luer-Lock™ fitting so that a glass syringe could be attached to the port for collection of liquid samples.

On 9 October 2018, the column was packed with 100 percent (%) crushed granular rock matrix. To ensure a homogeneous material bed, the column was packed vertically in 500-gram (g) increments. The column was then purged with carbon dioxide (CO_2) for 30 min, to prevent creation of air pockets during column saturation, and then saturated with deionized (DI) water. Values of bulk density, porosity, and pore volume (PV) were determined by weight, and are provided in **Table 1**.

3.1.3 Influent Water

Influent water for the column was prepared using laboratory grade chemicals to mimic Site water chemistry, including 290 mg/L calcium (Ca^{2+}), 170 mg/L mangnesium (Mg^{2+}), 990 mg/L sulphate (SO_4^{2-}) and 240 mg/L carbonate (CO_3^{2-}). Sodium nitrate ($NaNO_3$) and sodium selenate (Na_2SeO_4)

were also added to the groundwater at varying concentrations throughout the study to match the anticipated concentrations of nitrate and Se in the Site water. The target influent nitrate and selenium concentrations used in the various experimental phases of the study are shown in **Table 2**. The artificial groundwater was prepared in bulk and periodically siphoned into a 10 liter (L) Tedlar® bag with two Swagelok fittings with Teflon® septa. The Tedlar® bag was the influent reservoir for the column.

3.2 GBR Column Operation

The column operated for a period of 15 months, from 11 October 2018 to 28 January 2020. Over this time, operating variables were modified to satisfy the outlined project objectives. The variables were residence time, temperature, nitrate concentration, selenium concentration, electron donor (carbon) type, and concentrations. A schedule of the experimental phases that were tested during the operating period can be found in **Table 2**.

The test was subdivided into the following experimental phases:

1. Startup: 22℃, 40 mg/L NO3-N, 150 µg/L Se.
2. Electron donor (carbon) underdosing: 8℃, 40 mg/L NO3-N, 150 µg/L Se.
3. Optimal carbon dosing: 8℃, 40 mg/L NO3-N, 150 µg/L Se.
4. Optimal carbon dosing: 4˚C, 40 mg/L NO3-N, 150 µg/L Se.
5. Carbon overdosing: 8℃, 150 µg/L Se, increase in nitrate concentration to between 100 and 200 mg/L.
6. Carbon overdosing: 8℃, nitrate at 150 mg/L and Se at 1,000 µg/L.

Phases 1 and 2 were performed using methanol as the electron donor/carbon source. The remaining phases used sodium lactate as the electron donor/carbon source to promote broader microbial activity. The carbon dosing conditions are described below.

3.3 Amendments

The influent was continuously dosed with methanol or sodium lactate using a single syringe infusion pump (Cole-Parmer). This was achieved by inserting a plastic BD syringe (Fisher Scientific) with a 21-gauge needle into a section of Viton® tubing. Neat methanol was used to amend the column from 6 November 2018 to 22 March 2019. A 40% sodium lactate solution was used from 22 March 2019 until the end of the study.

The dosing rate of carbon sources (i.e., methanol and sodium lactate) varied in the test phases to simulate operating varying conditions (**Table 2**). The carbon dosing was normalized to the electron demand from the influent concentrations of dissolved oxygen (DO) and nitrate. The operating conditions tested included:

- Carbon underdosing. The concentration of carbon source equalled x1 or less electron demand from DO and NO3-N.
- Optimal carbon dosing. The concentration of carbon source equalled x1.5 of electron demand from DO and NO3-N.

- Carbon overdosing. The concentration of carbon source equalled x2 or more of electron demand from DO and NO3-N.

The objective of testing various carbon source dosing ratios was to simulate operating conditions in a GBR where concentrations of DO and/or nitrate may change rapidly, and that the dosing is not adjusted immediately.

Sodium phosphate was added to the influent reservoir at a concentration of approximately 1 to 4 mg/L. Yeast extract was amended directly into the column to provide additional nutrients, and to avoid fouling of the influent line. The target concentration in the column was 1 mg/L of yeast extract, thus 0.5 mL of the stock solution was injected into port A and port B and dispersed with approximately 2 mL of artificial groundwater from the reservoir. Amendments of yeast extract began on 16 November 2018. From 4 March 2019 the column was amended with yeast extract on a weekly basis.

3.3.1 Flow Rate and Temperature

A Masterflex® peristaltic pump was used to feed the artificial groundwater from the reservoir through the column in an upward flow direction. The pump tubing consisted of Viton® 2-stop tubing. All other tubing was 1/8-inch interior diameter Teflon® tubing. The flow rate was modified by adjusting the speed of the peristaltic pump to achieve a total residence time in the column varying from 2 to 10 days (**Table 2**).

Initially the column was operated at ambient room temperature (Phase 1). After 14 December 2018, the column and influent reservoir were operated in a Lab-line Instruments Inc. incubator to achieve the target operating temperature of 8° C (Phases 2, 3, 5 and 6) (**Figure 2**). The temperature was temporarily lowered to 4° C during Phase 4 of the test to assess nitrate and selenium reduction at lower temperatures.

3.4 Column Sampling Methods

The column was sampled for pH, Oxidation Reduction Potential (ORP), and anions on a weekly basis to monitor the establishment of reducing conditions and reduction of nitrate. Methanol and total volatile fatty acid (VFA) concentrations were also measured on a weekly basis to monitor the consumption of electron donor throughout the column.

Once denitrification was established, samples for total Se analysis were added to the weekly sampling protocol to monitor Se reduction. At select timepoints, Se speciation samples were collected to further characterize the Se reduction products.

After removing the stagnant water from the sampling needles, liquid samples were collected from the column sampling ports, the influent, and the effluent using glass on glass syringes. 1.5 mL of that sample were immediately transferred into a 5 mL plastic vial for ORP measurement. 0.5 mL were transferred to a 1.5 mL Eppendorf tube for pH and anion (total VFA, chloride, nitrate/nitrite, sulfate and phosphate) analysis. These samples were stored frozen until the time of analysis. During the period that methanol sampling was conducted, 2 mL of the sample were transferred into a liquid gas chromatography (GC) vial for methanol analysis.

Liquid samples for total metals analysis, including total Se were collected from the column sampling ports, the influent, and the effluent. When the sample was unfiltered, it was collected directly into a plastic vial containing nitric acid to acidify the sample to a pH of 2 for preservation purposes. When the sample was filtered, it was collected in a glass beaker and then filtered using either a 0.45 µm nylon filter (Wyvern Scientific Inc.) or 0.22 µm polyether sulfone Sterivex filter (MilliporeSigma) into the plastic vial containing nitric acid.

Samples were collected periodically for Se speciation for analyses for Se(VI) and Se(IV) at SGS (SGS, Lakefield, Ontario) and for detailed organic/inorganic Se speciation at Brooks Applied Labs (BAL, Bothell, WA). These samples were unfiltered and unpreserved. When using SGS, the samples were express shipped on the same day as collection. When using BAL, the samples were frozen to -80 °C prior to express shipping. Major anion samples for SGS were collected unfiltered and unpreserved directly into an amber glass bottle.

Next generation sequencing (NGS) samples were collected for characterization of the bacterial community in the column; these samples were collected directly into a plastic vial and refrigerated until further processing.

3.5 Analytical Methods

Methods of analysis for ORP, pH, DO, anions, methanol, total Se and Se speciation are provided in **Appendix B.**

4 Results

This section discusses the observed changes in water chemistry along the column, including nitrate and Se concentration trends. The column data were then quantified in terms of nitrate and Se reduction rates. Approximately 97 pore volumes (PVs) of artificial water were passed through the GBR column during the study.

Nitrate results are presented in **Table 3**. Total Se results are presented in **Table 4**. Selenium speciation results are presented in **Table 5**. Methanol and Total VFA results are presented in **Table 6**. Values of pH and ORP are presented in **Table 7**. Anion results are presented in **Table 8**. Laboratory reports from SGS and BAL are presented in **Appendix C** and **D**.

4.1 General Column Chemical Conditions

The influent water pH values varied from 7.3 to 8.1 (**Table 7**). In general, pH remained unchanged along the column length throughout the test. The observed pH range was within optimal values for stimulation of the targeted microbial processes, including nitrate and Se reduction. The ORP values in the influent varied +20 to +220 mV. As expected, the ORP decreased within the column as the result of reduction reactions mediated by microbial consumption of the added carbon source. In general, the values of ORP became more negative as the test progressed, reaching as low as -300 mV in Phases 5 and 6 where higher dosages of lactate were added in order to degrade increased nitrate concentrations (**Figure 5**).

The influent water contained chloride and sulfate (**Table 8**). No changes in chloride concentrations were observed along the column length, as expected. The behavior of sulfate, which is another electron acceptor but with a lower reduction potential than nitrate, Se(VI) and Se(IV), varied during the test (**Table 8; Figure 6**). No sulfate reduction was observed in Phases 1 through 4. Losses of approximately 200 to 400 mg/L sulphate were observed in the column water samples at the end of Phase 5 and through Phase 6.

4.2 Nitrate Results

The influent nitrate concentrations were approximately 40 mg/L as N in Phases 1 2, 3 and 4, and between 100 and 200 mg/L as N in Phases 5 and 6 (**Table 3; Figure 3).** The nitrate concentrations along the column length measured in Phases 1 and 2 varied, showing complete or partial removals of the influent nitrate (**Figure 3**). This is consistent with the carbon source underdosing conditions tested in these phases. Although some carbon was likely consumed due to reduction by other electron acceptors such as sulfate, it appeared that excess carbon was necessary to build biomass in the column. Based on previous results from GBRs treating nitrate and Se, optimal carbon dosing typically corresponds to approximately 1.2 to 1.5x electron demand from nitrate and DO. These column results have confirmed that.

Once the carbon dosing was increased in Phases 3 and 4, complete nitrate removal was consistently observed (**Figure 3**). Most of the nitrate removal occurred in the first third of the column length, as shown by the results from the column sampling Port A. The column residence time in those phases varied from 4 to 10 hours. No change in denitrification rate was observed when temperature was reduced from 8°C to 4°C (Phase 4).

The increase in the influent nitrate concentration to between 100 and 200 mg/L as N in Phase 5 caused an initial decrease in nitrate reduction capacity. The column concentrations of nitrate in the initial 60 days varied from nondetectable values to approximately 50 mg/L as N. Subsequently, complete nitrate removal was observed in the remainder of Phase 5 and consistently in Phase 6. These nitrate concentration trends appear to indicate that a sudden increase in the influent nitrate concentration (i.e., 2.5 to 5 times the initial value) required a period of biomass adjustment (either growth or increased nitrate reduction rate) until complete denitrification was achieved.

Denitrification is generally the dominant nitrate microbial transformation mechanism, which involves reduction of nitrate to nitrogen gas (N_2) through several intermediates including nitrite (Rivett et al., 2008). Test results showed no generation of nitrite (**Table 8**), and therefore the endpoint of nitrate reduction that occurred in the test was N_2.

4.3 Selenium Results

The influent total Se concentrations used in Phase 1, 2, 3, 4 and 5 ranged from approximately 100 to 200 µg/L, and the Se concentrations in the column influent in Phase 6 were increased to approximately 1,000 to 1,500 µg/L (**Table 4** and **Figure 4).** The Se concentration behavior in the column generally mimicked that of nitrate. In Phase 2 where the carbon source was underdosed, Se was removed partially or no removal was observed along the column. The removal of Se in the column improved from the start of Phase 3 and then in Phase 4, after the carbon source dosing was increased. The observed Se concentrations measured in the effluent during Phases 3 and 4 ranged from 7 to 24 µg/L. The Se concentration profiles for all sampling events showed a rapid reduction by the first sampling port (Port A), corresponding to the reduction of nitrate, with a much slower or no removal of Se in the reminder of the column in most sampling events.

In Phase 5, when the nitrate concentration was increased to 100-200 mg/L as N with carbon overdosing, Se removal efficiency decreased from 90% (Phase 4 average) to approximately 70%. The observed Se concentrations measured in the effluent ranged from 15 to 60 µg/L, compared to between 156 and 276 µg/L in the influent (**Table 4**). In Phase 6, the column was exposed to approximately 1,000 to 1,500 µg/L total Se. The column effluent concentrations of total Se ranged from 40 to 400 µg/L.

Speciation of Se(VI) and Se(IV) was investigated in four sampling events performed during Phase 3, 4 and 5 (**Table 4**). As expected, the column influent total Se consisted of primarily Se(VI) in all sampling events. The effluent samples contained no Se(VI), while Se(IV) was detected at concentrations ranging from 3 to 11 µg/L in Phases 3 and 4, accounting for between 11% to 19% of the corresponding total effluent Se values. Se(VI) and Se(VI) were not detected in the Phase 5 column effluent sample. The obtained speciation results indicate that the reduction of Se(VI) to Se(IV) was a minor reduction outcome, and that the process generally generated a more reduced species such as Se(0).

A more detailed speciation of Se species was performed in three sampling events conducted during Phases 5 and 6 (**Table 5**). The samples were analyzed for total recoverable selenium, Se(IV) and Se(VI), potential byproducts of selenium biological reduction, including selenocyanate [SeCN], selenomethionine [SeMet], methylseleninic acid [MeSe(IV)], selenosulfate [$SeSO_3$], and unknown Se species [Unk Se Sp]. Se(0) was not analyzed as it cannot be detected by analytical methods for aqueous samples.

For the Se speciation samples collected in the Phase 5 event, the only species measured above 1 µg/L were unknown Se species at approximately 5 µg/L, compared to the total Se of 51 to 61 µg/L. The unknown Se in the Phase 6 effluent were 11.3 µg/L in both samples, compared to 78 and 192 µg/L of total Se. Unknown Se species reported by BAL are compounds that contain Se, but are not identifiable from their library of Se species. The analytical results for these Phase 6 samples indicated Se(VI) concentrations between 31 and 124 ug/L. The detection of Se(VI) in the effluent may indicate that a maximum Se reduction loading was reached by the microbial population. The reduction of Se(VI) to Se(0) is driven by the microbial population in a fixed film process, and the degradation rate of Se is limited by the surface area of interaction between the impacted water and the surface of the gravel, where the fixed film microbial population exists.

Another explanation for the poor performance during this phase is a lack of carbon dosing leading to possible starvation and die-off of the microbial population. **Table 6** shows a drop in influent VFAs at the same time of the onset of the poor Se removal performance (Day 170). VFAs drop from around 1,200 mg/L to 450 mg/L and ORP for Port A rises more than 200 mV. A similar correlation is seen for the last data point when the Port A and B total Se spikes up again, corresponding to an influent VFA concentration decrease to 342 mg/L. These experimental artifacts may have arisen from a blockage in the carbon dosing system.

The speciation results showed that a large portion of total Se could not be attributed to common dissolved Se species or potential dissolved byproducts of selenium reduction. The remainder of Se is either referred to as particulate Se or missing Se, which is not captured by the dissolved Se speciation completed by BAL. Normally, particulate Se is the difference between the total Se of an unfiltered sample and the total Se of a filtered sample (or total dissolved Se). Attempts were made during the test to characterize the particulate Se by filtering the samples using 0.45 µm and 0.22 µm filters (**Table 4**). The results for total Se for filtered and unfiltered samples did differ slightly, indicating that the particulate Se made up 10-25% of the total Se in the effluent. The remaining unaccounted Se in the analysis is referred to as “missing Se”. This is Se that passes through a 0.45 µm filter but is not registered on BAL’s speciation analysis. One source of missing Se may be the formation of biogenic Se(0) nanoparticles as a product of microbial Se(VI) reduction which is commonly found in engineered bioremediation systems, and will pass through a 0.45 µm and 0.22 µm filters.

In other words, complete Se(VI) reduction occurred as desired and Se(0) was formed; however, a portion of the formed Se(0) was present in the form of colloidal nanoparticles that remained suspended, instead of being retained in the biomass or the rock matrix, and then were detected as total Se in the column samples. Lenz et al., 2008 reported testing results from an up-flow anaerobic bioreactor that showed removal of 790 µg/L Se to between 73 and 80 µg/L. In the absence of detection of any other Se species including potential selenium reduction intermediates, the presence of residual total Se in the bioreactor effluent was attributed to the formation of Se(0) nanoparticles. Yang et el. (2016) showed that Se(0) nano-particles formed as a result of biotransformation of oxidized Se using scanning transmission X-ray microscopy. Other research has shown that regardless of the microbial strain used, biogenic elemental Se was typically of nanoparticulate size (~50−500 nm) (Lenz et al., 2008; 2009; Oremland et al., 2004).

4.4 Nitrate and Selenium Reduction Kinetics

Biodegradation rates are often modeled using Monod kinetics, which is mechanistic (enzymological) based and considers active microbial concentrations (Alvarez and Illman, 2006). This equation, however, is hyperbolic and does not yield an explicit analytical solution of the reagent concentrations as a function of time. Therefore, simpler empirical kinetics expressions, such as first-order kinetics (i.e., the rate is proportional to the contaminant concentrations) and zero-order kinetics (i.e. the rate is constant and thus independent of the concentrations) are often used in evaluating biodegradation. Based on previous research in the area of nitrate and selenium bioremediation (Carucci et al., 1996; Lenz et al. 2008; Takada et al. 2008), we have assumed that the nitrate and selenium anaerobic biodegradation can been expressed as zero-order reactions:

$$C_{eff} = C_o - (k \times t) \tag{1}$$

Where: C_{eff} is the effluent concentration in solution at a given residence time (t);
C_o is the initial concentration; and,
k is the zero-order rate constant expressed in units of concentrations per time (e.g., mg/L/day or µg/L/day).

Calculated ranges in zero-order degradation rates for nitrate and Se in each column test phase are shown in **Table 9**, along with the % removal of influent concentrations. Due to the reaction completion occurring primarily before sample Port A, the kinetic rates for nitrate were calculated only for the residence time through the biologically active first third of the column (before Port A). The nitrate reduction rates in Phases 2, 3 and 4, obtained at influent concentrations between 26 and 50 mg/L as N, ranged from 10 to 30 mg as N/L/day. In Phase 5 and 6, under nitrate concentrations ranging from 108 to 251 mg/L as N, the rates ranged from 40 to 188 mg as N/L/day.

The Se reduction rates under influent concentrations between 117 and 276 µg/L ranged from 5 to 86 µg/L/day in Phase 2, from 56 to 91 µg/l/day in Phase 3, from 91 to 142 µg/L/day in Phase 4 and from 27 to 163 in Phase 5. The Se reduction rate in Phase 6, under Se influent concentrations ranging from 1,020 to 1,520 µg/L, ranged from 228 to 727 µg/L/day.

4.5 Microbial Community Characterization

Samples were collected from the effluent of the column during Phase 5 and 6 for next generation sequencing (NGS). NGS provides detailed characterization of microbial community structure, diversity, and taxonomic identification in environmental samples. This analysis targets both Bacteria and Archaea, thereby providing identity and community structure information for a wide range of prokaryotes. The results of NGS testing are shown in **Appendix E**.

The NGS column effluent samples were collected during test phases that were characterized by different influent composition and distinctly different geochemical trends within the column bed. At the time of Phase 5 sample collection, the column influent composition consisted of 181 mg/L of nitrate and 276 µg/L of Se, while at the time of Phase 6 sample collection the influent water consisted of 133 mg/L nitrate and 1,460 µg/L of Se (**Tables 3** and **4**). The influent sulfate concentration during Phase 5 sample collection ranged from 1,038 mg/L in the influent to 1,043 mg/L in the effluent. In contrast, at the time of Phase 6 sample collection, the influent concentration of 876 mg/L was reduced to 530 mg/L in the effluent (**Table 8**).

Distinctly different microbial taxonomic compositions were observed for the two samples (**Figure E1**). Phase 5 samples were dominated by the following strains: (i) *Pelosinus* (genus), a known fermenter of carbon source, (ii) *Pseudomonas sp.* (genus), a wide variety of mostly aerobic microorganisms known for biofilm formation, (iii) *Dechloromonas* (genus), known for nitrogen fixation, and (iv) *Desulfosporosinus* (genus) and *Comamonadaceae* (family), which are strict anaerobes and fermenters. In the Phase 6 samples, the microbial community shifted and was predominantly composed of anaerobes and sulfate reducers, *Desulfosporosinus* sp. (genus), *Sulurospirillum* (genus), *Desulfvovibrio* (genus), with a lower content of the major strains detected in Phase 5 sample listed above. Both samples contained *Pseudomonas* sp. and *Shewanellaceae* family that contain known microbial species responsible for oxidized Se reduction to Se(0) (Eswayah et al., 2016).

Figure E2 shows microbial composition in the two samples relative to metabolic functions of the microorganisms present. Both samples contained a similar ratio of chemoheterotrophic and carbon fermenting organisms that were responsible for fermentation of the organic substrate dosed into the column. The Phase 5 sample contained a larger ratio of nitrate respiring organisms, while Phase 6 sample contained a higher ratio of sulfate and selenium reducing organisms. In general, the microbial composition and metabolic functions in Phase 5 and 6 samples appeared to be closely related to the observed changes in the geochemical conditions within the column at the time of sampling. Sulfate reduction did not occur during Phase 5 until carbon dosing was increased to promote reduction of the increased concentration of Se used in Phase 6. This corresponded to the establishment of a more abundant sulfate reducing population. Both samples contained facultative selenium reducers.

5 Conclusions

Bench-scale GBR column treatability testing using Se and nitrate-spiked artificial water mimicking anticipated site conditions indicated that:

- Complete denitrification of influent nitrate concentrations ranging from 40 to 200 mg/L as N was observed at water temperatures as low as 4ºC. Denitrification rates ranged from 10 to 188 mg N/L/day. When increases in influent nitrate concentrations were implemented, there was generally a short lag period (days to a week) before complete denitrification of the higher nitrate concentration was reestablished;

- Influent concentrations of 100 to 200 ug/L total Se, in the presence of 40 mg/L of nitrate, were initially reduced in the column to concentrations ranging from 7 to 24 µg/L. Following the increase in nitrate concentration to 100 and 200 mg/L as N, the Se concentrations measured in the column effluent ranged 15 to 60 µg/L. When the column was exposed to approximately 1,000 to 1,500 µg/L total Se and 150 mg/L nitrate as N, the column effluent Se concentrations ranged from 40 to 400 µg/L. Selenium reduction rates ranged from 5 to 727 µg/L/day under the varying test conditions.

- Evaluation of speciation of aqueous Se revealed that reduction of oxidized Se to Se(0) occurred throughout the test, which is the expected biodegradation process in a GBR. The detections of residual concentrations of total Se in the column are believed to be caused by the creation of Se(0) in the form of colloidal nanoparticles that could not be separated by filtration.

- The denitrification and Se reduction rates did not change between testing temperatures of 8°C and 4°C.

- Optimal denitrification and Se reduction rates were observed under carbon source dosing of approximately 1.5 times the influent concentrations of nitrate and DO. Underdosing of the carbon source resulted in incomplete reduction of both constituents. Overdosing of the carbon source resulted in stimulation of sulfate reduction and possibly a decrease in reduction efficacy for nitrate and Se.

- The column microbial composition changed during the test period, corresponding with changes observed in geochemical trends driven largely by electron donor dosing and nitrate and selenium influent concentration. Microbial sulfate reduction was not observed through Phase 5 of the test, but establishment of a more abundant sulfate reducing population was observed in Phase 6 during which sulfate losses were observed in the column. Denitrifying bacteria, carbon fermenting bacteria and facultative selenium reducers were observed in the column water samples throughout the test.

6 References

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TABLES

TABLE 1
COLUMN AND MATERIALS SPECIFICATIONS
Grassy Mountain Project, Alberta

Column	GBR Column
Crushed Geological Material (%)	100
Dry Weight (g)	5168
Column Length	1.64 ft (50 cm)
Column Inside Diameter	0.328 ft (10 cm)
Measured Pore Volume (mL)	2000
Porosity	0.509
Bulk Density (g/cm^3)	1.316

Notes:

% - percent
cm - centimetres
ft- feet
ft/day - feet per day
g/cm^3 - grams per centimetre cube
GBR - gravel bed reactor
h - hour
mL - millilitres
g - gram

TABLE 2
COLUMN OPERATIONAL PARAMETERS AND CARBON SOURCE DOSING
Grassy Mountain Project, Alberta

<table>
<tr><th rowspan="2">Column PV</th><th rowspan="2">Date</th><th rowspan="2">Test Phase</th><th>Column Residence Time</th><th>Target influent Nitrate Concentration</th><th>Target Influent Se Concentration</th><th>Temperature</th><th>Carbon Source Used</th><th>Target Donor Safety Factor*</th></tr>
<tr><th>Days</th><th>mg/L</th><th>µg/L</th><th>°C</th><th></th><th></th></tr>
<tr><td>0.0</td><td>11-Oct-18</td><td rowspan="4">1a - Startup at room temperature</td><td rowspan="4">2</td><td rowspan="30">40</td><td rowspan="52">150</td><td rowspan="4">22</td><td rowspan="18">Methanol</td><td rowspan="16">1.0</td></tr>
<tr><td>4.1</td><td>1-Nov-18</td></tr>
<tr><td>13.7</td><td>28-Nov-18</td></tr>
<tr><td>15.5</td><td>7-Dec-18</td></tr>
<tr><td>19.2</td><td>18-Dec-18</td><td rowspan="14">2 - Carbon underdosing 8 °C</td><td rowspan="39">4</td><td rowspan="21">8</td></tr>
<tr><td>24.1</td><td>27-Dec-18</td></tr>
<tr><td>26.5</td><td>2-Jan-19</td></tr>
<tr><td>27.1</td><td>3-Jan-19</td></tr>
<tr><td>27.4</td><td>4-Jan-19</td></tr>
<tr><td>28.5</td><td>9-Jan-19</td></tr>
<tr><td>30.4</td><td>17-Jan-19</td></tr>
<tr><td>31.4</td><td>21-Jan-19</td></tr>
<tr><td>34.8</td><td>4-Feb-19</td></tr>
<tr><td>35.2</td><td>6-Feb-19</td></tr>
<tr><td>37.4</td><td>15-Feb-19</td></tr>
<tr><td>41.3</td><td>13-Mar-19</td></tr>
<tr><td>41.8</td><td>15-Mar-19</td><td rowspan="2">2.0</td></tr>
<tr><td>42.9</td><td>19-Mar-19</td></tr>
<tr><td>--</td><td>22-Mar-19</td><td rowspan="7">3 - Optimal carbon dosing, 8°C</td><td rowspan="45">Lactate</td><td rowspan="25">1.5</td></tr>
<tr><td>46.3</td><td>4-Apr-19</td></tr>
<tr><td>46.7</td><td>5-Apr-19</td></tr>
<tr><td>47.5</td><td>8-Apr-19</td></tr>
<tr><td>49.5</td><td>17-Apr-19</td></tr>
<tr><td>52.3</td><td>29-Apr-19</td></tr>
<tr><td>55.5</td><td>13-May-19</td></tr>
<tr><td>56.0</td><td>15-May-19</td><td rowspan="5">4 - Optimal carbon dosing, 4 °C</td><td rowspan="5">4</td></tr>
<tr><td>57.3</td><td>21-May-19</td></tr>
<tr><td>58.5</td><td>27-May-19</td></tr>
<tr><td>59.8</td><td>3-Jun-19</td></tr>
<tr><td>61.2</td><td>10-Jun-19</td></tr>
<tr><td>--</td><td>14-Jun-19</td><td rowspan="22">5 - Carbon overdosing, nitrate increased 100-200 mg/L, 8 °C</td><td rowspan="3">100</td><td rowspan="33">8</td></tr>
<tr><td>63.1</td><td>18-Jun-19</td></tr>
<tr><td>64.7</td><td>26-Jun-19</td></tr>
<tr><td>66.8</td><td>5-Jul-19</td><td rowspan="10">200</td></tr>
<tr><td>67.5</td><td>8-Jul-19</td></tr>
<tr><td>69.3</td><td>16-Jul-19</td></tr>
<tr><td>70.1</td><td>22-Jul-19</td></tr>
<tr><td>71.6</td><td>29-Jul-19</td></tr>
<tr><td>73.5</td><td>6-Aug-19</td></tr>
<tr><td>74.8</td><td>12-Aug-19</td></tr>
<tr><td>76.4</td><td>19-Aug-19</td></tr>
<tr><td>77.3</td><td>27-Aug-19</td></tr>
<tr><td>78.9</td><td>3-Sep-19</td></tr>
<tr><td>79.3</td><td>4-Sep-19</td><td rowspan="9">10</td><td rowspan="20">150</td><td rowspan="20">2.0</td></tr>
<tr><td>79.7</td><td>11-Sep-19</td></tr>
<tr><td>80.3</td><td>18-Sep-19</td></tr>
<tr><td>80.7</td><td>25-Sep-19</td></tr>
<tr><td>81.5</td><td>2-Oct-19</td></tr>
<tr><td>81.8</td><td>7-Oct-19</td></tr>
<tr><td>82.8</td><td>15-Oct-19</td></tr>
<tr><td>83.4</td><td>21-Oct-19</td></tr>
<tr><td>84.2</td><td>28-Oct-19</td></tr>
<tr><td>85.7</td><td>12-Nov-19</td><td rowspan="11">6 - Carbon overdosing, nitrate at 150 mg/L and Se increased to 1,000 µg/L, 8 °C</td><td rowspan="9">5</td><td rowspan="11">1,000</td></tr>
<tr><td>85.7</td><td>13-Nov-19</td></tr>
<tr><td>86.8</td><td>18-Nov-19</td></tr>
<tr><td>88.3</td><td>27-Nov-19</td></tr>
<tr><td>89.1</td><td>3-Dec-19</td></tr>
<tr><td>90.5</td><td>9-Dec-19</td></tr>
<tr><td>92.3</td><td>19-Dec-19</td></tr>
<tr><td>94.2</td><td>30-Dec-19</td></tr>
<tr><td>95.7</td><td>7-Jan-20</td></tr>
<tr><td>96.7</td><td>16-Jan-20</td><td rowspan="2">8</td></tr>
<tr><td>97.9</td><td>28-Jan-20</td></tr>
</table>

Note:

*Ratio of electron donor capacity of the dosed carbon substrate to the electron demand from nitrate and dissolved oxygen in the influent water
°C - degrees Celsius
GBR - gravel bed reactor
mg/L - milligrams per litre
µg/L - micrograms per litre
PV - pore volumes
Se - selenium

TABLE 3
WATER SAMPLE NITRATE-N RESULTS
Grassy Mountain Project, Alberta

PV	Date	Sample Location				Column Residence Time (days)	Test Phase
		Influent	Port A	Port B	Effluent		
		Nitrate Concentration (mg/L as N)					
4.1	1-Nov-18	<0.09	--	--	--	2	1 - Startup at room temperature
8.9	12-Nov-18	35	24	26	25		
11.9	20-Nov-18	43	--	--	36		
14.9	3-Dec-18	41	<0.09	<0.09	<0.09		
16.8	10-Dec-18	42	<0.09	<0.09	<0.09	4	2 - Carbon underdosing, 8 °C
19.2	18-Dec-18	37	28	33	30		
24.1	27-Dec-18	35	34	35	35		
26.5	2-Jan-19	38	34	29	12		
28.5	9-Jan-19	38	24	23	3.1		
30.4	17-Jan-19	40	24	25	30		
33.3	29-Jan-19	40	38	33	41		
35.2	6-Feb-19	50	2.3	3.5	4.1		
37.4	15-Feb-19	39	25	8.1	0.17		
39.2	27-Feb-19	36	<0.09	<0.09	<0.09		
41.3	13-Mar-19	39	7.6	8.2	<0.09		
42.9	19-Mar-19	43	36	40	27		
44.1	25-Mar-19	36	29	26	26		3 - Optimal carbon dosing, 8°C
45.8	1-Apr-19	33	0.70	1.4	14		
47.5	8-Apr-19	40	0.78	0.78	<0.09		
49.5	17-Apr-19	40	3.5	2.0	1.4		
52.3	29-Apr-19	35	0.88	2.5	<0.09		
53.9	6-May-19	37	<0.09	<0.09	<0.09		
55.5	13-May-19	41	<0.09	<0.09	0.73		
57.3	21-May-19	36	<0.09	<0.09	<0.09		4 - Optimal carbon dosing, 4 °C
58.5	27-May-19	26	<0.09	<0.09	0.17		
59.8	3-Jun-19	40	<0.09	0.82	<0.09		
61.2	10-Jun-19	31	<0.09	<0.09	0.22		
63.1	18-Jun-19	111	7.5	8.8	0.15		5 - Carbon overdosing, nitrate increased 100-200 mg/L, 8 °C
64.7	26-Jun-19	133	0.93	0.29	14		
66.8	5-Jul-19	108	5.5	5.4	5.0		
67.5	8-Jul-19	159	36	31	5.6		
69.3	16-Jul-19	152	2.6	6.6	24		
70.1	22-Jul-19	154	40	34	42		
71.6	29-Jul-19	251	<0.09	<0.09	1.1		
--	1-Aug-19	151	--	--	<0.09		
73.5	6-Aug-19	197	0.20	<0.09	<0.09		
74.8	12-Aug-19	168	<0.09	<0.09	<0.09		
76.4	19-Aug-19	194	48	39	35		
77.3	27-Aug-19	180	<0.09	<0.09	17		
78.9	3-Sep-19	201	<0.09	<0.09	<0.09		
79.7	11-Sep-19	167	<0.09	<0.09	<0.09	10	
80.3	18-Sep-19	181	<0.09	<0.09	0.82		
80.7	25-Sep-19	147	<0.09	<0.09	<0.09		
81.5	2-Oct-19	132	<0.09	<0.09	1.8		
81.8	7-Oct-19	143	<0.09	<0.09	<0.09		
82.8	15-Oct-19	143	<0.09	<0.09	<0.09		
83.4	21-Oct-19	152	<0.09	<0.09	<0.09		
84.2	28-Oct-19	149	<0.09	<0.09	<0.09		

TABLE 3
WATER SAMPLE NITRATE-N RESULTS
Grassy Mountain Project, Alberta

PV	Date	Sample Location				Column Residence Time (days)	Test Phase
		Influent	Port A	Port B	Effluent		
		Nitrate Concentration (mg/L as N)					
85.7	13-Nov-19	171	--	--	<0.09	5	6 - Carbon overdosing, nitrate at 150 mg/L and Se increased to 1,000 ug/L, 8 °C
86.8	18-Nov-19	138	0.58	2.2	5.9		
88.3	27-Nov-19	143	0.40	<0.09	<0.09		
89.1	3-Dec-19	140	<0.09	<0.09	<0.09		
90.5	9-Dec-19	133	<0.09	<0.09	<0.09		
92.3	19-Dec-19	134	0.67	<0.09	<0.09		
94.2	30-Dec-19	145	<0.09	<0.09	<0.09		
95.7	7-Jan-20	154	<0.09	<0.09	<0.09		
96.7	16-Jan-20	146	<0.09	<0.09	<0.09	8	
97.9	28-Jan-20	156	<0.09	7.1	<0.09		

Notes:

-- - sample not collected
< - not detected, associated value is the detection limit
mg/L - milligrams per litre
PV - pore volumes

TABLE 4
WATER SAMPLE SELENIUM RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Influent	Port A	Port B	Effluent	Column Residence Time (days)	Test Phase
			Concentration (µg/L)					
Total Selenium	16.8	10-Dec-18	164	49.9	47.3	50.3	4	2 - Carbon underdosing 8 °C
	19.2	18-Dec-18	144	147.0	152.0	149.0		
	24.1	27-Dec-18	146	151.0	157.0	153.0		
	28.5	9-Jan-19	163	156.0	161.0	89.5		
	35.2	6-Feb-19	171	176.0	176.0	173.0		
	37.4	15-Feb-19	160	147.0	119.0	40.4		
	39.2	27-Feb-19	161	59.3	50.6	54.9		
	41.3	13-Mar-19	167	101.0	113.0	15.8		
	42.9	19-Mar-19	166	171.0	176.0	106.0		
	46.3	3-Apr-19	140	65.1	61.7	64.2		3 - Optimal carbon dosing, 8°C
	47.5	8-Apr-19	147	25.4	14.1	17.7		
	49.5	17-Apr-19	145	35.1	27.2	26.4		
	50.7	22-Apr-19	107	13.2	14.5	21.6		
	52.3	29-Apr-19	127	13.3	17.2	20.4		
	53.9	6-May-19	127	19.1	17.9	24.4		
	55.5	13-May-19	117	19.8	15.5	19.4		
	57.3	21-May-19	155	24.2	15.9	16.1		4 - Optimal carbon dosing, 4 °C
	58.5	27-May-19	165	43.7	12.3	13.3		
	59.8	3-Jun-19	203	13.5	5.5	6.8		
	61.2	10-Jun-19	173	16.8	22.3	15.4		
	63.1	18-Jun-19	170	48.7	48.6	15.9		5 - carbon overdosing, nitrate increased 100-200 mg/L, 8 °C
	64.7	26-Jun-19	170	50.4	49.2	45.5		
	66.4	3-Jul-19	178	43.3	36.8	49.1 47.2 (filtered 0.45 µm)		
	67.5	8-Jul-19	183	58.0	39.9	49.3		
	69.3	16-Jul-19	176	61.9	60.6	108.0		
	70.1	22-Jul-19	171	62.7	60.1	64.2		
	71.6	29-Jul-19	171	58.2	59.7	72.4		
	73.5	6-Aug-19	249	60.2	59.4	61.4		
	74.8	12-Aug-19	225	29.4	31.2	34.9		
	76.4	19-Aug-19	250	40.8	38.1	36.0		
	77.3	27-Aug-19	260	48.7	69.6	59.8		
	78.9	3-Sep-19	276	58.8	48.8	57.9		
	79.7	11-Sep-19	158	59.0	--	48.2	10	
	80.3	18-Sep-19	157	49.6	48.4	61.9		
	80.7	25-Sep-19	156	216 (accidental discharge event)	47.9	69.1		
	81.5	2-Oct-19	157	45.4	39.9	40.8		
	81.8	7-Oct-19	--	--	--	34 30.4 (filtered 0.22 µm)		
	82.8	15-Oct-19	165	38.1	45.4	42.0		
	83.4	21-Oct-19	170	35.0	36.3	108.0		
	84.2	28-Oct-19	171	81.7	48.3	25.1 18.8 (filtered 0.22 µm) 20.7 (centrifuged)		6 - carbon overdosing, nitrate at 160 mg/L and Se increased to 1,000 ug/L, 8 °C
	85.1	6-Nov-19	156	--	--	45.5	5	
	85.7	13-Nov-19	1080	--	--	21.2 23.9 (unpreserved)		
	86.8	18-Nov-19	1070	45.9	59.9	91.8		
	88.3	27-Nov-19	1020	173 (filtered 0.45 µm)	41.4 (filtered 0.45 µm)	40.6 (filtered 0.45 µm)		
	89.1	3-Dec-19	1070	41.4 (filtered 0.45 µm)	48.7 (filtered 0.45 µm)	21.4 (filtered 0.45 µm)		
	90.5	9-Dec-19	1460	248 (filtered 0.45 µm)	273 (filtered 0.45 µm)	89 (filtered 0.45 µm)		
	92.3	19-Dec-19	1520	814 (filtered 0.45 µm)	136 (filtered 0.45 µm)	128 (filtered 0.45 µm)		
	94.2	30-Dec-19	1060	237 (filtered 0.45 µm)	180 (filtered 0.45 µm)	199 (filtered 0.45 µm)		
	95.7	7-Jan-20	1150	432 (filtered 0.45 µm)	450 (filtered 0.45 µm)	435 (filtered 0.45 µm)		
	96.7	16-Jan-20	1160	164 (filtered 0.45 µm)	254 (filtered 0.45 µm)	197 (filtered 0.45 µm)	8	
	97.9	28-Jan-20	1050	443 (filtered 0.45 µm)	400 (filtered 0.45 µm)	68.5 (filtered 0.45 µm)		

TABLE 4
WATER SAMPLE SELENIUM RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location: Influent	Port A	Port B	Effluent	Column Residence Time (days)	Test Phase
			Concentration (µg/L)					
Selenium IV	42.9	19-Mar-19	< 0.5	--	--	11.4	4	2
	52.3	29-Apr-19	< 0.5	--	--	3.3		3
	61.2	10-Jun-19	< 0.5	--	--	2.9		4
	80.3	18-Sep-19	< 0.5	--	--	< 0.5	10	5
Selenium VI	42.9	19-Mar-19	190	--	--	87.3	4	2
	52.3	29-Apr-19	150	--	--	< 0.5		3
	61.2	10-Jun-19	1.3	--	--	< 0.5		4
	80.3	18-Sep-19	150	--	--	< 0.5	10	5

Notes:

-- - sample not collected
< - not detected, associated value is the detection limit
µm - micrometre
GBR - gravel bed reactor
µg/L - micrograms per litre
PV - pore volumes
Analyses for total Se, SeVI and SeIV were performed by SGS Analytical Laboratory in Lakefield, ON

TABLE 5
WATER SAMPLE SELENIUM SPECIATION RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location							
			Influent		Port A		Port B		Effluent	
			Concentration (µg/L)	Qualifier	Concentration (µg/L)	Qualifier	Concentration (µg/L)	Qualifier	Concentration (µg/L)	Qualifier
MeSe(IV)	80.3	18-Sep-19	<0.175	U	--	--	--	--	0.940	--
	81.8	7-Oct-19	<0.175	--	0.935	H	0.857	H	0.704	H
	81.8	7-Oct-19	--	--	--	--	--	--	0.903*	H
	96.7	16-Jan-20	--	--	--	--	--	--	2.61	--
	97.9	28-Jan-20	--	--	--	--	--	--	<0.175	J-1 U
Se(IV)	80.3	18-Sep-19	<0.175	U	--	--	--	--	0.816	--
	81.8	7-Oct-19	<0.175	--	0.580	H J	0.556	H J	0.652	H
	81.8	7-Oct-19	--	--	--	--	--	--	0.493*	H J
	96.7	16-Jan-20	--	--	--	--	--	--	<0.175	U
	97.9	28-Jan-20	--	--	--	--	--	--	<0.175	U
Se(VI)	80.3	18-Sep-19	156	--	--	--	--	--	0.184	J
	81.8	7-Oct-19	146	--	<0.150	H U	<0.150	H U	<0.150	H U
	81.8	7-Oct-19	--	--	--	--	--	--	<0.150*	H U
	96.7	16-Jan-20	--	--	--	--	--	--	124	--
	97.9	28-Jan-20	--	--	--	--	--	--	31.3	--
SeCN	80.3	18-Sep-19	<0.125	U	--	--	--	--	0.517	J
	81.8	7-Oct-19	<0.125	--	0.185	H J	0.181	H J	0.150	H J
	81.8	7-Oct-19	--	--	--	--	--	--	0.174*	H J
	96.7	16-Jan-20	--	--	--	--	--	--	0.718	--
	97.9	28-Jan-20	--	--	--	--	--	--	0.240	J
SeMet	80.3	18-Sep-19	<0.175	U	--	--	--	--	<0.175	U
	81.8	7-Oct-19	<0.175	--	<0.175	H U	<0.175	H U	<0.175	H U
	81.8	7-Oct-19	--	--	--	--	--	--	<0.175*	H U
	96.7	16-Jan-20	--	--	--	--	--	--	<0.175	U
	97.9	28-Jan-20	--	--	--	--	--	--	<0.175	U
SeSO3	80.3	18-Sep-19	<0.150	U	--	--	--	--	0.209	J
	81.8	7-Oct-19	<0.150	--	<0.150	H U	<0.150	H U	<0.150	H U
	81.8	7-Oct-19	--	--	--	--	--	--	<0.150*	H U
	96.7	16-Jan-20	--	--	--	--	--	--	0.631	--
	97.9	28-Jan-20	--	--	--	--	--	--	<0.150	U
Unk Se	80.3	18-Sep-19	<0.175	U	--	--	--	--	8.61	--
	81.8	7-Oct-19	<0.175	--	6.22	H	6.57	H	5.13	H
	81.8	7-Oct-19	--	--	--	--	--	--	5.46*	H
	96.7	16-Jan-20	--	--	--	--	--	--	11.3	--
	97.9	28-Jan-20	--	--	--	--	--	--	11.3	--
Total Se	80.3	18-Sep-19	167	--	--	--	--	--	61.2	--
	81.8	7-Oct-19	162	--	58.1	--	47.5	--	50.9	--
	96.7	16-Jan-20	-- (1,160)	--	--	--	--	--	192	
	97.9	28-Jan-20	-- (1,050)	--	--	--	--	--	79.7	

Notes:

* - filtered at 0.22 µm
-- - sample not collected
< - not detected, associated value is the detection limit
µg/L - micrograms per litre
Analyses were performed by Brooks Applied - Brooks Applied Labs in Bothell, WA
H - Samples received at 8.7ºC
J - Detected by the instrument, the result is > the MDL but ≤ the MRL. Result is reported and considered an estimate.
MeSe(IV) - methylseleninic acid
PV - pore volumes
Se - selenium
Se(IV) - selenite
Se(VI) - selenate
SeCN - selenocyanate
SeMet - selenomethionine
SeSO3 - selenosulfate
U - Result is ≤ the MDL or client requested reporting limit (CRRL). Result reported as the MDL or CRRL.
Unk Se - unknown selenium species
( ) Total Se values at 96.7 and 97.9 PVs from SGS analyses

TABLE 6
WATER SAMPLE ORGANIC CARBON RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent*	Port A	Port B	Effluent
			Concentration (mg/L)			
Methanol	4.1	1-Nov-18	<30	--	--	--
	7.0	8-Nov-18	--	--		--
	13.7	28-Nov-18	<1.1	<1.1	<1.1	<1.1
	14.9	3-Dec-18	--	82	81	66
	16.8	10-Dec-18	--	24	18	8.3
	19.2	18-Dec-18	--	<1.1	<1.1	<1.1
	24.1	27-Dec-18	<1.1	<1.1	<1.1	<1.1
	26.5	2-Jan-19	5.4	<1.1	<1.1	<1.1
	27.4	4-Jan-19	1,271	--	--	--
	28.5	9-Jan-19	107	11	<1.1	<1.1
	30.4	17-Jan-19	3.7	<1.1	<1.1	<1.1
	31.4	21-Jan-19*	38	--	--	--
	33.3	29-Jan-19	--	<1.1	<1.1	<1.1
	34.8	4-Feb-19	92	<1.1	<1.1	<1.1
	35.2	6-Feb-19	91	<1.1	<1.1	<1.1
	37.4	15-Feb-19	99	<1.1	4.3	--
	39.2	27-Feb-19	--	--	--	--
	41.3	13-Mar-19	249	<1.1	<1.1	<1.1
	42.9	19-Mar-19	612	<1.1	<1.1	<1.1
Total VFAs	44.1	25-Mar-19	--	75	90	<0.07
	45.8	1-Apr-19	--	<0.07	<0.07	<0.07
	46.3	4-Apr-19	164	--	--	--
	47.5	8-Apr-19	191	86	101	77
	49.5	17-Apr-19	394	<0.07	<0.07	<0.07
	50.7	22-Apr-19	359	20	9.5	3.4
	52.3	29-Apr-19	312	12	11	<0.07
	53.9	6-May-19	271	97	80	87
	55.5	13-May-19	29	88	90	98
	--	16-May-19	284	--	--	--
	57.3	21-May-19	383	149	107	29
	58.5	27-May-19	232	218	225	161
	59.8	3-Jun-19	487	183	172	114
	61.2	10-Jun-19	355	178	155	145
	63.1	18-Jun-19	458	4.1	<0.07	123
	64.7	26-Jun-19	423	<0.07	<0.07	<0.07
	66.8	5-Jul-19	528	<0.07	<0.07	<0.07
	67.5	8-Jul-19	476	<0.07	<0.07	<0.07
	69.3	16-Jul-19	107	2.3	2.9	5.6
	70.1	22-Jul-19	461	<0.07	<0.07	<0.07
	71.6	29-Jul-19	2,005	670	207	<0.07
	73.5	6-Aug-19	1,915	311	27	13
	74.8	12-Aug-19	<0.07	59	35	<0.07
	--	14-Aug-19	1,167	--	--	--
	76.4	19-Aug-19	<0.07	<0.07	<0.07	<0.07
	77.3	27-Aug-19	1,156	467	448	5.3
	78.9	3-Sep-19	1,782	753	745	725
	--	5-Sep-19	1,786	--	--	--
	79.7	11-Sep-19	1,488	844	732	647
	--	16-Sep-19	1,570	--	--	--
	80.3	18-Sep-19	2,542	1,096	1,147	987
	80.7	25-Sep-19	1,876	729	764	787
	81.5	2-Oct-19	1,653	966	943	914
	81.8	7-Oct-19	1,826	856	830	739
	82.8	15-Oct-19	1,894	932	957	959
	83.4	21-Oct-19	1,645	768	905	647
	84.2	28-Oct-19	1,879	1,319	1,063	713
	85.1	6-Nov-19	--	--	--	845
	85.7	13-Nov-19	1,026	--	--	692

TABLE 6
WATER SAMPLE ORGANIC CARBON RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent*	Port A	Port B	Effluent
			Concentration (mg/L)			
Total VFAs	86.8	18-Nov-19	215	585	591	584
	88.3	27-Nov-19	1,182	638	461	168
	89.1	3-Dec-19	784	478	502	394
	90.5	9-Dec-19	450	413	412	383
	92.3	19-Dec-19	1,220	784	417	397
	94.2	30-Dec-19	1,180	539	418	394
	95.7	7-Jan-20	1,334	505	547	465
	96.7	16-Jan-20	1,528	991	658	554
	97.9	28-Jan-20	342	1,146	1,054	651

Notes:

*Prior to 21 Jan 2019, influent donor concentrations were measured from groundwater reservoir before electron donor addition port or directly from line. After 21 Jan 2019, influent donor samples were collected from an in-line flow through cell positioned after the electron donor amendment pump.

-- - sample not collected

< - not detected, associated value is the detection limit

mg/L - milligrams per litre

PV - pore volumes

VFA - volatile fatty acid

TABLE 7
WATER SAMPLE pH AND ORP RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent	Port A	Port B	Effluent
			Instrument Readings			
pH	0.0	11-Oct-18	7.33	--	--	--
	4.1	1-Nov-18	7.26	7.28	7.08	7.02
	8.9	12-Nov-18	7.20	7.20	7.45	7.24
	13.7	28-Nov-18	7.03	7.23	7.30	7.22
	14.9	3-Dec-18	7.34	7.81	7.83	7.56
	16.8	10-Dec-18	7.38	7.84	7.82	7.68
	19.2	18-Dec-18	7.40	7.71	7.63	7.63
	24.1	27-Dec-18	7.51	7.43	7.46	7.50
	26.5	2-Jan-19	7.43	7.52	7.49	7.52
	28.5	9-Jan-19	7.25	7.51	7.61	7.66
	30.4	17-Jan-19	7.67	7.71	7.67	7.69
	33.3	29-Jan-19	7.47	7.25	7.26	7.41
	35.2	6-Feb-19	7.27	7.71	7.96	7.80
	37.4	15-Feb-19	7.25	7.21	7.70	7.53
	39.2	27-Feb-19	7.44	7.59	7.74	7.79
	41.3	13-Mar-19	7.51	7.88	7.83	7.44
	42.9	19-Mar-19	7.30	7.39	7.43	7.41
	47.5	8-Apr-19	7.55	8.02	8.04	7.98
	49.5	17-Apr-19	7.98	8.06	8.13	7.95
	50.7	22-Apr-19	7.89	8.23	8.05	8.01
	52.3	29-Apr-19	7.81	8.05	8.08	7.98
	53.9	6-May-19	7.79	7.87	7.83	7.37
	55.5	13-May-19	7.69	7.63	7.66	7.34
	57.3	21-May-19	7.75	7.67	7.67	7.50
	58.5	27-May-19	7.16	7.44	7.41	7.35
	59.8	3-Jun-19	7.62	7.50	7.49	7.29
	61.2	10-Jun-19	7.79	7.74	7.76	7.75
	63.1	18-Jun-19	7.96	7.79	7.74	7.65
	64.7	26-Jun-19	7.90	7.90	7.89	7.76
	66.8	5-Jul-19	7.93	7.85	7.94	7.94
	67.5	8-Jul-19	7.69	7.98	7.98	7.92
	69.3	16-Jul-19	7.83	8.06	8.04	7.91
	70.1	22-Jul-19	7.79	7.77	7.80	7.73
	71.6	29-Jul-19	7.82	7.60	7.93	7.97
	73.5	6-Aug-19	7.88	7.89	7.98	8.03
	74.8	12-Aug-19	7.72	7.83	7.79	7.71
	76.4	19-Aug-19	7.72	7.69	7.62	7.62
	77.3	27-Aug-19	7.74	7.43	7.66	7.79
	78.9	3-Sep-19	7.63	7.16	7.14	7.19
	79.7	11-Sep-19	7.94	6.99	7.25	7.29
	80.3	18-Sep-19	8.05	7.24	7.29	7.52
	80.7	25-Sep-19	7.89	7.28	7.40	7.29
	81.5	2-Oct-19	7.79	7.39	7.66	7.58
	81.8	7-Oct-19	7.72	6.97	7.00	7.09
	82.8	15-Oct-19	7.88	7.39	7.41	7.33
	83.4	21-Oct-19	7.64	7.20	7.36	7.39
	84.2	28-Oct-19	7.63	6.96	7.01	7.16
	85.1	6-Nov-19	7.20	--	--	7.03
	85.7	13-Nov-19	7.56	--	--	7.10
	86.8	18-Nov-19	7.58	7.49	7.27	7.36
	88.3	25-Nov-19	7.75	7.90	7.86	7.59
	89.1	2-Dec-19	7.40	7.55	7.55	7.60
	90.5	9-Dec-19	7.72	7.52	7.52	7.71
	92.3	19-Dec-19	7.61	7.88	7.30	7.44

TABLE 7
WATER SAMPLE pH AND ORP RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent	Port A	Port B	Effluent
			Instrument Readings			
pH	94.2	30-Dec-19	7.62	7.20	7.23	7.58
	95.7	7-Jan-20	7.51	7.32	7.28	7.48
	96.7	16-Jan-20	7.76	7.24	7.27	7.22
	97.9	28-Jan-20	8.07	7.70	7.66	7.72
ORP (mV)	0.0	11-Oct-18	237	--	--	--
	4.1	1-Nov-18	215	217	219	220
	8.9	12-Nov-18	60	49	43	42
	13.7	28-Nov-18	99	40	20	-15
	14.9	3-Dec-18	221	154	123	105
	16.8	10-Dec-18	138	25	-10	-23
	19.2	18-Dec-18	98	69	45	89
	24.1	27-Dec-18	199	184	130	76
	26.5	2-Jan-19	180	77	24	-14
	28.5	9-Jan-19	38	-29	-57	-66
	30.4	17-Jan-19	22	-50	-62	-76
	33.3	29-Jan-19	128	44	28	6
	35.2	6-Feb-19	94	-26	-69	-45
	37.4	15-Feb-19	104	-11	-46	-53
	39.2	27-Feb-19	52	-42	-63	-55
	41.3	13-Mar-19	63	-40	-54	-51
	42.9	19-Mar-19	106	74	70	72
	46.3	3-Apr-19	97	77	83	101
	47.5	8-Apr-19	129	117	64	5
	49.5	17-Apr-19	132	75	65	96
	50.7	22-Apr-19	120	-63	-38	85
	52.3	29-Apr-19	105	-22	17	56
	53.9	6-May-19	84	32	50	39
	55.5	13-May-19	69	45	-2	29
	57.3	21-May-19	166	18	175	178
	58.5	27-May-19	77	-55	-24	0
	59.8	3-Jun-19	93	-42	-19	-6
	61.2	10-Jun-19	102	-99	-92	-44
	63.1	18-Jun-19	88	20	16	-51
	64.7	26-Jun-19	137	74	67	77
	66.8	5-Jul-19	114	101	83	80
	67.5	8-Jul-19	218	159	91	125
	69.3	16-Jul-19	107	63	66	59
	70.1	22-Jul-19	112	61	62	70
	71.6	29-Jul-19	127	-57	22	60
	73.5	6-Aug-19	86	26	28	24
	74.8	12-Aug-19	107	82	80	116
	76.4	19-Aug-19	116	65	47	76
	77.3	27-Aug-19	59	-76	-55	36
	78.9	3-Sep-19	150	-66	-58	-52
	79.7	11-Sep-19	175	-104	-91	-102
	80.3	18-Sep-19	143	-91	-70	-43
	80.7	25-Sep-19	79	-63	-35	-2
	81.5	2-Oct-19	178	-123	-75	-80
	81.8	7-Oct-19	128	-72	-74	-107
	82.8	15-Oct-19	161	-3	-53	-40
	83.4	21-Oct-19	158	-58	-52	-136
	84.2	28-Oct-19	186	-204	-50	33
	85.1	6-Nov-19	148	--	--	-68
	85.7	13-Nov-19	144	--	--	-191

TABLE 7
WATER SAMPLE pH AND ORP RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent	Port A	Port B	Effluent
			Instrument Readings			
ORP (mV)	86.8	18-Nov-19	153	-228	-218	-223
	88.3	25-Nov-19	169	-164	-87	-176
	89.1	2-Dec-19	119	-249	-232	-253
	90.5	9-Dec-19	98	-201	-174	-264
	92.3	19-Dec-19	198	-33	-250	-252
	94.2	30-Dec-19	134	-304	-276	-288
	95.7	7-Jan-20	150	-238	-244	-313
	96.7	16-Jan-20	244	-280	-265	-281
	97.9	28-Jan-20	118	-248	-255	-244

Notes:

-- - sample not collected
mV - millivolts
ORP - oxidation reduction potential
PV - pore volumes

TABLE 8
WATER SAMPLE CHLORIDE, NITRITE-N, SULFATE, AND PHOSPHATE RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent	Port A	Port B	Effluent
			Concentration (mg/L)			
Chloride	4.1	1-Nov-18	260	247	247	240
	8.9	12-Nov-18	257	273	283	277
	11.9	20-Nov-18	251	--	--	275
	14.9	3-Dec-18	271	248	256	273
	16.8	10-Dec-18	289	277	275	251
	19.2	18-Dec-18	253	253	279	264
	24.1	27-Dec-18	241	261	253	248
	26.5	2-Jan-19	261	273	238	310
	28.5	9-Jan-19	266	267	248	268
	30.4	17-Jan-19	277	252	250	318
	33.3	29-Jan-19	277	273	246	303
	35.2	6-Feb-19	315	319	298	288
	37.4	15-Feb-19	271	254	251	243
	39.2	27-Feb-19	264	263	271	291
	41.3	13-Mar-19	281	279	276	288
	42.9	19-Mar-19	302	303	325	272
	44.1	25-Mar-19	251	349	317	314
	45.8	1-Apr-19	236	254	250	271
	47.5	8-Apr-19	280	259	265	246
	49.5	17-Apr-19	275	286	334	311
	50.7	22-Apr-19	264	257	263	251
	52.3	29-Apr-19	251	234	215	226
	53.9	6-May-19	259	251	251	249
	55.5	13-May-19	272	250	284	302
	57.3	21-May-19	259	264	284	262
	58.5	27-May-19	250	324	323	272
	59.8	3-Jun-19	274	271	270	283
	61.2	10-Jun-19	241	263	237	225
	63.1	18-Jun-19	294	251	251	243
	64.7	26-Jun-19	369	368	370	405
	66.8	5-Jul-19	298	314	285	274
	67.5	8-Jul-19	282	278	268	254
	69.3	16-Jul-19	275	269	281	249
	70.1	22-Jul-19	290	294	250	283
	71.6	29-Jul-19	200	237	289	373
	73.5	6-Aug-19	379	356	362	381
	74.8	12-Aug-19	296	248	244	265
	76.4	19-Aug-19	276	318	260	251
	77.3	27-Aug-19	250	249	257	265
	78.9	3-Sep-19	271	289	296	305
	79.7	11-Sep-19	274	254	284	278
	80.3	18-Sep-19	338	290	329	348
	80.7	25-Sep-19	271	240	247	250
	81.5	2-Oct-19	254	238	248	247
	81.8	7-Oct-19	274	252	245	248
	82.8	15-Oct-19	272	256	248	249
	83.4	21-Oct-19	277	305	339	267
	84.2	28-Oct-19	280	313	295	269
	85.7	13-Nov-19	262	--	--	245
	86.8	18-Nov-19	245	230	234	206
	88.3	27-Nov-19	262	283	273	235
	89.1	3-Dec-19	260	266	299	249
	90.5	9-Dec-19	240	223	229	222
	92.3	19-Dec-19	238	257	237	291
	94.2	30-Dec-19	261	249	243	242
	95.7	7-Jan-20	280	260	257	254
	96.7	16-Jan-20	263	247	256	267
	97.9	28-Jan-20	272	280	239	214

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TABLE 8
WATER SAMPLE CHLORIDE, NITRITE-N, SULFATE, AND PHOSPHATE RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent	Port A	Port B	Effluent
			Concentration (mg/L)			
Nitrite-N	4.1	1-Nov-18	5.9	5.3	5.6	5.4
	8.9	12-Nov-18	<0.09	4.8	5.1	5.4
	11.9	20-Nov-18	6.9	--	--	7.2
	14.9	3-Dec-18	5.6	5.8	6.7	7.0
	16.8	10-Dec-18	6.0	7.1	7.2	6.9
	19.2	18-Dec-18	4.4	5.7	8.1	5.6
	24.1	27-Dec-18	<0.09	<0.09	<0.09	<0.09
	26.5	2-Jan-19	<0.09	<0.09	<0.09	14
	28.5	9-Jan-19	<0.09	6.2	<0.09	6.5
	30.4	17-Jan-19	4.6	4.7	4.8	5.3
	33.3	29-Jan-19	4.2	4.5	3.6	5.0
	35.2	6-Feb-19	4.6	6.9	7.2	7.2
	37.4	15-Feb-19	4.0	4.8	5.4	5.1
	39.2	27-Feb-19	<0.09	<0.09	<0.09	<0.09
	41.3	13-Mar-19	<0.09	5.4	<0.09	7.6
	42.9	19-Mar-19	5.0	5.6	5.9	9.3
	44.1	25-Mar-19	<0.09	<0.09	<0.09	<0.09
	45.8	1-Apr-19	<0.09	<0.09	<0.09	<0.09
	47.5	8-Apr-19	<0.09	<0.09	<0.09	<0.09
	49.5	17-Apr-19	<0.09	<0.09	<0.09	<0.09
	50.7	22-Apr-19	<0.09	<0.09	<0.09	<0.09
	52.3	29-Apr-19	<0.09	<0.09	<0.09	<0.09
	53.9	6-May-19	<0.09	<0.09	<0.09	<0.09
	55.5	13-May-19	<0.09	<0.09	<0.09	<0.09
	57.3	21-May-19	<0.09	<0.09	<0.09	<0.09
	58.5	27-May-19	<0.09	<0.09	<0.09	<0.09
	59.8	3-Jun-19	<0.09	<0.09	<0.09	<0.09
	61.2	10-Jun-19	<0.09	<0.09	<0.09	<0.09
	63.1	18-Jun-19	<0.09	<0.09	<0.09	<0.09
	64.7	26-Jun-19	<0.09	<0.09	<0.09	<0.09
	66.8	5-Jul-19	<0.09	<0.09	<0.09	<0.09
	67.5	8-Jul-19	<0.09	<0.09	<0.09	<0.09
	69.3	16-Jul-19	<0.09	<0.09	<0.09	<0.09
	70.1	22-Jul-19	<0.09	<0.09	<0.09	<0.09
	71.6	29-Jul-19	<0.09	<0.09	<0.09	<0.09
	73.5	6-Aug-19	<0.09	<0.09	<0.09	<0.09
	74.8	12-Aug-19	<0.09	<0.09	<0.09	<0.09
	76.4	19-Aug-19	<0.09	<0.09	<0.09	<0.09
	77.3	27-Aug-19	<0.09	<0.09	<0.09	<0.09
	78.9	3-Sep-19	<0.09	<0.09	<0.09	<0.09
	79.7	11-Sep-19	<0.09	<0.09	<0.09	<0.09
	80.3	18-Sep-19	<0.09	<0.09	<0.09	<0.09
	80.7	25-Sep-19	<0.09	<0.09	<0.09	<0.09
	81.5	2-Oct-19	<0.09	<0.09	<0.09	<0.09
	81.8	7-Oct-19	<0.09	<0.09	<0.09	<0.09
	82.8	15-Oct-19	<0.09	<0.09	<0.09	<0.09
	83.4	21-Oct-19	<0.09	<0.09	<0.09	<0.09
	84.2	28-Oct-19	<0.09	<0.09	<0.09	<0.09
	85.1	6-Nov-19	--	--	--	<0.09
	85.7	13-Nov-19	<0.09	--	--	<0.09
	86.8	18-Nov-19	<0.09	<0.09	<0.09	<0.09
	88.3	27-Nov-19	<0.09	<0.09	<0.09	<0.09
	89.1	3-Dec-19	<0.09	<0.09	<0.09	<0.09
	90.5	9-Dec-19	<0.09	<0.09	<0.09	<0.09
	92.3	19-Dec-19	<0.09	14	<0.09	<0.09
	94.2	30-Dec-19	<0.09	<0.09	<0.09	<0.09
	95.7	7-Jan-20	<0.09	<0.09	<0.09	<0.09
	96.7	16-Jan-20	<0.09	<0.09	<0.09	<0.09
	97.9	28-Jan-20	<0.09	<0.09	<0.09	<0.09

TABLE 8
WATER SAMPLE CHLORIDE, NITRITE-N, SULFATE, AND PHOSPHATE RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent	Port A	Port B	Effluent
			Concentration (mg/L)			
Sulfate	4.1	1-Nov-18	975	843	819	900
	8.9	12-Nov-18	898	988	1,043	1,068
	11.9	20-Nov-18	876	--	--	1,075
	14.9	3-Dec-18	1,032	863	935	1,148
	16.8	10-Dec-18	1,176	1,092	1,075	876
	19.2	18-Dec-18	939	943	1,139	942
	24.1	27-Dec-18	798	822	821	782
	26.5	2-Jan-19	1,003	1,035	866	1,205
	28.5	9-Jan-19	974	985	912	982.2
	30.4	17-Jan-19	1124	897	884	1052
	33.3	29-Jan-19	1,138	1,107	885	1,198
	35.2	6-Feb-19	1,116	1,119	1,178	1,121
	37.4	15-Feb-19	973	921	909	867
	39.2	27-Feb-19	904	927	963	1,024
	41.3	13-Mar-19	994	985	975	1,015
	42.9	19-Mar-19	1,222	1,185	1,282	950
	44.1	25-Mar-19	920	1,253	1,148	1,087
	45.8	1-Apr-19	844	915	899	974
	47.5	8-Apr-19	834	785	869	702
	49.5	17-Apr-19	718	810	886	745
	50.7	22-Apr-19	966	926	952	744
	52.3	29-Apr-19	828	711	588	635
	53.9	6-May-19	807	824	788	823
	55.5	13-May-19	891	745	784	906
	57.3	21-May-19	826	828	879	808
	58.5	27-May-19	910	1,153	1,146	961
	59.8	3-Jun-19	1,029	1,029	942	1,037
	61.2	10-Jun-19	793	976	758	723
	63.1	18-Jun-19	871	844	825	742
	64.7	26-Jun-19	1,333	1,377	1,254	1,327
	66.8	5-Jul-19	1,145	1,240	1,059	915
	67.5	8-Jul-19	998	978	970	858
	69.3	16-Jul-19	861	840	893	774
	70.1	22-Jul-19	991	940	804	1,003
	71.6	29-Jul-19	1,429	1,039	799	606
	--	1-Aug-19	810	--	--	865
	73.5	6-Aug-19	1,432	1,146	1,112	1,071
	74.8	12-Aug-19	1,199	859	809	986
	76.4	19-Aug-19	998	1,102	861	757
	77.3	27-Aug-19	867	835	878	882
	78.9	3-Sep-19	1,038	1,114	1,088	1,073
	79.7	11-Sep-19	856	783	801	801
	80.3	18-Sep-19	1,264	841	977	1,043
	80.7	25-Sep-19	890	504	546	566
	81.5	2-Oct-19	867	622	666	668
	81.8	7-Oct-19	969	564	542	575
	82.8	15-Oct-19	967	649	649	657
	83.4	21-Oct-19	1,009	759	835	617
	84.2	28-Oct-19	1,167	987	808	631
	85.7	13-Nov-19	1,011	--	--	223
	86.8	18-Nov-19	820	708	691	543
	88.3	27-Nov-19	946	713	647	604
	89.1	3-Dec-19	885	682	740	557
	90.5	9-Dec-19	876	546	553	530
	92.3	19-Dec-19	881	787	541	520
	94.2	30-Dec-19	917	685	545	516
	95.7	7-Jan-20	969	599	589	536
	96.7	16-Jan-20	915	473	382	412
	97.9	28-Jan-20	977	572	475	237

TABLE 8
WATER SAMPLE CHLORIDE, NITRITE-N, SULFATE, AND PHOSPHATE RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent	Port A	Port B	Effluent
			Concentration (mg/L)			
Phosphate	4.1	1-Nov-18	<0.07	<0.07	<0.07	<0.07
	8.9	12-Nov-18	7.5	4.6	4.6	4.9
	11.9	20-Nov-18	5.9	--	--	8.2
	14.9	3-Dec-18	10	6.8	8.8	5.9
	16.8	10-Dec-18	16	`	8.2	5.9
	19.2	18-Dec-18	9.4	8.9	9.6	12
	24.1	27-Dec-18	7.0	5.2	6.0	6.0
	26.5	2-Jan-19	12	11	9.3	9.1
	28.5	9-Jan-19	9.2	8.9	9.1	8.3
	30.4	17-Jan-19	10	7.3	7.2	8.4
	33.3	29-Jan-19	11	9.3	8.7	8.2
	35.2	6-Feb-19	4	1.8	2.1	1.9
	37.4	15-Feb-19	13	8.3	6.4	6.2
	39.2	27-Feb-19	13	6.7	7.9	8.9
	41.3	13-Mar-19	11	7.8	7.6	5.7
	42.9	19-Mar-19	15	12	12	10
	44.1	25-Mar-19	13	13	12	7.3
	45.8	1-Apr-19	14	11	12	11
	47.5	8-Apr-19	1.8	4.1	4.5	3.6
	49.5	17-Apr-19	1.7	4.1	4.3	3.7
	50.7	22-Apr-19	1.2	2.7	3.5	4.8
	52.3	29-Apr-19	0.76	1.6	1.5	1.6
	53.9	6-May-19	<0.07	1.8	1.9	2.3
	55.5	13-May-19	0.84	1.2	1.2	1.2
	57.3	21-May-19	1.2	0.7	1.8	2.9
	58.5	27-May-19	0.31	0.43	0.66	0.83
	59.8	3-Jun-19	<0.07	<0.07	<0.07	<0.07
	61.2	10-Jun-19	<0.07	<0.07	<0.07	<0.07
	63.1	18-Jun-19	<0.07	<0.07	<0.07	<0.07
	64.7	26-Jun-19	<0.07	<0.07	<0.07	<0.07
	66.8	5-Jul-19	<0.07	<0.07	<0.07	<0.07
	67.5	8-Jul-19	<0.07	<0.07	<0.07	<0.07
	69.3	16-Jul-19	<0.07	<0.07	<0.07	<0.07
	70.1	22-Jul-19	<0.07	<0.07	<0.07	<0.07
	71.6	29-Jul-19	<0.07	<0.07	<0.07	<0.07
	73.5	6-Aug-19	<0.07	<0.07	<0.07	<0.07
	74.8	12-Aug-19	<0.07	<0.07	<0.07	<0.07
	76.4	19-Aug-19	<0.07	<0.07	<0.07	<0.07
	77.3	27-Aug-19	<0.07	<0.07	<0.07	<0.07
	78.9	3-Sep-19	<0.07	<0.07	<0.07	<0.07
	79.7	11-Sep-19	<0.07	<0.07	<0.07	<0.07
	80.3	18-Sep-19	<0.07	<0.07	<0.07	<0.07
	80.7	25-Sep-19	<0.07	<0.07	<0.07	<0.07
	81.5	2-Oct-19	<0.07	<0.07	<0.07	<0.07
	81.8	7-Oct-19	<0.07	<0.07	<0.07	<0.07
	82.8	15-Oct-19	<0.07	<0.07	<0.07	<0.07
	83.4	21-Oct-19	<0.07	<0.07	<0.07	<0.07
	84.2	28-Oct-19	<0.07	<0.07	<0.07	<0.07
	85.7	13-Nov-19	<0.07	--	--	<0.07
	86.8	18-Nov-19	<0.07	<0.07	<0.07	<0.07
	88.3	27-Nov-19	<0.07	<0.07	<0.07	<0.07
	89.1	3-Dec-19	<0.07	<0.07	<0.07	<0.07
	90.5	9-Dec-19	<0.07	<0.07	<0.07	<0.07
	92.3	19-Dec-19	<0.07	<0.07	<0.07	<0.07
	94.2	30-Dec-19	<0.07	<0.07	<0.07	<0.07
	95.7	7-Jan-20	<0.07	<0.07	<0.07	<0.07
	96.7	16-Jan-20	<0.07	<0.07	<0.07	<0.07
	97.9	28-Jan-20	<0.07	<0.07	<0.07	<0.07

TABLE 8
WATER SAMPLE CHLORIDE, NITRITE-N, SULFATE, AND PHOSPHATE RESULTS
Grassy Mountain Project, Alberta

Analyte	PV	Date	Sample Location			
			Influent	Port A	Port B	Effluent
			Concentration (mg/L)			

Notes:

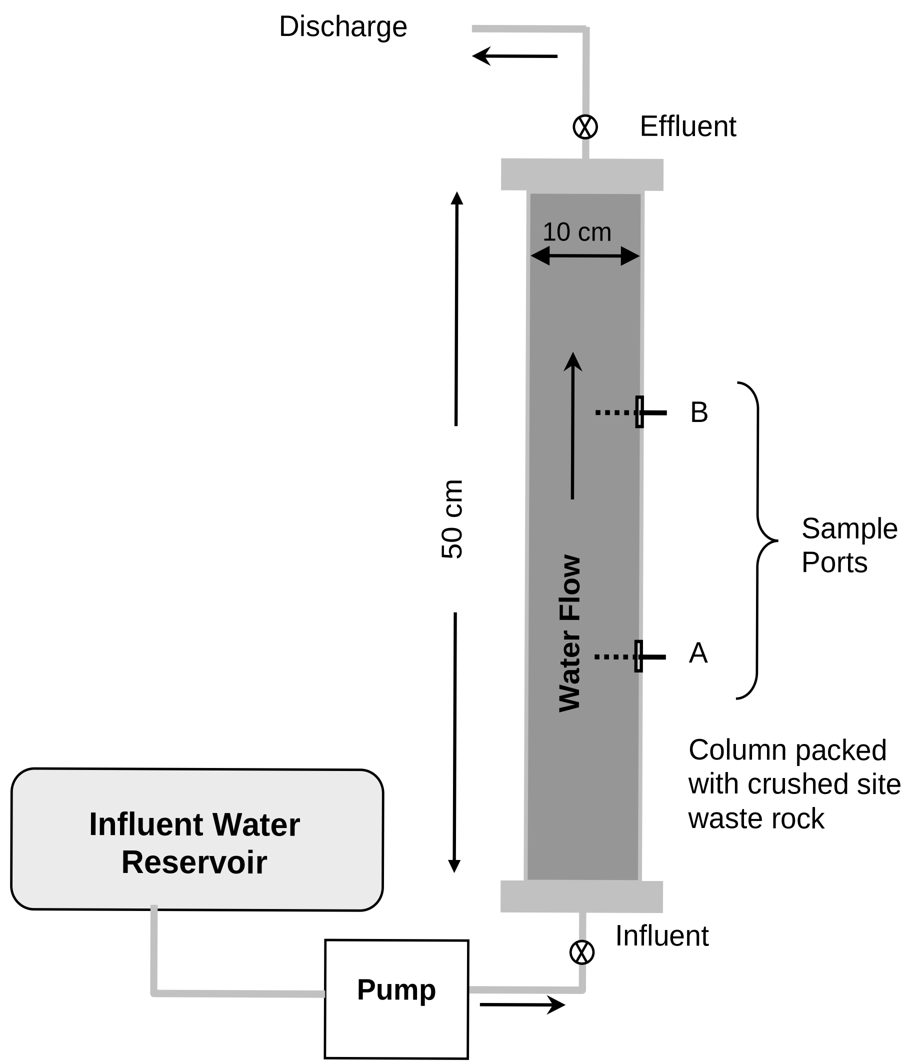
-- - sample not collected
< - not detected, associated value is the detection limit
mg/L - milligrams per litre
PV - pore volumes

TABLE 9
CALCULATED NITRATE AND Se REDUCTION RATES
Grassy Mountain Project, Alberta

Test Phase	Nitrate (as N) Reduction Rates			Se Reduction Rates		
	Influent Concentration (mg/L)	% Removal	Reduction Rate[1] (mg/L/day)	Influent Concentration (µg/L)	% Removal	Reduction Rate[2] (µg/L/day)
2 - Carbon underdosing 8 °C	35 - 50	2% - 100%	10 - 36	144 - 171	4% - 70%	5 - 86
3 - Optimal carbon dosing, 8°C	33 - 41	91% - 100%	24 - 30	117 - 147	76% - 90%	56 - 91
4 - Optimal carbon dosing, 4 °C	26 - 40	100%	20 - 30	155 - 203	74% - 93%	91 - 142
5 - Carbon overdosing, nitrate increased 100-200 mg/L, 8 °C	108 - 251	74% - 100%	40 - 188	156 - 276	52% - 87%	27 - 163
6 - Carbon overdosing, nitrate at 150 mg/L and Se increased to 1,000 µg/L	133 - 156	100%	55 - 93	1,020 - 1,520	46% - 96%	228 - 727

1 - Zero-order rate calculated based on the influent and Port A concentrations and the residence time
2 - Zero-order rate calculated based on the influent and effluent concentrations and the residence time

FIGURES



Notes:
cm - centimetre

Schematic of Column Set Up

Grassy Mountain Project, Alberta

Geosyntec consultants

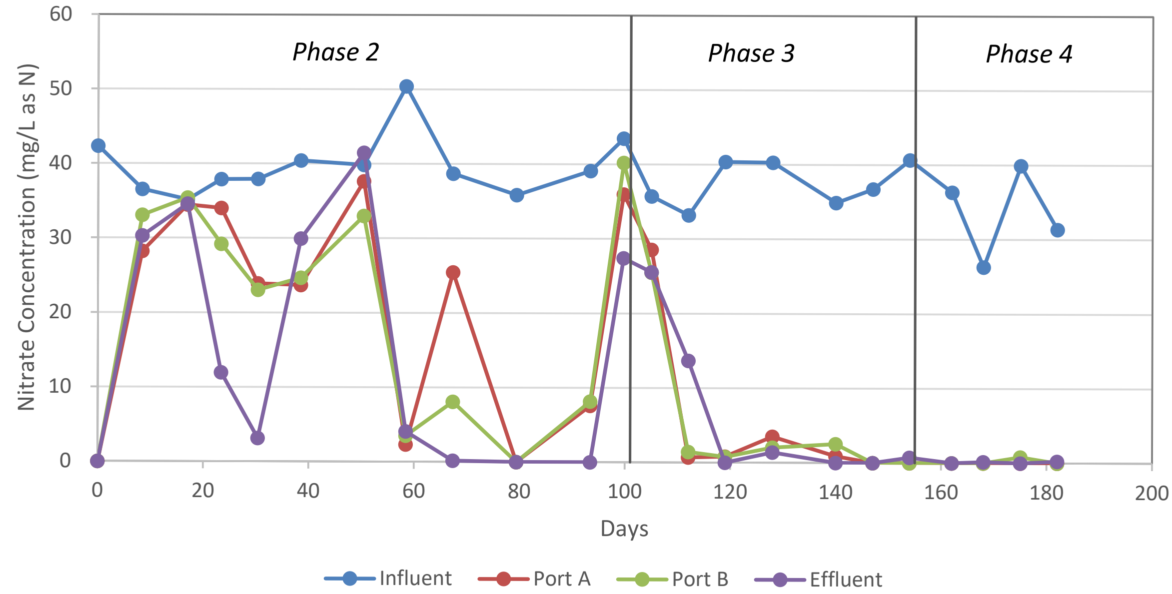
March 2020

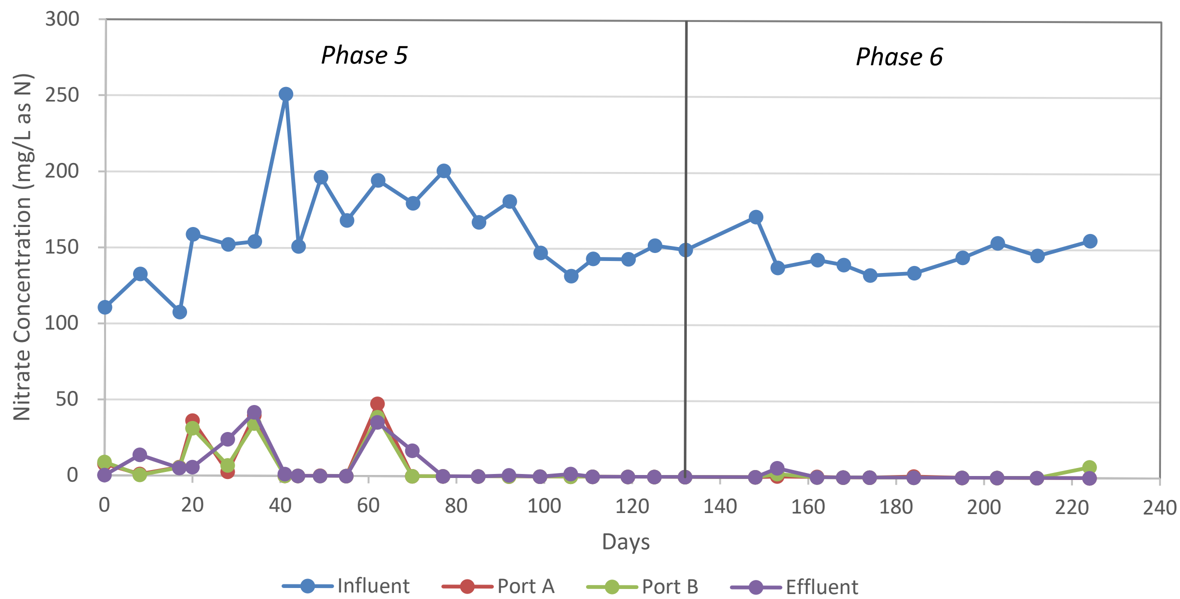
Figure: **1**

Photograph of Temperature Controlled Column Set Up

Grassy Mountain Project, Alberta

Geosyntec consultants	March 2020
	Figure: **2**





Notes:
Phase 1: - Startup at room temperature (not shown)
Phase 2: Carbon underdosing, 8 °C
Phase 3: Optimal carbon dosing, 8°C
Phase 4: Optimal carbon dosing, 4 °C
Phase 5: Carbon overdosing, nitrate increased 100-200 mg/L, 8 °C
Phase 6: Carbon overdosing, nitrate at 150 mg/L and selenium increased to 1,000 µg/L, 8 °C

Nitrate Concentrations in Column Sampling Ports during Test Period

Grassy Mountain Project, Alberta

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Figure 3

Guelph

March 2020

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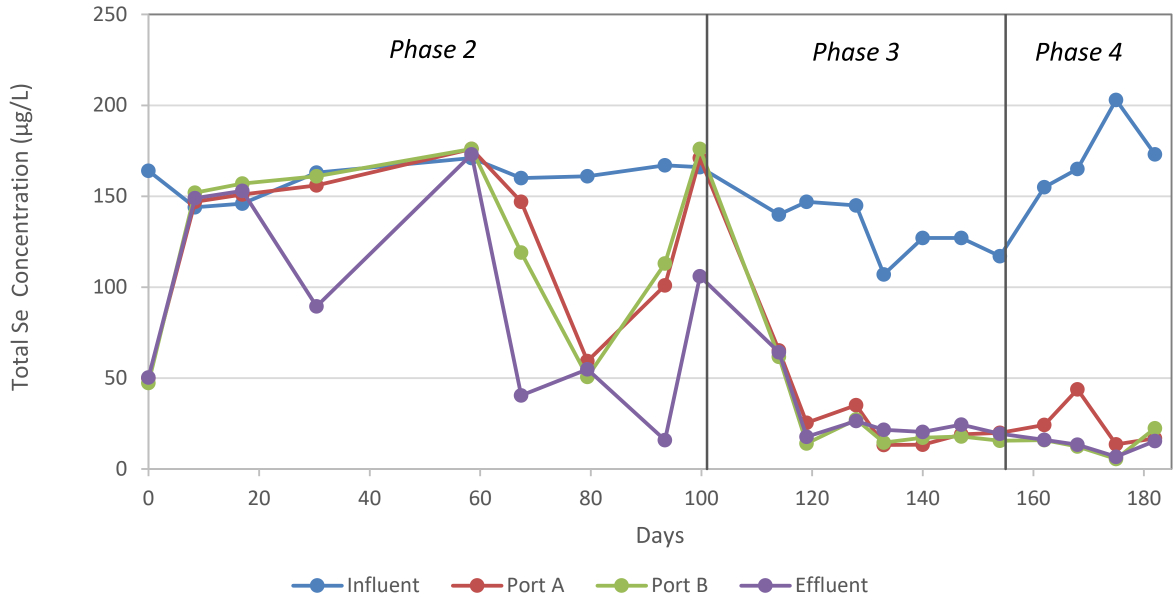

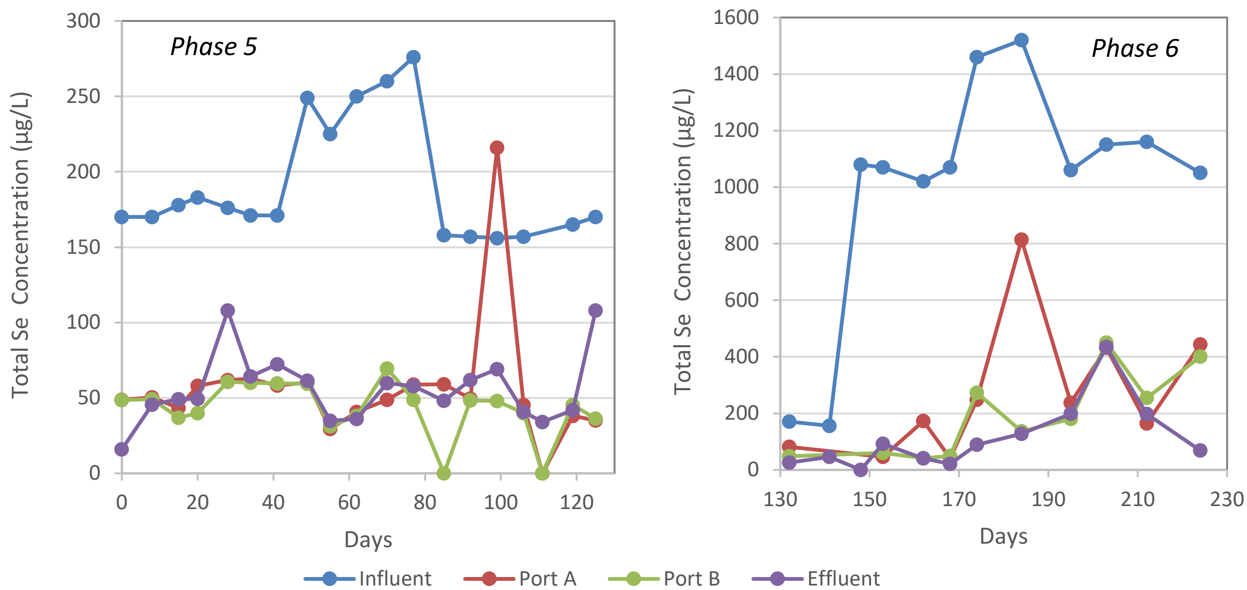

Notes:
Phase 1: - Startup at room temperature (not shown)
Phase 2: Carbon underdosing, 8 °C
Phase 3: Optimal carbon dosing, 8°C
Phase 4: Optimal carbon dosing, 4 °C
Phase 5: Carbon overdosing, nitrate increased 100-200 mg/L, 8 °C
Phase 6: Carbon overdosing, nitrate at 150 mg/L and Se increased to 1,000 ug/L, 8 °C

Total Selenium Concentrations in Column Sampling Ports during Test Period

Grassy Mountain Project, Alberta

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Figure 4

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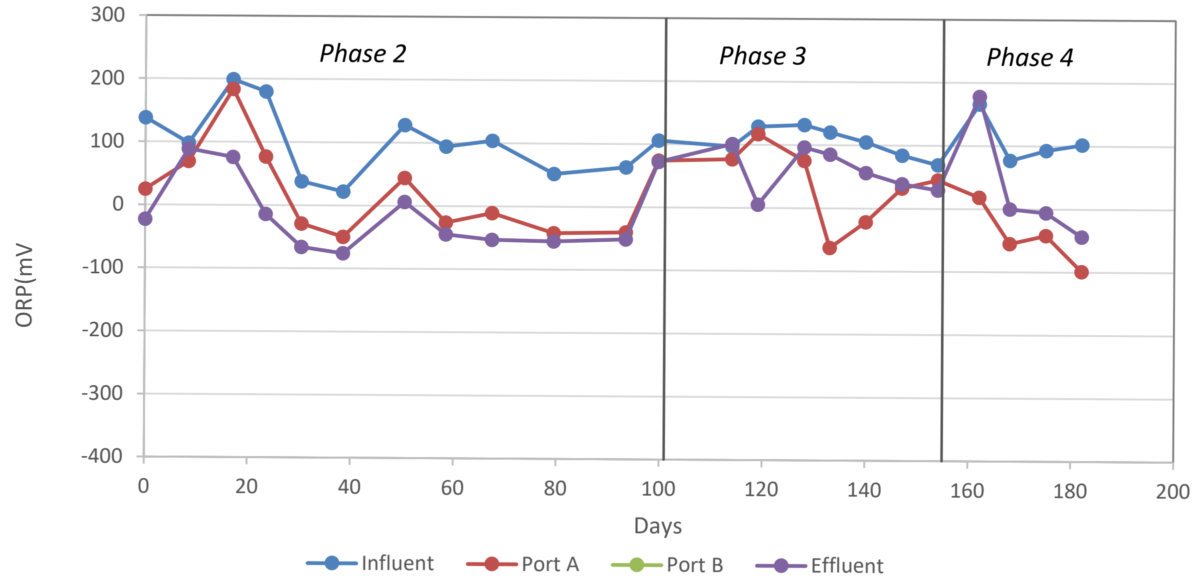

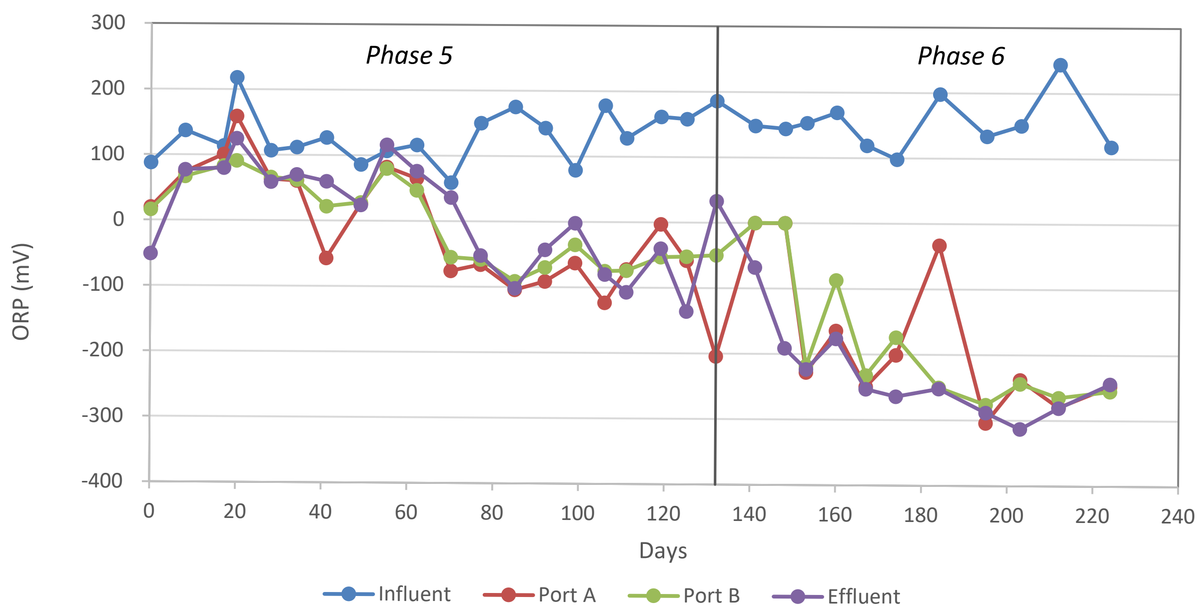

Notes:
Phase 1: - Startup at room temperature (not shown)
Phase 2: Carbon underdosing, 8 °C
Phase 3: Optimal carbon dosing, 8°C
Phase 4: Optimal carbon dosing, 4 °C
Phase 5: Carbon overdosing, nitrate increased 100-200 mg/L, 8 °C
Phase 6: Carbon overdosing, nitrate at 150 mg/L and Se increased to 1,000 ug/L, 8 °C

Oxidation-Reduction Potential (ORP) Values in Column Sampling Ports during Test Period

Grassy Mountain Project, Alberta

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Figure 5

Guelph | March 2020

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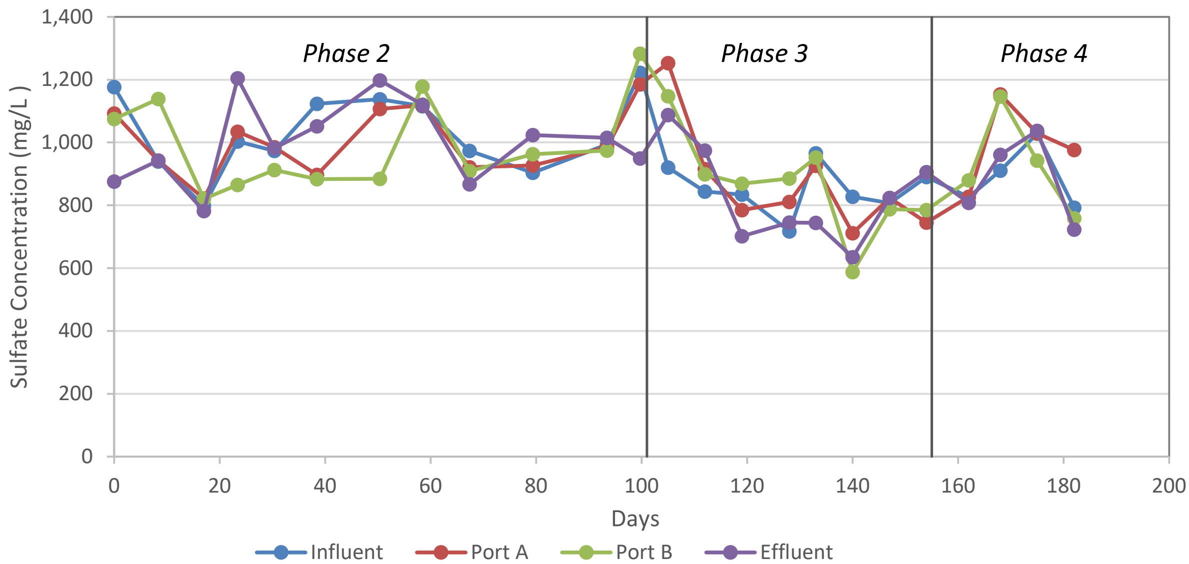

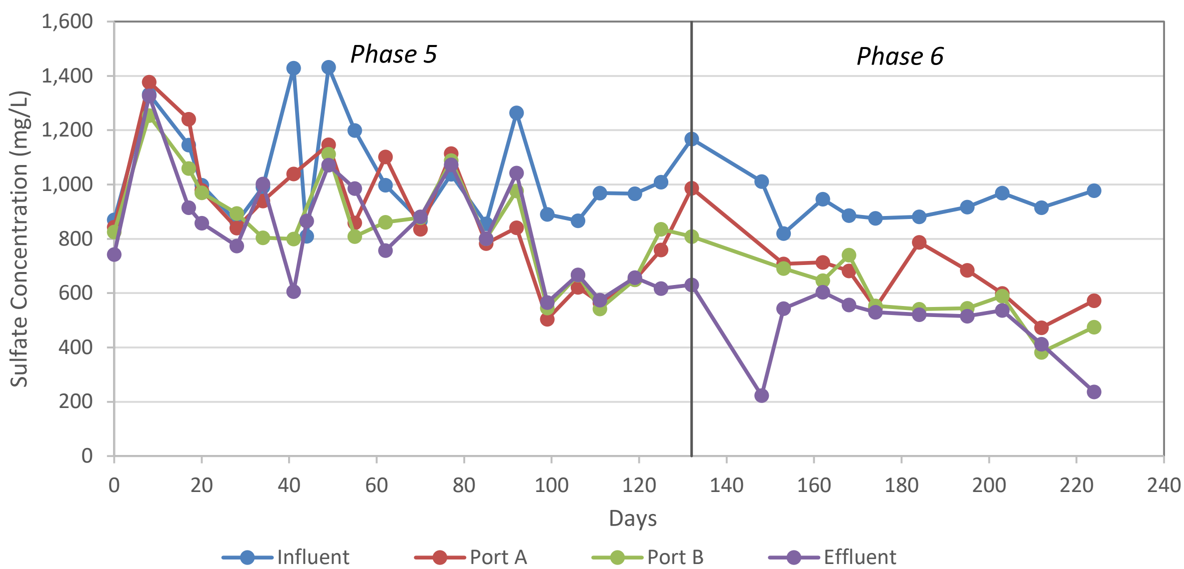

Notes:
Phase 1: - Startup at room temperature (not shown)
Phase 2: Carbon underdosing, 8 °C
Phase 3: Optimal carbon dosing, 8°C
Phase 4: Optimal carbon dosing, 4 °C
Phase 5: Carbon overdosing, nitrate increased 100-200 mg/L, 8 °C
Phase 6: Carbon overdosing, nitrate at 150 mg/L and Se increased to 1,000 ug/L, 8 °C

Sulphate Concentrations in Column Sampling Ports during Test Period Grassy Mountain Project, Alberta		
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Guelph	March 2020	

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APPENDIX A

CHAIN OF CUSTODY DOCUMENTATION

SiREM

Chain-of-Custody Form

siremlab.com

130 Stone Road West
Guelph ON, Canada N1G 3Z2
(519) 822-2265

Lab # S-5018

*Project Name: Grassy Mountain	*Project #:
*Project Manager: Alisdair Gibbons	*Company: Benga Mining Limited
*Email Address: <email address removed>	
Address (Street): <personal information removed>	
City: Blairmore	State/Province: Alberta / Country: Canada
*Phone #: <personal information removed>	
*Sampler's Signature: <Signature removed>	*Sampler's Printed Name: Bryan Kaentyes

Analysis

Client Sample ID	Sampling Date	Sampling Time	Matrix	# of Containers	Gene-Trac DHC	Gene-Trac VC	Gene-Trac DHB	Gene-Trac DHG	Treatability Study							Other Information
Grassy Mountain 1	9/17/2018	9:00	Rock	1					X							Geological core sample from well drilling activities.

Preservative Key
0. None
1. HCL
2. Other ____
3. Other ____
4. Other ____
5. Other ____
6. Other ____

Billing Information

P.O. #

*Bill To: Benga Mining Limited

Bridget.Buckle@rivresources.com

Turnaround Time Requested

Normal ☒
Rush ☐

For Lab Use Only

Cooler Condition: Ripped Cooler Bag

Cooler Temperature: 20°C

Custody Seals: Yes ☐ No ☒

For Lab Use Only

Proposal #: Si-3674-091118

Relinquished By:	Received By:	Relinquished By:	Received By:	Relinquished By:	Received By:
Signature <Original signed by>	Signature <Original signed by>	Signature	Signature	Signature	Signature
Printed Name Bryan Koentges	Printed Name Michael Healey	Printed Name	Printed Name	Printed Name	Printed Name
Firm Benga Mining Limit.	Firm SiREM Lab	Firm	Firm	Firm	Firm
Date/Time 09/17/2018	Date/Time 21Sep18/ 10:05 am	Date/Time	Date/Time	Date/Time	Date/Time

Distribution: White - return to Originator; Yellow - Lab Copy; Pink - Retained by Client

** Mandatory Fields*

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APPENDIX B:

ANALYTICAL METHODS

ANALYTICAL METHODS

This section describes the methods of analysis for ORP, pH, DO, anions, methanol, total Se and Se speciation.

Analysis of ORP and pH

The pH measurements were performed using an Oakton pH spear with combination pH electrode. A 0.5 mL sample was collected (as described in Section 3.3) and added to a 1.5 mL Eppendorf tube and the pH probe was inserted into the sample vial on the lab bench for pH measurement. The pH meter was calibrated at the beginning of each sampling session using pH 4.0, 7.0 and 10 standards.

The ORP measurements were performed using an Orion 250A meter with double junction ORP electrode. A 3.0 mL sample was collected and the ORP probe was inserted into the sample vial on the lab bench. A single point calibration of the meter was performed at each sampling event with Zobell ORP calibration solution according to the manufacturer's instructions.

Analysis of Major Anions and Total VFAs

Anion analysis was performed on a Thermo-Fisher ICS-2100 ion chromatograph (IC) equipped with a Thermo-Fisher AS-DV auto sampler and an AS18 column. The sample loop volume was 25 µL. An isocratic separation was performed using 33 millimolar (mM) reagent grade sodium hydroxide (Thermo Scientific, Oakville, ON) eluent for 15 min at a flow rate of 0.25 mL/min. One standard was analyzed with each set of samples tested to verify the seven-point calibration using external standards of known concentrations. External standards were prepared gravimetrically using chemicals of the highest purity available (Sigma St Louis, MO or Bioshop, Burlington, ON). Data were integrated using Chromeleon 7 Chromatography software (Thermo Scientific, Oakville, ON). The quantitation limits (QLs) were as follows: 0.07 mg/L total VFAs, 0.07 mg/L chloride, 0.09 mg/L nitrite, 0.09 mg/L nitrate, 0.07 mg/L sulfate, 0.07 mg/L phosphate and 0.08 mg/L bromide.

A 0.5 mL sample was withdrawn (as described in section 3.5.1), after which the sample was placed in a 1.5 mL micro-centrifuge tube. Samples were centrifuged for five minutes at 13,000 revolutions per minute (RPM) to remove solids. The supernatant was sub-sampled, diluted 50-fold in deionized water and placed in a Thermo-Fisher auto sampler vial with a cap that filters the sample during automated injection onto the IC.\

Analysis of Methanol

This section describes the methods used to quantify methanol at SiREM. The quantitation limit for methanol was 1 mg/L in the reactors based on the lowest concentration standards that were included in the linear calibration trend.

Aqueous methanol concentrations in the reactors were measured using an Agilent 7890B gas chromatograph equipped with an Agilent 7693 liquid injection auto sampler programmed to inject 1 microliter of sample into a HP-5 column (0.32 millimeters x 30 meters with a 0.25 µm film, J&W)

with FID detection. The inlet temperature was 250 °C and operated in splitless mode and the detector temperature was 300 °C. The oven temperature was programmed as follows: 30 °C for 5 min, increased to 48 °C at 5 degrees Celsius per minute (°C/min) and held for 2 min and finally increased to 220 °C at a rate of 50 °C/min and held for 5 min. The carrier gas was helium at a flow rate of 6.5 mL/min.

After withdrawing a 0.5 mL sample from the reactors, the sample was filtered through a 0.45 µm syringe filter into a 1.5 mL glass vial with screw-top septa cap (Agilent, Mississauga, ON). The vial was loaded on to the autosampler for automated injection of 1 µL of filtered groundwater. One methanol standard was analysed with each set of samples to verify the instrument eight-point calibration curve. Calibration was performed using external standard solutions (Sigma, St Louis, MO), where known volumes of standard solutions were prepared and analysed as described above for microcosm samples. Data were integrated using Chemstation Software (Agilent Technologies, Santa Clara, CA).

Analysis of Gene-Trac® NGS

A 50 mL sample was collected from the effluent for NGS analysis on 16 Sep 2019 (Phase 5) and 9 Dec 2019 (Phase 6). These samples were refrigerated until they were filtered and stabilized within 7 days of collection. Deoxyribonucleic acid was extracted and submitted to Delta Genomics (Edmonton, AB) for sequencing using Illumina® platform. The sequencing results were analyzed by SiREM. The NGS procedures and report are provided in Appendix D.

Analysis of Total Metals and Se Speciation

SGS, Lakefield, Ontario performed the following analyses:

- Total metals analysis using SM 3030/EPA 200.8
- Se speciation analysis using custom ICP-MS method
- Major anion analysis using EPA 300.1

Brooks Applied Lab, Bothell, WA performed the following analyses:

- Total recoverable Se analysis using a modified EPA 1638 method
- Se speciation analysis using a custom IC-ICP-CRC-MS method

APPENDIX C:

SGS LABORATORY REPORTS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

12-December-2018

SiREM Laboratory
Attn : Alicia Hill

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada
<contact information removed>

Date Rec. : 06 December 2018
LR Report: **CA12222-DEC18**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SI-3674-Efflent-12/3/2018	6: SI-3674-Port B-12/3/2018	7: SI-3674- Port A-12/3/2018	8: SI-3674- Influent-12/3/2018
Sample Date & Time					03-Dec-18 12:00	03-Dec-18 12:00	03-Dec-18 12:00	03-Dec-18 12:00
Temp Upon Receipt [°C]	---	---	---	---	6.0	6.0	6.0	6.0
Ag (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.003	0.003	0.004	0.018
As (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.0021	0.0017	0.0016	< 0.0002
Ba (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.0843	0.0635	0.0622	0.00643
Be (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.007	0.007	0.008	0.008
Bi (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.000008	0.000015	0.000034	0.000008
Ca (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	270	263	265	328
Cd (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.000064	0.000021	0.000013	0.000010
Co (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.00176	0.00256	0.00190	0.000353
Cr (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.00048	0.00046	0.00039	0.00177
Cu (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.00113	0.00389	0.00520	0.0114
Fe (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.016	0.031	0.041	0.121
K (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	155	151	151	160
Li (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.0014	0.0012	0.0013	0.0009
Mg (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	158	153	156	159
Mn (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.151	0.140	0.165	0.00523
Mo (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.00115	0.00095	0.00094	0.00019
Na (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	76.6	74.0	76.1	76.8

SGS Canada Inc.
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LR Report : CA12222-DEC18

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SI-3674-Efflent-12/3/2018	6: SI-3674-Port B-12/3/2018	7: SI-3674- Port A-12/3/2018	8: SI-3674- Influent-12/3/2018
Ni (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.0054	0.106	0.132	0.0014
Pb (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.00002	0.00035	0.00028	0.00297
Sb (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.0004	0.0004	0.0004	< 0.0002
Se (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.0503	0.0473	0.0499	0.164
Sn (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.00034	0.00028	0.00041	0.00025
Sr (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.132	0.126	0.128	0.155
Ti (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.00034	0.00041	0.00038	0.00228
Tl (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.000707	0.000320	0.000246	< 0.000005
U (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.000797	0.000688	0.000593	0.000019
V (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.00045	0.00021	0.00016	0.00003
W (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.00012	0.00011	0.00010	0.00002
Y (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.000015	0.000013	0.000012	0.00213
Zn (tot) [mg/L]	10-Dec-18	21:02	11-Dec-18	15:52	0.007	0.011	0.017	0.026

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
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28-December-2018

SiREM Laboratory
Attn : Alicia Hill

130 Stone Road W
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N1G 3Z2, Canada
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Date Rec. : 20 December 2018
LR Report: **CA13458-DEC18**
Reference: Si-3674

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SI-3674-Effluent-12/18/2018	6: SI-3674-Port B-12/18/2018	7: SI-3674- Port A-12/18/2018	8: SI-3674- Influent-12/18/2018
Sample Date & Time					18-Dec-18 12:00	18-Dec-18 12:00	18-Dec-18 12:00	18-Dec-18 12:00
Temp Upon Receipt [°C]	---	---	---	---	2.0	2.0	2.0	2.0
Ag (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.002	0.008	0.002	0.011
As (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.0016	0.0016	0.0013	< 0.0002
Ba (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.0576	0.0566	0.0486	0.0348
Be (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	< 0.000007	< 0.000007	< 0.000007	0.000007
B (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.013	0.014	0.015	0.016
Bi (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.000008	0.000047	0.000008	0.000023
Ca (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	274	284	281	302
Cd (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.000066	0.000074	0.000171	0.000017
Co (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.00193	0.00179	0.00137	0.000639
Cr (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.00063	0.00064	0.00062	0.00186
Cu (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.00131	0.00094	0.00150	0.0146
Fe (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	< 0.007	0.020	< 0.007	0.333
K (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	128	133	133	139

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SGS Canada Inc.
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LR Report : CA13458-DEC18

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SI-3674-Effluent-12/18/2018	6: SI-3674-Port B-12/18/2018	7: SI-3674- Port A-12/18/2018	8: SI-3674- Influent-12/18/2018
Li (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.0012	0.0012	0.0012	0.0010
Mg (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	156	157	153	150
Mn (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.161	0.154	0.121	0.00973
Mo (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.00051	0.00050	0.00040	0.00012
Na (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	76.2	76.8	76.3	75.6
Ni (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.0143	0.0242	0.0884	0.0021
Pb (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.00049	0.00049	0.00046	0.00225
Sb (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.0003	0.0002	0.0002	< 0.0002
Se (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.149	0.152	0.147	0.144
Sn (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.00047	0.00040	0.00033	0.00053
Sr (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.425	0.429	0.444	0.550
Ti (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.00038	0.00044	0.00030	0.00095
Tl (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.000538	0.000449	0.000338	0.000007
U (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.000257	0.000236	0.000199	0.000012
V (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.00186	0.00173	0.00104	0.00005
W (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.00004	0.00003	0.00003	0.00002
Y (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.000009	0.000009	0.000005	0.000704
Zn (tot) [mg/L]	21-Dec-18	09:30	27-Dec-18	13:03	0.006	0.009	0.010	0.055

<Original signed by>

CHARTERED CATHARINE ARNOLD CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
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Phone: 705-652-2000 FAX: 705-652-6365

07-January-2019

SiREM Laboratory
Attn : Alicia Hill

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Guelph, ON
N1G 3Z2, Canada

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Date Rec. : 28 December 2018
LR Report: **CA14615-DEC18**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Riversdale_Effl_ 27Dec18	6: Riversdale_Port B_ 27Dec18
Sample Date & Time					27-Dec-18 10:30	27-Dec-18 12:30
Temp Upon Receipt [°C]	---	---	---	---	6.0	6.0
Ag (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	< 0.00005	< 0.00005
Al (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.003	0.002
As (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0009	0.0009
Ba (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0413	0.0422
Be (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	< 0.000007	< 0.000007
B (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.020	0.020
Bi (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000042	0.000033
Ca (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	285	292
Cd (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000193	0.000205
Co (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00136	0.00132
Cr (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00098	0.00078
Cu (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0251	0.00141
Fe (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.015	0.007
K (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	156	162
Li (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0027	0.0011
Mg (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	175	178
Mn (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0785	0.0821
Mo (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00033	0.00026
Na (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	84.0	84.3
Ni (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0191	0.0269
Pb (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00088	0.00020
Sb (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	< 0.0002	< 0.0002
Se (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.153	0.157
Sn (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00054	0.00037
Sr (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.137	0.144
Ti (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00050	0.00052

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0001623804

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LR Report : **CA14615-DEC18**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Riversdale_Effl_27Dec18	6: Riversdale_Port B_27Dec18
Tl (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000384	0.000377
U (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000188	0.000136
V (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00083	0.00092
W (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00223	0.00006
Y (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000023	0.000003
Zn (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.045	0.011

Analysis	7: Riversdale_Port A_27Dec18	8: Riversdale_Infl_27Dec-18
Sample Date & Time	27-Dec-18 14:30	27-Dec-18 16:00
Temp Upon Receipt [°C]	6.0	6.0
Ag (tot) [mg/L]	< 0.00005	< 0.00005
Al (tot) [mg/L]	0.002	0.009
As (tot) [mg/L]	0.0009	< 0.0002
Ba (tot) [mg/L]	0.0382	0.00937
Be (tot) [mg/L]	< 0.000007	< 0.000007
B (tot) [mg/L]	0.020	0.021
Bi (tot) [mg/L]	0.000107	0.000035
Ca (tot) [mg/L]	278	291
Cd (tot) [mg/L]	0.000228	0.000021
Co (tot) [mg/L]	0.00116	0.00103
Cr (tot) [mg/L]	0.00140	0.00143
Cu (tot) [mg/L]	0.00277	0.00432
Fe (tot) [mg/L]	0.009	0.036
K (tot) [mg/L]	153	162
Li (tot) [mg/L]	0.0016	0.0010
Mg (tot) [mg/L]	177	182
Mn (tot) [mg/L]	0.0742	0.00919
Mo (tot) [mg/L]	0.00025	0.00006
Na (tot) [mg/L]	83.2	87.9
Ni (tot) [mg/L]	0.0410	0.0022
Pb (tot) [mg/L]	0.00014	0.00025
Sb (tot) [mg/L]	< 0.0002	< 0.0002
Se (tot) [mg/L]	0.151	0.146
Sn (tot) [mg/L]	0.00111	0.00124
Sr (tot) [mg/L]	0.137	0.0909
Ti (tot) [mg/L]	0.00053	0.00070
Tl (tot) [mg/L]	0.000335	0.000007
U (tot) [mg/L]	0.000138	0.000047
V (tot) [mg/L]	0.00075	0.00005
W (tot) [mg/L]	0.00003	0.00003

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA14615-DEC18**

Analysis	**7: Riversdale_Port A_27Dec18**	**8: Riversdale_Infl_27Dec-18**
Y (tot) [mg/L]	0.000004	0.000079
Zn (tot) [mg/L]	0.013	0.026

<Original signed by>

CHARTERED
CATHARINE ARNOLD
CHEMIST
ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

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21-January-2019

SiREM Laboratory
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Date Rec. : 11 January 2019
LR Report: **CA12268-JAN19**
Reference: Si-3674

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-1/9/2019	6: Si-3674-Port B-1/9/2019	7: Si-3674-Port A-1/9/2019	8: Si-3674-Influent-1/9/2019
Sample Date & Time					09-Jan-19 12:00	09-Jan-19 12:00	09-Jan-19 12:00	09-Jan-19 12:00
Temp Upon Receipt [°C]	---	---	---	---	2.0	2.0	2.0	2.0
Ag (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.00066	0.00045	0.00113	0.00040
Al (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.003	0.001	0.002	0.007
As (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.0013	0.0009	0.0008	< 0.0002
Ba (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.0398	0.0369	0.0306	0.00699
Be (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.019	0.019	0.019	0.021
Bi (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.000032	0.000024	0.000032	0.000023
Ca (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	277	281	290	291
Cd (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.000105	0.000019	0.000089	< 0.000003
Co (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.000987	0.000960	0.000734	0.000046
Cr (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.00156	0.00161	0.00154	0.00211
Cu (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.00310	0.00290	0.00042	0.00071
Fe (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.009	< 0.007	0.012	< 0.007
K (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	162	163	169	170

OnLine LIMS

0001637470

CPAWS 96

SGS Canada Inc.
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LR Report : CA12268-JAN19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-1/9/2019	6: Si-3674-Port B-1/9/2019	7: Si-3674-Port A-1/9/2019	8: Si-3674-Influent-1/9/2019
Li (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.0010	0.0009	0.0009	0.0009
Mg (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	157	156	157	155
Mn (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.0775	0.0646	0.0512	0.00061
Mo (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.00059	0.00046	0.00026	0.00032
Na (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	79.7	79.1	79.0	78.6
Ni (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.0040	0.0097	0.0458	0.0016
Pb (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.00014	0.00005	< 0.00001	0.00006
Sb (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Se (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.0895	0.161	0.156	0.163
Sn (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.00008	0.00006	0.00006	0.00033
Sr (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.329	0.371	0.388	0.437
Ti (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.00072	0.00025	0.00036	0.00029
Tl (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.000351	0.000271	0.000213	0.000006
U (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.000316	0.000148	0.000141	0.000006
V (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.00084	0.00059	0.00059	0.00003
W (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.00026	0.00013	0.00008	0.00005
Y (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.000009	0.000011	0.000007	< 0.000002
Zn (tot) [mg/L]	16-Jan-19	19:31	17-Jan-19	16:31	0.017	0.012	0.004	0.005

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0001637470

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07-January-2019

SiREM Laboratory
Attn : Alicia Hill

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

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Date Rec. : 28 December 2018
LR Report: **CA14615-DEC18**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Riversdale_Effl_ 27Dec18	6: Riversdale_Port B_ 27Dec18
Sample Date & Time					27-Dec-18 10:30	27-Dec-18 12:30
Temp Upon Receipt [°C]	---	---	---	---	6.0	6.0
Ag (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	< 0.00005	< 0.00005
Al (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.003	0.002
As (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0009	0.0009
Ba (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0413	0.0422
Be (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	< 0.000007	< 0.000007
B (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.020	0.020
Bi (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000042	0.000033
Ca (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	285	292
Cd (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000193	0.000205
Co (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00136	0.00132
Cr (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00098	0.00078
Cu (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0251	0.00141
Fe (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.015	0.007
K (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	156	162
Li (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0027	0.0011
Mg (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	175	178
Mn (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0785	0.0821
Mo (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00033	0.00026
Na (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	84.0	84.3
Ni (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.0191	0.0269
Pb (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00088	0.00020
Sb (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	< 0.0002	< 0.0002
Se (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.153	0.157
Sn (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00054	0.00037
Sr (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.137	0.144
Ti (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00050	0.00052

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LR Report : CA14615-DEC18

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Riversdale_Effl_27Dec18	6: Riversdale_Port B_27Dec18
Tl (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000384	0.000377
U (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000188	0.000136
V (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00083	0.00092
W (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.00223	0.00006
Y (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.000023	0.000003
Zn (tot) [mg/L]	03-Jan-19	11:14	04-Jan-19	16:41	0.045	0.011

Analysis	7: Riversdale_Port A_27Dec18	8: Riversdale_Infl_27Dec-18
Sample Date & Time	27-Dec-18 14:30	27-Dec-18 16:00
Temp Upon Receipt [°C]	6.0	6.0
Ag (tot) [mg/L]	< 0.00005	< 0.00005
Al (tot) [mg/L]	0.002	0.009
As (tot) [mg/L]	0.0009	< 0.0002
Ba (tot) [mg/L]	0.0382	0.00937
Be (tot) [mg/L]	< 0.000007	< 0.000007
B (tot) [mg/L]	0.020	0.021
Bi (tot) [mg/L]	0.000107	0.000035
Ca (tot) [mg/L]	278	291
Cd (tot) [mg/L]	0.000228	0.000021
Co (tot) [mg/L]	0.00116	0.00103
Cr (tot) [mg/L]	0.00140	0.00143
Cu (tot) [mg/L]	0.00277	0.00432
Fe (tot) [mg/L]	0.009	0.036
K (tot) [mg/L]	153	162
Li (tot) [mg/L]	0.0016	0.0010
Mg (tot) [mg/L]	177	182
Mn (tot) [mg/L]	0.0742	0.00919
Mo (tot) [mg/L]	0.00025	0.00006
Na (tot) [mg/L]	83.2	87.9
Ni (tot) [mg/L]	0.0410	0.0022
Pb (tot) [mg/L]	0.00014	0.00025
Sb (tot) [mg/L]	< 0.0002	< 0.0002
Se (tot) [mg/L]	0.151	0.146
Sn (tot) [mg/L]	0.00111	0.00124
Sr (tot) [mg/L]	0.137	0.0909
Ti (tot) [mg/L]	0.00053	0.00070
Tl (tot) [mg/L]	0.000335	0.000007
U (tot) [mg/L]	0.000138	0.000047
V (tot) [mg/L]	0.00075	0.00005
W (tot) [mg/L]	0.00003	0.00003

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LR Report : CA14615-DEC18

Analysis	7: Riversdale_Port A_27Dec18	8: Riversdale_Infl_27Dec-18
Y (tot) [mg/L]	0.000004	0.000079
Zn (tot) [mg/L]	0.013	0.026

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ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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21-February-2019

SiREM Laboratory
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N1G 3Z2, Canada
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Date Rec. : 12 February 2019
LR Report: **CA13315-FEB19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-2/6/2019	6: Si-3674-Port B-2/6/2019	7: Si-3674-Port A-2/6/2019	8: Si-3674-Influent-2/6/2019
Sample Date & Time					06-Feb-19 12:00	06-Feb-19 12:00	06-Feb-19 12:00	06-Feb-19 12:00
Temp Upon Receipt [°C]	---	---	---	---	1.0	1.0	1.0	1.0
Ag (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.002	0.002	0.002	0.002
As (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.0011	0.0010	0.0010	< 0.0002
Ba (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.0313	0.0293	0.0282	0.00224
Be (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.016	0.017	0.017	0.018
Bi (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.000008	0.000010	0.000011	< 0.000007
Ca (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	246	244	255	246
Cd (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.000067	0.000056	0.000075	0.000006
Co (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.000588	0.000537	0.000548	0.000716
Cr (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.00031	0.00031	0.00046	0.00081
Cu (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.00170	0.00150	0.00180	0.00142
Fe (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	< 0.007	0.007	0.016	0.028
K (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	141	139	144	138

OnLine LIMS

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LR Report : CA13315-FEB19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-2/6/2019	6: Si-3674-Port B-2/6/2019	7: Si-3674-Port A-2/6/2019	8: Si-3674-Influent-2/6/2019
Li (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.0035	0.0038	0.0041	0.0027
Mg (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	137	137	132	135
Mn (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.0490	0.0417	0.0406	0.00552
Mo (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.00027	0.00022	0.00029	0.00012
Na (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	69.3	70.9	68.7	70.0
Ni (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.0018	0.0293	0.0105	0.0010
Pb (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.00009	0.00006	0.00002	0.00003
Sb (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Se (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.173	0.176	0.176	0.171
Sn (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.00054	0.00025	0.00037	0.00073
Sr (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.152	0.142	0.142	0.0852
Ti (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.00028	0.00028	0.00033	0.00050
Tl (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.000249	0.000231	0.000226	< 0.000005
U (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.000201	0.000210	0.000202	0.000011
V (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.00057	0.00054	0.00053	0.00004
W (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Y (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.000006	0.000005	0.000009	0.000011
Zn (tot) [mg/L]	14-Feb-19	09:35	15-Feb-19	10:28	0.004	0.011	0.006	0.021

<Original signed by>

CHARTERED CATHARINE ARNOLD CHEMIST ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
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OnLine LIMS

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CPAWS 102

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27-February-2019

SiREM Laboratory
Attn : Alicia Hill

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Date Rec. : 20 February 2019
LR Report: **CA12536-FEB19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-2/15/2019	6: Si-3674-Port B-2/15/2019	7: Si-3674-Port A-2/15/2019	8: Si-3674-Influent-2/15/2019
Sample Date & Time					15-Feb-19 12:00	15-Feb-19 12:00	15-Feb-19 12:00	15-Feb-19 12:00
Temp Upon Receipt [°C]	---	---	---	---	5.0	5.0	5.0	5.0
Ag (tot) [mg/L]	22-Feb-19	15:27	27-Feb-19	10:59	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.004	0.002	0.002	0.001
As (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.0009	0.0010	0.0008	< 0.0002
Ba (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.0321	0.0298	0.0262	0.00206
Be (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.019	0.020	0.023	0.024
Bi (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.000009	< 0.000007	< 0.000007	< 0.000007
Ca (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	248	245	253	256
Cd (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.000028	0.000009	0.000032	0.000018
Co (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.000709	0.000663	0.000602	0.000542
Cr (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.00133	0.00032	0.00046	0.00098
Cu (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.00091	0.00992	0.00381	0.00180
Fe (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.024	0.007	0.007	0.038
K (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	150	146	149	149

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LR Report : CA12536-FEB19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-2/15/2019	6: Si-3674-Port B-2/15/2019	7: Si-3674-Port A-2/15/2019	8: Si-3674-Influent-2/15/2019
Li (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.0013	0.0010	0.0011	0.0008
Mg (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	138	137	134	141
Mn (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.0504	0.0456	0.0371	0.00475
Mo (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.00064	0.00030	0.00024	0.00019
Na (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	70.0	70.8	69.5	71.3
Ni (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.0032	0.0242	0.0384	0.0012
Pb (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.00003	0.00025	0.00014	< 0.00001
Sb (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Se (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.0404	0.119	0.147	0.160
Sn (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.00222	0.00025	0.00035	0.00034
Sr (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.130	0.123	0.108	0.0847
Ti (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.00038	0.00036	0.00034	0.00048
Tl (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.000106	0.000173	0.000263	< 0.000005
U (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.000312	0.000216	0.000129	0.000015
V (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.00024	0.00024	0.00038	0.00003
W (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.00004	0.00003	0.00003	0.00007
Y (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.000006	0.000002	0.000003	0.000010
Zn (tot) [mg/L]	22-Feb-19	15:27	25-Feb-19	11:47	0.005	0.021	0.015	0.016

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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CHEMIST

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22-March-2019

SiREM Laboratory
Attn : Alicia Hill

130 Stone Road W, Guelph
Canada, N1G 3Z2
<contact information removed>

Date Rec. : 15 March 2019
LR Report: **CA12495-MAR19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Completed Date**	**4: Analysis Completed Time**	**5: Si-3674-Effluent-3/13/2019**	**6: Si-3674-Port B-3/13/2019**	**7: Si-3674-Port A-3/13/2019**	**8: Si-3674-Influent-3/13/2019**
Sample Date & Time					13-Mar-19 12:00	13-Mar-19 12:00	13-Mar-19 12:00	13-Mar-19 12:00
Temp Upon Receipt [°C]	---	---	---	---	6.0	6.0	6.0	6.0
Ag (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	< 0.00005	< 0.00005	< 0.00005	0.00088
Al (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.003	0.002	0.002	0.033
As (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.0010	0.0010	0.0009	0.0003
Ba (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.0302	0.0239	0.0229	0.0220
Be (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	< 0.000007	< 0.000007	< 0.000007	0.000012
B (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.014	0.016	0.015	0.019
Bi (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.000007	< 0.000007	0.000016	0.000161
Ca (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	237	240	244	489
Cd (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.000010	0.000005	< 0.000003	0.000184
Co (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.00113	0.000882	0.000694	0.000699
Cr (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.00039	0.00044	0.00033	0.00291
Cu (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.0008	0.0019	0.0034	0.0339
Fe (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.031	0.012	0.010	0.233
K (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	152	152	156	161
Li (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.0008	0.0009	0.0008	0.0009
Mg (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	135	134	136	140
Mn (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.0920	0.0569	0.0549	0.0118
Mo (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.00046	0.00015	0.00015	0.00015
Na (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	67.9	67.5	67.2	69.2
Ni (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.0027	0.0137	0.0028	0.0016
Pb (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.00002	0.00003	0.00012	0.00808
Sb (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.0158	0.113	0.101	0.167
Sn (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.00031	0.00034	0.00028	0.00111
Sr (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.312	0.368	0.379	0.979
Ti (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.00050	0.00038	0.00032	0.00084
Tl (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.000048	0.000046	0.000052	< 0.000005
U (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.000258	0.000099	0.000102	0.000028
V (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.00007	0.00006	0.00008	0.00009
W (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.00003	< 0.00002	< 0.00002	< 0.00002

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LR Report : CA12495-MAR19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-3/13/2019	6: Si-3674-Port B-3/13/2019	7: Si-3674-Port A-3/13/2019	8: Si-3674-Influent-3/13/2019
Y (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.000016	< 0.000002	0.000004	0.000561
Zn (tot) [mg/L]	19-Mar-19	11:47	21-Mar-19	09:53	0.003	0.007	0.010	0.062

<Original signed by>

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CHEMIST
ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

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CPAWS 106

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10-March-2019

SiREM Laboratory
Attn : Alicia Hill

130 Stone Road W, Guelph
Canada, N1G 3Z2
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Date Rec. : 01 March 2019
LR Report: **CA12036-MAR19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-2/27/2019	6: Si-3674-Port B-2/27/2019	7: Si-3674-Port A-2/27/2019	8: Si-3674-Influent-2/27/2019
Sample Date & Time					27-Feb-19 12:00	27-Feb-19 12:00	27-Feb-19 12:00	27-Feb-19 12:00
Temp Upon Receipt [°C]	---	---	---	---	1.0	1.0	1.0	1.0
Ag (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.006	0.002	0.002	0.002
As (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.0009	0.0009	0.0006	< 0.0002
Ba (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.0289	0.0254	0.0209	0.00271
Be (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.015	0.015	0.016	0.020
Bi (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.000010	< 0.000007	< 0.000007	0.000008
Ca (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	37.4	42.6	44.4	41.9
Cd (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.000040	0.000012	< 0.000003	0.000010
Co (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.000710	0.000711	0.000554	0.000263
Cr (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.00037	0.00042	0.00041	0.00106
Cu (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.00088	0.00834	0.00222	0.00069
Fe (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.016	< 0.007	< 0.007	0.007
K (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	136	139	140	142
Li (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.0009	0.0008	0.0007	0.0007
Mg (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	140	140	144	143
Mn (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.0497	0.0441	0.0318	0.00330
Mo (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.00079	0.00052	0.00027	0.00012
Na (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	72.0	69.8	72.0	70.3

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LR Report : **CA12036-MAR19**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-2/27/2019	6: Si-3674-Port B-2/27/2019	7: Si-3674-Port A-2/27/2019	8: Si-3674-Influent-2/27/2019
Ni (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.0020	0.0417	0.0021	0.0008
Pb (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.00004	0.00032	0.00006	0.00003
Sb (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.0002	< 0.0002	< 0.0002	< 0.0002
Se (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.0549	0.0506	0.0593	0.161
Sn (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.00026	0.00032	0.00034	0.00033
Sr (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.169	0.192	0.261	0.424
Ti (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.00038	0.00039	0.00044	0.00042
Tl (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.000085	0.000064	0.000059	< 0.000005
U (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.000253	0.000211	0.000140	0.000003
V (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.00011	0.00009	0.00008	0.00006
W (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.00015	0.00009	0.00004	0.00004
Y (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.000012	0.000003	< 0.000002	0.000012
Zn (tot) [mg/L]	05-Mar-19	13:04	06-Mar-19	12:02	0.006	0.017	0.004	0.007

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Environment, Health & Safety

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CPAWS 108

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28-March-2019

SiREM Laboratory
Attn : Alicia Hill

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

<contact information removed>

Date Rec. : 20 March 2019
LR Report: **CA15344-MAR19**
Reference: Si-3674

Copy: #2

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-3/19/2019	6: Si-3674-Port B-3/19/2019	7: Si-3674-Port A-3-19/2019	8: Si-3674-Influent-3/19/2019
Sample Date & Time					19-Mar-19 12:00	19-Mar-19 12:00	19-Mar-19 12:00	19-Mar-19 12:00
Temp Upon Receipt [°C]	---	---	---	---	6.0	6.0	6.0	6.0
F [mg/L]	20-Mar-19	20:02	21-Mar-19	13:26	< 0.06	---	---	< 0.06
Cl [mg/L]	21-Mar-19	09:11	21-Mar-19	14:09	290	---	---	300
SO4 [mg/L]	21-Mar-19	10:39	22-Mar-19	10:44	1100	---	---	1000
Br [mg/L]	20-Mar-19	19:32	22-Mar-19	12:45	< 0.3	---	---	< 0.3
NO2 [as N mg/L]	20-Mar-19	19:32	22-Mar-19	09:16	0.13	---	---	< 0.03
NO3 [as N mg/L]	20-Mar-19	19:32	22-Mar-19	15:08	23.8	---	---	40.4
NO2+NO3 [as N mg/L]	20-Mar-19	19:32	22-Mar-19	15:08	23.9	---	---	40.4
Tot.Reactive P [mg/L]	20-Mar-19	13:43	21-Mar-19	16:18	4.92	---	---	7.96
Se (IV) [mg/L]	27-Mar-19	12:03	27-Mar-19	13:42	0.0114	---	---	< 0.0005
Se (VI) [mg/L]	27-Mar-19	12:03	27-Mar-19	13:42	0.0873	---	---	0.19
Ag (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.004	0.001	0.002	0.003
As (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.0017	0.0014	0.0008	< 0.0002
Ba (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.0341	0.0334	0.0276	0.00455
Be (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.017	0.020	0.020	0.018
Bi (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Ca (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	273	301	306	301

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LR Report : **CA15344-MAR19**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-3/19/2019	6: Si-3674-Port B-3/19/2019	7: Si-3674-Port A-3-19/2019	8: Si-3674-Influent-3/19/2019
Cd (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.000007	0.000014	0.000107	0.000020
Co (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.00123	0.00134	0.00112	0.000188
Cr (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.00045	0.00032	0.00067	0.00100
Cu (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.0020	0.0025	0.0023	0.0019
Fe (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.015	0.011	0.008	< 0.007
K (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	166	175	175	172
Li (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.0010	0.0011	0.0011	0.0009
Mg (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	158	166	163	162
Mn (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.0949	0.0830	0.0562	0.00321
Mo (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.00057	0.00025	0.00018	0.00006
Na (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	80.2	81.3	80.8	80.4
Ni (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.0024	0.0380	0.0318	0.0007
Pb (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.00009	0.00004	0.00002	0.00006
Sb (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.106	0.176	0.171	0.166
Sn (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.00097	0.00026	0.00035	0.00038
Sr (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.327	0.432	0.469	0.538
Ti (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.00051	0.00085	0.00090	0.00079
Tl (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.000180	0.000363	0.000373	< 0.000005
U (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.000180	0.000069	0.000045	0.000005
V (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.00017	0.00059	0.00103	0.00003
W (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.00004	< 0.00002	< 0.00002	< 0.00002
Y (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.000006	0.000005	0.000005	0.000011
Zn (diss) [mg/L]	21-Mar-19	10:31	22-Mar-19	15:29	0.006	0.009	0.008	0.008

<Original signed by>

CHARTERED CATHARINE ARNOLD CHEMIST ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

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CPAWS 110

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Phone: 705-652-2000 FAX: 705-652-6365

Project : Si-3674

15-April-2019

SiREM Laboratory
Attn : Steve Sande

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada
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Date Rec. : 05 April 2019
LR Report: **CA12289-APR19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-4/3/2019	6: Si-3674-Port B-4/3/2019	7: Si-3674-Port A-4/3/2019	8: Si-3674-Influent-4/3/2019
Sample Date & Time					03-Apr-19 12:00	03-Apr-19 12:00	03-Apr-19 12:00	03-Apr-19 12:00
Temp Upon Receipt [°C]	---	---	---	---	2.0	2.0	2.0	2.0
Ag (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.003	0.004	0.004	0.586
As (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.0008	0.0007	0.0007	< 0.0002
Ba (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.0264	0.0260	0.0253	0.00232
Be (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.015	0.016	0.017	0.020
Bi (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Ca (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	239	242	254	184
Cd (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.000023	0.000029	0.000032	0.000035
Co (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.00253	0.00255	0.00259	0.000128
Cr (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.00023	0.00098	0.00033	0.00105
Cu (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.0005	0.0012	0.0009	0.0022
Fe (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.008	0.013	0.012	0.007
K (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	142	147	155	152
Li (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.0009	0.0009	0.0009	0.0007
Mg (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	141	145	155	147
Mn (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.0560	0.0510	0.0501	0.00285
Mo (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.00012	0.00012	0.00011	0.00006
Na (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	104	106	115	65.7
Ni (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.0033	0.0085	0.0040	0.0003
Pb (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.00003	0.00007	0.00005	0.00020
Sb (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.0642	0.0617	0.0651	0.140
Sn (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.00025	0.00021	0.00020	0.00018
Sr (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.389	0.394	0.444	0.256
Ti (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.00050	0.00041	0.00052	0.00027
Tl (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.000211	0.000198	0.000150	< 0.000005
U (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.000130	0.000139	0.000146	0.000342
V (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.00067	0.00059	0.00055	0.00012
W (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Y (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.000003	0.000007	0.000003	0.000019
Zn (tot) [mg/L]	10-Apr-19	09:37	11-Apr-19	10:25	0.003	0.009	0.009	0.009

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Project : Si-3674

LR Report : CA12289-APR19

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19-April-2019

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Date Rec. : 11 April 2019
LR Report: **CA13283-APR19**

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -4/8/2019	6: Si-3674-Port B-4/8/2019	7: Si-3674-Port A-4/8/2019	8: Si-3674-Influent -4/8/2019
Sample Date & Time					08-Apr-19	08-Apr-19	08-Apr-19	08-Apr-19
Temp Upon Receipt [°C]	---	---	---	---	9.0	9.0	9.0	9.0
Ag (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.008	0.016	0.008	0.022
As (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.0009	0.0008	0.0006	< 0.0002
Ba (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.0203	0.0231	0.0206	0.00206
Be (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.033	0.033	0.030	0.024
Bi (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	< 0.000007	0.000015	< 0.000007	0.000013
Ca (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	201	204	195	176
Cd (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.000022	0.000018	0.000016	0.000022
Co (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.00268	0.00262	0.00223	0.000141
Cr (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.00048	0.00062	0.00047	0.00100
Cu (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.0023	0.0015	0.0012	0.0022
Fe (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.034	0.048	0.024	0.010
K (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	141	147	144	148
Li (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.0008	0.0017	0.0009	0.0007
Mg (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	141	138	139	143
Mn (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.0557	0.0542	0.0461	0.00286
Mo (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.00035	0.00020	0.00015	0.00005
Na (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	128	122	118	63.8
Ni (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.0039	0.0051	0.0041	0.0004
Pb (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.00010	0.00011	0.00006	0.00011
Sb (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.0177	0.0141	0.0254	0.147
Sn (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.00027	0.00010	0.00018	0.00025
Sr (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.324	0.324	0.313	0.256
Ti (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.00030	0.00029	0.00040	0.00013
Tl (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.000084	0.000042	0.000056	< 0.000005
U (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.000145	0.000202	0.000149	0.000015
V (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.00117	0.00115	0.00101	0.00006
W (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.00003	0.00002	< 0.00002	0.00002
Y (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.000006	0.000025	0.000004	0.000014
Zn (diss) [mg/L]	12-Apr-19	13:39	15-Apr-19	14:08	0.006	0.014	0.007	0.009

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Project : Si-3674

02-May-2019

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Date Rec. : 24 April 2019
LR Report: **CA15403-APR19**

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -4/17/2019	6: Si-3674-Port B-4/17/2019	7: Si-3674-Port A-4/17/2019	8: Si-3674-Influent -4/17/2019	9: Si-3674-Effluent -4/22/2019	10: Si-3674-Port B-4/22/2019	11: Si-3674-Port A-4/22/2019	12: Si-3674-Influent -4/22/2019
Sample Date & Time					17-Apr-19	17-Apr-19	17-Apr-19	17-Apr-19	22-Apr-19	22-Apr-19	22-Apr-19	22-Apr-19
Temp Upon Receipt [°C]	---	---	---	---	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ag (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.007	0.005	0.004	0.016	0.005	0.006	0.007	0.014
As (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0006	0.0005	0.0006	< 0.0002	0.0006	0.0005	0.0004	< 0.0002
Ba (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0295	0.0296	0.0277	0.00239	0.0352	0.0450	0.0437	0.00225
Be (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.016	0.016	0.016	0.019	0.015	0.015	0.015	0.019
Bi (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.000007	< 0.000007	< 0.000007	0.000009	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Ca (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	210	209	212	195	224	257	262	269
Cd (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.000016	0.000018	0.000014	0.000023	0.000012	0.000015	0.000006	0.000006
Co (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00174	0.00174	0.00148	0.000100	0.00185	0.00222	0.00131	0.00020
Cr (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00056	0.00055	0.00043	0.00098	0.00038	0.00035	0.00044	0.00110
Cu (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0019	0.0015	0.0012	0.0019	0.0011	0.0011	0.0022	0.0009
Fe (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.024	0.038	0.026	< 0.007	0.028	0.086	0.090	< 0.007
K (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	156	155	156	156	159	172	174	168
Li (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0008	0.0008	0.0007	0.0007	0.0008	0.0008	0.0009	0.0008
Mg (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	152	153	150	157	153	166	168	158
Mn (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.125	0.124	0.115	0.00225	0.148	0.235	0.294	0.00150
Mo (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00027	0.00028	0.00029	0.00005	0.00051	0.00040	0.00028	< 0.00004
Na (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	109	107	101	68.9	109	119	137	70.4

SGS

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Project : Si-3674
LR Report : **CA15403-APR19**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -4/17/2019	6: Si-3674-Port B-4/17/2019	7: Si-3674-Port A-4/17/2019	8: Si-3674-Influent -4/17/2019	9: Si-3674-Effluent -4/22/2019	10: Si-3674-Port B-4/22/2019	11: Si-3674-Port A-4/22/2019	12: Si-3674-Influent -4/22/2019
Ni (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0033	0.0114	0.0054	0.0001	0.0036	0.0056	0.0036	0.0002
Pb (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00005	0.00004	0.00003	0.00009	0.00004	0.00005	0.00053	0.00006
Sb (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0264	0.0272	0.0351	0.145	0.0216	0.0145	0.0132	0.107
Sn (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00010	0.00027	< 0.00006	0.00008	0.00018	0.00015	0.00193	0.00008
Sr (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.251	0.252	0.253	0.225	0.259	0.307	0.329	0.331
Ti (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00026	0.00028	0.00025	0.00015	0.00038	0.00042	0.00027	0.00012
Tl (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.000047	0.000030	0.000039	< 0.000005	0.000024	0.000005	< 0.000005	< 0.000005
U (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.000207	0.000205	0.000199	< 0.000002	0.000325	0.000207	0.000138	< 0.000002
V (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00033	0.00024	0.00019	0.00006	0.00029	0.00025	0.00029	0.00007
W (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.00002	0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Y (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.000008	0.000008	0.000011	0.000011	0.000013	0.000010	0.000004	0.000008
Zn (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.004	0.005	0.005	0.013	0.007	0.007	0.008	0.006

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Project : Si-3674

02-May-2019

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Date Rec. : 24 April 2019
LR Report: **CA15403-APR19**

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -4/17/2019	6: Si-3674-Port B-4/17/2019	7: Si-3674-Port A-4/17/2019	8: Si-3674-Influent -4/17/2019	9: Si-3674-Effluent -4/22/2019	10: Si-3674-Port B-4/22/2019	11: Si-3674-Port A-4/22/2019	12: Si-3674-Influent -4/22/2019
Sample Date & Time					17-Apr-19	17-Apr-19	17-Apr-19	17-Apr-19	22-Apr-19	22-Apr-19	22-Apr-19	22-Apr-19
Temp Upon Receipt [°C]	---	---	---	---	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Ag (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.007	0.005	0.004	0.016	0.005	0.006	0.007	0.014
As (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0006	0.0005	0.0006	< 0.0002	0.0006	0.0005	0.0004	< 0.0002
Ba (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0295	0.0296	0.0277	0.00239	0.0352	0.0450	0.0437	0.00225
Be (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.016	0.016	0.016	0.019	0.015	0.015	0.015	0.019
Bi (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.000007	< 0.000007	< 0.000007	0.000009	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Ca (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	210	209	212	195	224	257	262	269
Cd (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.000016	0.000018	0.000014	0.000023	0.000012	0.000015	0.000006	0.000006
Co (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00174	0.00174	0.00148	0.000100	0.00185	0.00222	0.00131	0.00020
Cr (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00056	0.00055	0.00043	0.00098	0.00038	0.00035	0.00044	0.00110
Cu (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0019	0.0015	0.0012	0.0019	0.0011	0.0011	0.0022	0.0009
Fe (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.024	0.038	0.026	< 0.007	0.028	0.086	0.090	< 0.007
K (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	156	155	156	156	159	172	174	168
Li (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0008	0.0008	0.0007	0.0007	0.0008	0.0008	0.0009	0.0008
Mg (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	152	153	150	157	153	166	168	158
Mn (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.125	0.124	0.115	0.00225	0.148	0.235	0.294	0.00150
Mo (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00027	0.00028	0.00029	0.00005	0.00051	0.00040	0.00028	< 0.00004
Na (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	109	107	101	68.9	109	119	137	70.4

CPAWS 117

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : Si-3674
LR Report : CA15403-APR19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -4/17/2019	6: Si-3674-Port B-4/17/2019	7: Si-3674-Port A-4/17/2019	8: Si-3674-Influent -4/17/2019	9: Si-3674-Effluent -4/22/2019	10: Si-3674-Port B-4/22/2019	11: Si-3674-Port A-4/22/2019	12: Si-3674-Influent -4/22/2019
Ni (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0033	0.0114	0.0054	0.0001	0.0036	0.0056	0.0036	0.0002
Pb (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00005	0.00004	0.00003	0.00009	0.00004	0.00005	0.00053	0.00006
Sb (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.0264	0.0272	0.0351	0.145	0.0216	0.0145	0.0132	0.107
Sn (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00010	0.00027	< 0.00006	0.00008	0.00018	0.00015	0.00193	0.00008
Sr (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.251	0.252	0.253	0.225	0.259	0.307	0.329	0.331
Ti (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00026	0.00028	0.00025	0.00015	0.00038	0.00042	0.00027	0.00012
Tl (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.000047	0.000030	0.000039	< 0.000005	0.000024	0.000005	< 0.000005	< 0.000005
U (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.000207	0.000205	0.000199	< 0.000002	0.000325	0.000207	0.000138	< 0.000002
V (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.00033	0.00024	0.00019	0.00006	0.00029	0.00025	0.00029	0.00007
W (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	< 0.00002	0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Y (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.000008	0.000008	0.000011	0.000011	0.000013	0.000010	0.000004	0.000008
Zn (tot) [mg/L]	28-Apr-19	12:01	30-Apr-19	14:40	0.004	0.005	0.005	0.013	0.007	0.007	0.008	0.006

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0001733521

SGS Canada Inc.
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24-May-2019

SiREM Laboratory
Attn : Steve Sande

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

<contact information removed>

Date Rec. : 02 May 2019
LR Report: **CA17513-MAY19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -4/29/19	6: Si-3674-Port B-4/29/19	7: Si-3674-Port A-4/29/19	8: Si-3674-Influent -4/29/19	9: Si-3674-Effluent-5/1/19	10: Si-3674-Influent -5/1/19
Sample Date & Time					29-Apr-19	29-Apr-19	29-Apr-19	29-Apr-19	01-May-19	01-May-19
Temp Upon Receipt [°C]	---	---	---	---	6.0	6.0	6.0	6.0	6.0	6.0
Se (IV) [mg/L]	23-May-19	17:56	24-May-19	10:56	---	---	---	---	0.0033	< 0.0005
Se (VI) [mg/L]	23-May-19	17:56	24-May-19	10:56	---	---	---	---	< 0.0005	0.15
Ag (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	< 0.00005	< 0.00005	< 0.00005	< 0.00005	---	---
Al (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.006	0.005	0.007	0.078	---	---
As (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.0025	0.0016	0.0014	0.0006	---	---
Ba (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.0529	0.0582	0.0626	0.00219	---	---
Be (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	< 0.000007	< 0.000007	< 0.000007	< 0.000007	---	---
B (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.021	0.016	0.017	0.023	---	---
Bi (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.000012	0.000007	0.000008	< 0.000007	---	---
Ca (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	218	240	249	275	---	---
Cd (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.000016	0.000006	0.000003	0.000037	---	---
Co (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.00146	0.00146	0.000816	0.000203	---	---
Cr (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.00032	0.00035	0.00041	0.00110	---	---
Cu (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.0015	0.0029	0.0014	0.0012	---	---
Fe (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.190	0.162	0.151	0.012	---	---
K (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	146	160	169	180	---	---
Li (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.0012	0.0011	0.0010	0.0011	---	---
Mg (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	143	158	165	173	---	---

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

CPAWS 119

SGS
SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : CA17513-MAY19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -4/29/19	6: Si-3674-Port B-4/29/19	7: Si-3674-Port A-4/29/19	8: Si-3674-Influent -4/29/19	9: Si-3674-Effluent-5/1/19	10: Si-3674-Influent -5/1/19
Mn (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.340	0.382	0.461	0.00188	---	---
Mo (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.00075	0.00069	0.00075	0.00004	---	---
Na (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	106	117	152	76.7	---	---
Ni (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.0029	0.0064	0.0028	0.0004	---	---
Pb (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.00004	0.00042	0.00003	0.00005	---	---
Sb (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	< 0.0009	< 0.0009	< 0.0009	< 0.0009	---	---
Se (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.0204	0.0172	0.0133	0.127	---	---
Sn (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.00027	0.00171	0.00015	0.00030	---	---
Sr (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.333	0.360	0.382	0.415	---	---
Ti (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.00019	0.00019	0.00024	0.00031	---	---
Tl (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.000010	0.000010	< 0.000005	< 0.000005	---	---
U (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.000283	0.000285	0.000198	0.000008	---	---
V (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.00028	0.00030	0.00064	0.00007	---	---
W (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.00003	0.00003	0.00003	< 0.00002	---	---
Y (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.000010	0.000009	0.000008	0.000002	---	---
Zn (diss) [mg/L]	04-May-19	12:30	07-May-19	13:55	0.004	0.007	0.005	0.007	---	---

<Original signed by>

CHARTERED CATHARINE ARNOLD CHEMIST
ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
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OnLine LIMS

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CPAWS 120

SGS

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04-June-2019

SiREM Laboratory
Attn : Steve Sande

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Date Rec. : 23 May 2019
LR Report: **CA13920-MAY19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SI-3674-Effluent -5/6/19	6: SI-3674-Port B-5/6/19	7: SI-3674-Port A-5/6/19	8: SI-3674-Influent -5/6/19	9: SI-3674-Effluent -5/13/19	10: SI-3674-Port B-5/13/19	11: SI-3674-Port A-5/13/19	12: SI-3674-Influent -5/13/19
Sample Date & Time					06-May-19	06-May-19	06-May-19	06-May-19	13-May-19	13-May-19	13-May-19	13-May-19
Temp Upon Receipt [°C]	---	---	---	---	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Ag (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.005	0.004	0.005	0.228	0.004	0.004	0.006	0.110
As (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.0023	0.0021	0.0024	< 0.0002	0.0017	0.0017	0.0018	< 0.0002
Ba (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.0709	0.0686	0.0654	0.00340	0.0689	0.0711	0.0646	0.00187
Be (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.012	0.012	0.012	0.020	0.010	0.012	0.011	0.013
Bi (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.000020	0.000010	0.000008	0.000024	0.000008	< 0.000007	< 0.000007	< 0.000007
Ca (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	224	224	218	265	219	219	221	230
Cd (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.000008	0.000015	0.000003	0.000050	0.000011	0.000004	0.000009	< 0.000003
Co (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.00180	0.00121	0.000894	0.000290	0.00137	0.00127	0.000770	0.000192
Cr (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.00043	0.00039	0.00034	0.00132	0.00122	0.00044	0.00033	0.00098
Cu (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.0007	0.0008	0.0006	0.0060	0.0024	0.0073	0.0005	0.0027
Fe (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.367	0.238	0.280	0.014	0.504	0.456	0.503	< 0.007
K (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	134	136	133	158	137	134	137	136
Li (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.0006	0.0007	0.0006	0.0009	0.0006	0.0006	0.0006	0.0005
Mg (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	151	149	148	157	150	149	149	145
Mn (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.580	0.529	0.522	0.00320	0.569	0.558	0.494	0.00178
Mo (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.00171	0.00144	0.00132	0.00013	0.00147	0.00148	0.00121	0.00006
Na (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	139	133	129	72.4	144	145	144	68.2

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CPAWS 121

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LR Report : CA13920-MAY19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SI-3674-Effluent -5/6/19	6: SI-3674-Port B-5/6/19	7: SI-3674-Port A-5/6/19	8: SI-3674-Influent -5/6/19	9: SI-3674-Effluent -5/13/19	10: SI-3674-Port B-5/13/19	11: SI-3674-Port A-5/13/19	12: SI-3674-Influent -5/13/19
Ni (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.0033	0.0098	0.0056	0.0007	0.0018	0.0304	0.0043	0.0005
Pb (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.00006	0.00003	0.00002	0.00091	0.00047	0.00058	0.00003	0.00012
Sb (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.0244	0.0179	0.0191	0.127	0.0194	0.0155	0.0198	0.117
Sn (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.00013	0.00010	0.00008	0.00011	0.00219	0.00230	0.00012	0.00022
Sr (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.397	0.391	0.383	0.432	0.381	0.381	0.384	0.380
Ti (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.00032	0.00026	0.00027	0.00033	0.00030	0.00024	0.00023	0.00017
Tl (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.000005	0.000007	0.000006	< 0.000005	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.000282	0.000306	0.000305	0.000018	0.000275	0.000269	0.000212	0.000139
V (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.00055	0.00045	0.00041	0.00007	0.00044	0.00049	0.00048	0.00010
W (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.00004	0.00004	0.00004	0.00016	0.00004	0.00004	0.00003	< 0.00002
Y (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.000022	0.000013	0.000013	0.000078	0.000023	0.000014	0.000010	0.000006
Zn (diss) [mg/L]	29-May-19	10:51	30-May-19	15:07	0.004	0.004	0.004	0.012	0.006	0.009	0.010	0.006

Analysis	13: SI-3674-Effluent -5/21/19	14: SI-3674-Port B-5/21/19	15: SI-3674-Port A-5/21/19	16: SI-3674-Influent -5/21/19
Sample Date & Time	21-May-19	21-May-19	21-May-19	21-May-19
Temp Upon Receipt [°C]	14.0	14.0	14.0	14.0
Ag (diss) [mg/L]	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	0.004	0.004	0.004	0.070
As (diss) [mg/L]	0.0016	0.0017	0.0012	< 0.0002
Ba (diss) [mg/L]	0.0674	0.0669	0.0679	0.00352
Be (diss) [mg/L]	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	0.009	0.009	0.010	0.013
Bi (diss) [mg/L]	< 0.000007	< 0.000007	< 0.000007	0.000015
Ca (diss) [mg/L]	228	223	228	259
Cd (diss) [mg/L]	0.000005	0.000007	0.000006	0.000021
Co (diss) [mg/L]	0.00205	0.00169	0.00100	0.000133
Cr (diss) [mg/L]	0.00040	0.00029	0.00038	0.00073
Cu (diss) [mg/L]	0.0006	0.0018	0.0010	0.0016
Fe (diss) [mg/L]	0.606	0.589	1.57	0.009
K (diss) [mg/L]	133	132	136	139
Li (diss) [mg/L]	0.0005	0.0006	0.0005	0.0004
Mg (diss) [mg/L]	148	149	148	149

SGS Canada Inc.
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Analysis	13: SI-3674-Effluent -5/21/19	14: SI-3674-Port B-5/21/19	15: SI-3674-Port A-5/21/19	16: SI-3674-Influent -5/21/19
Mn (diss) [mg/L]	0.577	0.557	0.495	0.00276
Mo (diss) [mg/L]	0.00127	0.00144	0.00119	0.00005
Na (diss) [mg/L]	128	131	153	65.8
Ni (diss) [mg/L]	0.0019	0.0045	0.0024	0.0003
Pb (diss) [mg/L]	0.00002	0.00043	0.00003	0.00051
Sb (diss) [mg/L]	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	0.0161	0.0159	0.0242	0.155
Sn (diss) [mg/L]	0.00012	0.00191	0.00012	< 0.00006
Sr (diss) [mg/L]	0.374	0.372	0.369	0.379
Ti (diss) [mg/L]	0.00027	0.00024	0.00021	0.00014
Tl (diss) [mg/L]	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	0.000275	0.000255	0.000107	0.000016
V (diss) [mg/L]	0.00034	0.00040	0.00084	0.00004
W (diss) [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Y (diss) [mg/L]	0.000031	0.000051	0.000020	0.000055
Zn (diss) [mg/L]	0.003	0.006	0.003	0.007

<Original signed by>

CHARTERED CATHARINE ARNOLD CHEMIST
ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

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SGS

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14-June-2019

SiREM Laboratory
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Date Rec. : 31 May 2019
LR Report: **CA19575-MAY19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -5/27/2019	6: Si-3674-Port B-5/27/2019	7: Si-3674-Port A-5/27/2019	8: Si-3674-Influent -5/27/2019
Sample Date & Time					27-May-19	27-May-19	27-May-19	27-May-19
Temp Upon Receipt [°C]	---	---	---	---	8.0	8.0	8.0	8.0
Ag (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.00005	< 0.00005	0.00015	< 0.00005
Al (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.005	0.014	0.006	0.171
As (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.0021	0.0019	0.0014	< 0.0002
Ba (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.0930	0.0888	0.0588	0.00300
Be (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (tot) [mg/L]	03-Jun-19	18:42	07-Jun-19	12:12	0.019	0.020	0.018	0.024
Bi (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.000007	< 0.000007	0.000010	< 0.000007
Cd (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.000003	< 0.000003	0.000006	0.000007
Co (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.00307	0.00242	0.00115	0.000100
Cr (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.00008	0.00010	0.00016	0.00064
Cu (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.0002	< 0.0002	0.0004	0.0009
Fe (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	1.34	1.54	1.40	0.007
K (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	166	169	158	167
Li (tot) [mg/L]	03-Jun-19	18:42	11-Jun-19	10:04	0.0014	0.0014	0.0013	0.0022
Mg (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	164	163	162	157
Mn (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.821	0.740	0.439	0.00223
Mo (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.00196	0.00140	0.00093	0.00010
Na (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	166	175	172	70.7
Ni (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.0024	0.0103	0.0053	0.0003
Pb (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.00001	< 0.00001	0.00011	0.00003
Sb (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.0133	0.0123	0.0437	0.165
Sn (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.00006	< 0.00006	< 0.00006	< 0.00006
Sr (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.359	0.363	0.344	0.343
Ti (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.00020	0.00016	0.00016	0.00014
Tl (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.000280	0.000184	0.000138	0.000002
V (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.00052	0.00071	0.00066	0.00011
W (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.00003	0.00003	0.00003	0.00006
Y (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	0.000038	0.000037	0.000030	0.000003
Zn (tot) [mg/L]	03-Jun-19	18:42	04-Jun-19	14:24	< 0.002	< 0.002	< 0.002	0.003

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LR Report : CA19575-MAY19

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16-July-2019

SiREM Laboratory
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Date Rec. : 14 June 2019
LR Report: **CA13526-JUN19**
Reference: Si-3674

Copy: #2

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-6/3/2019	6: SI-3674-Port B-6/3/2019	7: SI-3674-Port A-6/3/2019	8: SI-3674-Influent-6/3/2019	9: Si-3674-Effluent-6/10/2019	10: SI-3674-Port B-6/10/2019	11: SI-3674-Port A-6/10/2019	12: SI-3674-Influent-6/10/2019
Sample Date & Time					03-Jun-19	03-Jun-19	03-Jun-19	03-Jun-19	10-Jun-19	10-Jun-19	10-Jun-19	10-Jun-19
Temp Upon Receipt [°C]	---	---	---	---	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Se (IV) [mg/L]	15-Jul-19	08:37	15-Jul-19	14:34	---	---	---	---	0.0029	---	---	< 0.0005
Se (VI) [mg/L]	15-Jul-19	08:37	15-Jul-19	14:34	---	---	---	---	< 0.0005	---	---	0.0013
Ag (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.004	0.004	0.005	0.092	0.031	0.004	0.005	0.098
As (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.0022	0.0022	0.0016	< 0.0002	0.0022	0.0021	0.0020	< 0.0002
Ba (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.0871	0.0865	0.0746	0.0021	0.0884	0.0724	0.0714	0.00876
Be (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.016	0.023	0.021	0.024	0.028	0.020	0.020	0.029
Bi (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	< 0.000007	< 0.000007	< 0.000007	0.000010	0.000013	0.000013	0.000024	0.000011
Ca (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	291	289	296	305	294	292	280	303
Cd (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.000004	0.000008	< 0.000003	0.000009	0.000016	0.000007	0.000007	0.000009
Co (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.00408	0.00305	0.00214	0.000124	0.00389	0.00296	0.00235	0.000143
Cr (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.00009	< 0.00008	0.00020	0.00080	0.00028	0.00035	0.00038	0.00451
Cu (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.0002	0.0002	0.0003	0.0016	0.0021	0.0006	0.0011	0.0022
Fe (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	2.04	1.85	2.47	0.009	2.43	1.78	2.17	0.057
K (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	179	179	182	179	181	175	168	180
Li (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.0011	0.0012	0.0012	0.0010	0.0012	0.0012	0.0012	0.0009
Mg (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	192	190	194	190	188	185	175	188
Mn (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.830	0.834	0.764	0.00294	0.815	0.703	0.696	0.00367

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LR Report : **CA13526-JUN19**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-6/3/2019	6: SI-3674-Port B-6/3/2019	7: SI-3674-Port A-6/3/2019	8: SI-3674-Influent-6/3/2019	9: SI-3674-Effluent-6/10/2019	10: SI-3674-Port B-6/10/2019	11: SI-3674-Port A-6/10/2019	12: SI-3674-Influent-6/10/2019
Mo (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.00191	0.00225	0.00158	0.00021	0.00210	0.00171	0.00184	0.00012
Na (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	220	217	236	90.1	202	197	191	91.2
Ni (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.0027	0.0040	0.0033	0.0004	0.0032	0.0110	0.0111	0.0027
Pb (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.00017	0.00018	0.00015	0.00035	0.00040	< 0.00001	0.00002	0.00047
Sb (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.00675	0.00552	0.0135	0.203	0.0154	0.0223	0.0168	0.173
Sn (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	< 0.00006	< 0.00006	< 0.00006	< 0.00006	0.00057	0.00026	0.00035	0.00075
Sr (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.401	0.400	0.411	0.388	0.394	0.390	0.400	0.385
Ti (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.00031	0.00034	0.00035	0.00029	0.00094	0.00025	0.00033	0.00088
Tl (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	< 0.000005	< 0.000005	< 0.000005	< 0.000005	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.000232	0.000239	0.000197	0.000009	0.000312	0.000226	0.000244	0.000009
V (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.00060	0.00067	0.00093	0.00009	0.00051	0.00039	0.00052	0.00009
W (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	< 0.00002	0.00003	< 0.00002	0.00002	0.00006	0.00004	0.00006	0.00003
Y (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.000055	0.000049	0.000044	0.000022	0.000081	0.000074	0.000068	0.000019
Zn (diss) [mg/L]	18-Jun-19	11:07	21-Jun-19	16:35	0.006	0.007	0.006	0.010	0.007	0.003	0.005	0.004

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28-June-2019

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Date Rec. : 25 June 2019
LR Report: **CA12979-JUN19**

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -6/18/2019	6: Si-3674-Port B-6/18/2019	7: Si-3674-Port A--6/18/2019	8: Si-3674-Influent -6/18/2019
Sample Date & Time					18-Jun-19	18-Jun-19	18-Jun-19	18-Jun-19
Temp Upon Receipt [°C]	---	---	---	---	12.0	12.0	12.0	12.0
Ag (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.005	0.007	0.005	0.086
As (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.0026	0.0019	0.0023	< 0.0002
Ba (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.102	0.0453	0.0911	0.00210
Be (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.025	0.022	0.029	0.025
Bi (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	< 0.000007	< 0.000007	< 0.000007	0.000013
Ca (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	227	209	240	246
Cd (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.000009	0.000011	0.000043	0.000006
Co (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.00335	0.00127	0.00289	0.000160
Cr (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.00054	0.00048	0.00058	0.00119
Cu (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.0006	0.0014	0.0023	0.0024
Fe (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	2.92	0.352	1.15	0.007
K (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	153	152	157	146
Li (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.0012	0.0009	0.0011	0.0008
Mg (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	156	160	162	155
Mn (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.860	0.230	0.615	0.00486
Mo (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.00313	0.00082	0.00206	0.00006
Na (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	164	252	196	157
Ni (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.0020	0.0057	0.0075	0.0003
Pb (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.00003	0.00006	0.00011	0.00068
Sb (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.0159	0.0486	0.0487	0.170
Sn (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.00040	0.00048	0.00049	0.00044
Sr (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.351	0.322	0.360	0.374
Ti (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.00005	0.00012	0.00017	< 0.00005
Tl (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.000005	< 0.000005	0.000020	< 0.000005
U (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.000401	0.000240	0.000500	0.000009
V (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.00052	0.00032	0.00020	0.00003
W (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.00004	0.00006	0.00018	0.00006
Y (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.000075	0.000112	0.000237	0.000033
Zn (diss) [mg/L]	26-Jun-19	18:53	27-Jun-19	12:35	0.007	0.008	0.007	0.009

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05-July-2019

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Date Rec. : 28 June 2019
LR Report: **CA13905-JUN19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -6/26/2019	6: Si-3674-Port-B-6/26/2019	7: Si-3674-Port-A-6/26/2019	8: Si-3674-Influent -6/26/2019
Sample Date & Time					26-Jun-19	26-Jun-19	26-Jun-19	26-Jun-19
Temp Upon Receipt [°C]	---	---	---	---	8.0	8.0	8.0	8.0
Ag (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.003	0.005	0.007	0.146
As (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.0016	0.0021	0.0016	< 0.0002
Ba (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.0797	0.0708	0.0486	0.00364
Be (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	< 0.000007	< 0.000007	0.000007	< 0.000007
B (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.023	0.021	0.018	0.020
Bi (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Ca (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	225	215	203	268
Cd (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.000031	0.000016	0.000038	0.000023
Co (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.00306	0.00237	0.00133	0.000287
Cr (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.00077	0.00064	0.00052	0.00164
Cu (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.0013	0.0023	0.0014	0.0031
Fe (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.364	0.447	0.239	0.023
K (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	150	144	143	141
Li (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.0011	0.0011	0.0009	0.0007
Mg (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	156	152	152	154
Mn (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.610	0.476	0.260	0.00518
Mo (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.00151	0.00120	0.00068	< 0.00004
Na (diss) [mg/L]	43651	0.469444	05-Jul-19	12:24	214	231	247	154
Ni (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.0069	0.0137	0.0091	0.0008
Pb (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.00008	0.00047	0.00031	0.00110
Sb (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.0455	0.0492	0.0504	0.170
Sn (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.00009	< 0.00006	< 0.00006	< 0.00006
Sr (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.350	0.347	0.353	0.456
Ti (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	< 0.00005	0.00019	0.00011	< 0.00005
Tl (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.000011	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.000723	0.000594	0.000298	0.000008
V (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.00017	0.00015	0.00025	0.00010
W (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.00003	0.00008	0.00006	< 0.00002
Y (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.000167	0.000141	0.000128	0.000074
Zn (diss) [mg/L]	05-Jul-19	11:16	05-Jul-19	12:24	0.006	0.010	0.011	0.016

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LR Report : **CA13905-JUN19**

<Original signed by>

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Project : Si-3674

19-July-2019

SiREM Laboratory
Attn : Steve Sande

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Date Rec. : 05 July 2019
LR Report: **CA15105-JUL19**

Copy: #2

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -7/3/2019	6: Si-3674-Port B-7/3/2019	7: Si-3674-Port A-7/3/2019	8: Si-3674-Influent-7/3/2019	9: Si-3674-Effluent Filtered-7/3/2019
Sample Date & Time					03-Jul-19	03-Jul-19	03-Jul-19	03-Jul-19	03-Jul-19
Temp Upon Receipt [°C]	---	---	---	---	6.0	6.0	6.0	6.0	6.0
Ag (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.004	0.005	0.008	0.123	0.006
As (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.0012	0.0013	0.0011	< 0.0002	0.0011
Ba (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.0558	0.0587	0.0487	0.0033	0.0543
Be (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.019	0.020	0.017	0.021	0.017
Bi (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.000026	0.000008	0.000011	0.000030	0.000016
Ca (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	227	225	225	280	220
Cd (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.000011	0.000022	0.000018	0.000021	0.000007
Co (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.00187	0.00200	0.00124	0.000319	0.00152
Cr (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.00054	0.00043	0.00054	0.00142	0.00072
Cu (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.0013	0.0009	0.0019	0.0024	0.0034
Fe (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.125	0.282	0.164	0.027	0.044
K (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	157	157	167	163	160
Li (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.0013	0.0014	0.0013	0.0013	0.0014
Mg (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	147	151	148	150	147

OnLine LIMS

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CPAWS 132

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Project : Si-3674
LR Report : CA15105-JUL19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -7/3/2019	6: Si-3674-Port B-7/3/2019	7: Si-3674-Port A-7/3/2019	8: Si-3674-Influent-7/3/2019	9: Si-3674-Effluent Filtered-7/3/2019
Mn (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.389	0.410	0.287	0.00465	0.319
Mo (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	0.00074	0.00076	0.00059	0.00007	0.00049
Na (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:16	208	216	224	149	223
Ni (diss) [mg/L]	12-Jul-19	16:30	19-Jul-19	16:12	0.0042	0.0203	0.0117	0.0006	0.0072
Pb (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.00006	0.00007	0.00007	0.00110	0.00097
Sb (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.0491	0.0368	0.0433	0.178	0.0472
Sn (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.00036	0.00053	0.00068	0.00045	0.00054
Sr (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.376	0.380	0.356	0.435	0.351
Ti (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.00011	0.00011	0.00017	0.00013	0.00015
Tl (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.000007	0.000012	< 0.000005	< 0.000005	0.000010
U (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.000350	0.000356	0.000241	0.000007	0.000306
V (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.00014	0.00017	0.00019	0.00006	0.00017
W (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.00005	0.00004	0.00004	< 0.00002	< 0.00002
Y (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.000077	0.000101	0.000107	0.000046	0.000038
Zn (diss) [mg/L]	12-Jul-19	16:30	15-Jul-19	15:13	0.005	0.009	0.027	0.015	0.067

<Original signed by>

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17-July-2019

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Date Rec. : 11 July 2019
LR Report: **CA12521-JUL19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -7/8/2019	6: Si-3674-Port B-7/8/2019	7: Si-3674-Port A-7/8/2019	8: Si-3674-Influent -7/8/2019
Sample Date & Time					08-Jul-19	08-Jul-19	08-Jul-19	08-Jul-19
Temp Upon Receipt [°C]	---	---	---	---	13.0	13.0	13.0	13.0
Ag (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.004	0.004	0.024	0.013
As (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.0014	0.0013	0.0010	< 0.0002
Ba (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.0563	0.0552	0.0446	0.00383
Be (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.020	0.022	0.019	0.021
Bi (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.000012	0.000007	0.000008	0.000010
Ca (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	205	191	189	249
Cd (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.000033	0.000016	0.000035	0.000033
Co (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.00213	0.00178	0.00123	0.000321
Cr (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.00052	0.00038	0.00044	0.00148
Cu (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.0015	0.0010	0.0046	0.0017
Fe (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.141	0.180	0.142	0.024
K (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	143	141	146	142
Li (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.0008	0.0007	0.0006	0.0004
Mg (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	149	144	149	150
Mn (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.406	0.346	0.222	0.00571
Mo (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.00315	0.00328	0.00244	0.00119
Na (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	227	293	316	226
Ni (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.0051	0.0241	0.0150	0.0009
Pb (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.00007	0.00009	0.00050	0.00012
Sb (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.0493	0.0399	0.0580	0.183
Sn (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.00036	0.00039	0.00047	0.00034
Sr (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.352	0.335	0.315	0.396
Ti (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.00015	0.00014	0.00036	0.00018
Tl (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.000007	0.000006	< 0.000005	< 0.000005
U (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.000516	0.000290	0.000205	0.000011
V (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.00017	0.00020	0.00036	0.00021
W (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.00021	0.00023	0.00020	0.00007
Y (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.000090	0.000106	0.000163	0.000010
Zn (diss) [mg/L]	16-Jul-19	21:55	17-Jul-19	16:27	0.007	0.009	0.187	0.019

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LR Report : CA12521-JUL19

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26-July-2019

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Date Rec. : 18 July 2019
LR Report: **CA12762-JUL19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -7/16/2019	6: Si-3674-Port B-7/16/2019	7: Si-3674-Port A-7/16/2019	8: Si-3674-Influent-7/16/2019
Sample Date & Time					16-Jul-19	16-Jul-19	16-Jul-19	16-Jul-19
Temperature Upon Receipt [°C]	---	---	---	---	11.0	11.0	11.0	11.0
Silver (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Aluminum (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.005	0.004	0.007	0.017
Arsenic (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.0020	0.0014	0.0012	< 0.0002
Barium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.0556	0.0536	0.0397	0.00279
Beryllium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Boron (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.023	0.021	0.020	0.023
Bismuth (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.000007	< 0.000007	0.000007	< 0.000007
Calcium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	200	197	178	268
Cadmium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.000043	0.000026	0.000008	0.000039
Cobalt (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.00163	0.00162	0.00117	0.000290
Chromium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.00040	0.00031	0.00056	0.00131
Copper (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.0017	0.0014	0.0012	0.0023
Iron (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.143	0.173	0.203	0.008
Potassium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	150	152	152	153
Lithium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.0011	0.0010	0.0009	0.0008
Magnesium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	149	147	151	150
Manganese (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.279	0.284	0.141	0.00368

CPAWS 136

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LR Report : CA12762-JUL19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -7/16/2019	6: Si-3674-Port B-7/16/2019	7: Si-3674-Port A-7/16/2019	8: Si-3674-Influent-7/16/2019
Molybdenum (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.00199	0.00138	0.00119	0.00021
Sodium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	358	365	429	246
Nickel (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.0059	0.0127	0.0163	0.0011
Lead (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.00024	0.00007	0.00006	0.00007
Antimony (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Selenium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.108	0.0606	0.0619	0.176
Tin (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.00054	0.00030	0.00042	0.00036
Strontium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.312	0.312	0.279	0.397
Titanium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.00011	0.00010	0.00012	0.00008
Thallium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.000019	0.000007	0.000006	< 0.000005
Uranium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.000455	0.000441	0.000205	0.000011
Vanadium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.00024	0.00019	0.00029	0.00013
Tungsten (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.00009	0.00007	0.00009	< 0.00002
Yttrium (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.000131	0.000124	0.000144	0.000006
Zinc (dissolved) [mg/L]	23-Jul-19	13:48	24-Jul-19	18:04	0.005	0.006	0.009	0.011

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Project : Si-3674

06-August-2019

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Date Rec. : 25 July 2019
LR Report: **CA13615-JUL19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -7/22/2019	6: Si-3674-Port B-7/22/2019	7: Si-3674-Port A-7/22/2019	8: Si-3674-Influent -7/22/2019
Sample Date & Time					22-Jul-19	22-Jul-19	22-Jul-19	22-Jul-19
Temp Upon Receipt [°C]	---	---	---	---	11.0	11.0	11.0	11.0
Ag (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	< 0.00005	< 0.00005	< 0.00005	0.00041
Al (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.004	0.004	0.008	0.011
As (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.0008	0.0009	0.0009	< 0.0002
Ba (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.0401	0.0427	0.0426	0.00283
Be (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.021	0.023	0.023	0.024
Bi (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	< 0.000007	< 0.000007	< 0.000007	0.000027
Ca (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	195	196	202	275
Cd (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.000025	0.000015	0.000027	0.000048
Co (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.00132	0.00147	0.00122	0.000367
Cr (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.00065	0.00055	0.00102	0.00203
Cu (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.0012	0.0017	0.0014	0.0056
Fe (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.129	0.182	0.169	0.034
K (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	148	150	153	151
Li (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.0008	0.0009	0.0009	0.0006
Mg (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	162	157	159	155
Mn (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.225	0.236	0.225	0.00522
Mo (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.00727	0.00575	0.00415	0.00179
Na (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	360	345	353	242
Ni (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.0045	0.0166	0.0194	0.0027
Pb (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.00006	0.00008	0.00018	0.00047
Sb (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.0642	0.0601	0.0627	0.171
Sn (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.00036	0.00034	0.00038	0.00033
Sr (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.296	0.288	0.300	0.390
Ti (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.00022	0.00018	0.00024	0.00029
Tl (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.000007	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.000285	0.000266	0.000264	0.000019
V (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.00028	0.00024	0.00023	0.00008
W (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.00020	0.00013	0.00012	0.00004
Y (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.000113	0.000090	0.000109	0.000054
Zn (diss) [mg/L]	26-Jul-19	12:23	29-Jul-19	16:30	0.004	0.007	0.015	0.035

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Project : Si-3674

LR Report : CA13615-JUL19

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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08-August-2019

SiREM Laboratory
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Guelph, ON
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<contact information removed>

Date Rec. : 31 July 2019
LR Report: **CA13789-JUL19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SI-3674-Effluent -7/29/2019	6: SI-3674-Port B-7/29/2019	7: SI-3674-Port A-7/29/2019	8: SI-3674-Influent -7/29/2019
Sample Date & Time					29-Jul-19	29-Jul-19	29-Jul-19	29-Jul-19
Temp Upon Receipt [°C]	---	---	---	---	9.0	9.0	9.0	9.0
Ag (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.005	0.005	0.007	0.009
As (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.0015	0.0025	0.0024	0.0002
Ba (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.0516	0.0445	0.0565	0.00310
Be (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.024	0.027	0.027	0.025
Bi (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	< 0.000007	0.000012	< 0.000007	< 0.000007
Ca (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	180	147	124	292
Cd (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.000028	0.000016	0.000010	0.000038
Co (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.00208	0.00257	0.00233	0.000346
Cr (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.00056	0.00086	0.00111	0.00139
Cu (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.0015	0.0011	0.0020	0.0018
Fe (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.134	0.506	2.67	0.013
K (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	158	157	167	169
Li (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.0009	0.0009	0.0009	0.0007
Mg (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	155	157	164	164
Mn (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.266	0.227	0.232	0.00438
Mo (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.00950	0.0129	0.00695	0.00343
Na (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	431	560	671	314
Ni (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.0065	0.0177	0.0182	0.0010
Pb (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.00007	0.00007	0.00004	0.00032
Sb (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.0724	0.0597	0.0582	0.171
Sn (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.00041	0.00050	0.00055	0.00047
Sr (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.242	0.201	0.168	0.410
Ti (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.00022	0.00022	0.00051	0.00012
Tl (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.000011	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.000372	0.000241	0.000121	0.000030
V (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.00042	0.00084	0.00294	0.00017
W (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.00010	0.00014	0.00009	0.00006
Y (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.000107	0.000123	0.000163	0.000012
Zn (diss) [mg/L]	06-Aug-19	13:48	07-Aug-19	11:48	0.006	0.009	0.010	0.014

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Project : Si-3674

23-August-2019

SiREM Laboratory
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Date Rec. : 09 August 2019
LR Report: **CA13235-AUG19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -8/6/2019	6: Si-3674-Port B-8/6/2019	7: Si-3674-Port A-8/6/2019	8: Si-3674-Influent -8/6-2019
Sample Date & Time					06-Aug-19	06-Aug-19	06-Aug-19	06-Aug-19
Temp Upon Receipt [°C]	---	---	---	---	12.0	12.0	12.0	12.0
Ag (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.005	0.006	0.004	0.010
As (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.0012	0.0012	0.0015	< 0.0002
Ba (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.0524	0.0459	0.0549	0.00379
Be (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.023	0.020	0.020	0.022
Bi (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.000018	< 0.000007	< 0.000007	< 0.000007
Ca (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	168	155	160	335
Cd (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.000012	0.000010	0.000008	0.000015
Co (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.00197	0.00222	0.00231	0.000719
Cr (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.00061	0.00050	0.00044	0.00151
Cu (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.0011	0.0012	0.0021	0.0025
Fe (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.552	0.685	1.45	0.034
K (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	194	187	182	196
Li (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.0013	0.0008	0.0008	0.0006
Mg (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	182	177	164	174
Mn (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.175	0.189	0.239	0.00542
Mo (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.00617	0.00195	0.00145	0.00058
Na (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	543	535	527	255
Ni (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.0041	0.0084	0.0160	0.0036
Pb (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.00011	0.00016	0.00007	0.00061
Sb (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.0614	0.0594	0.0602	0.249
Sn (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.00118	0.00056	0.00037	0.00059
Sr (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.266	0.197	0.200	0.184
Ti (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.00032	0.00033	0.00026	0.00026
Tl (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.000225	0.000220	0.000275	0.000006
V (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.00027	0.00030	0.00081	< 0.00001
W (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.00040	0.00016	0.00006	0.00010
Y (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.000125	0.000105	0.000148	0.000209
Zn (diss) [mg/L]	13-Aug-19	14:13	14-Aug-19	14:39	0.007	0.009	0.009	0.021

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Project : Si-3674
LR Report : CA13235-AUG19

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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30-August-2019

SiREM Laboratory
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Date Rec. : 22 August 2019
LR Report: **CA12914-AUG19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-8/12/2019	6: Si-3674-Port B-8/12/2019	7: Si-3674-Port-A-8/12/2019	8: Si-3674-Influent-8/12/2019	9: Si-3674-Effluent-8/19/2019
Sample Date & Time					12-Aug-19	12-Aug-19	12-Aug-19	12-Aug-19	12-Aug-19
Temp Upon Receipt [°C]	---	---	---	---	7.0	7.0	7.0	7.0	7.0
Ag (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Al (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.01	< 0.01	< 0.01	0.03	< 0.01
As (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Ba (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0543	0.0540	0.0591	0.0033	0.0491
Be (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.00007	< 0.00007	< 0.00007	< 0.00007	< 0.00007
B (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.02	0.02	0.02	0.03	0.02
Bi (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.00007	< 0.00007	< 0.00007	< 0.00007	< 0.00007
Ca (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	169	175	177	262	168
Cd (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003
Co (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.00252	0.00263	0.00260	0.00084	0.00229
Cr (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0010	< 0.0008	< 0.0008	0.0015	< 0.0008
Cu (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.002	< 0.002	< 0.002	0.003	< 0.002
Fe (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	1.82	1.91	2.20	< 0.07	0.33
K (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	147	153	154	152	151
Li (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Mg (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	164	168	167	164	167
Mn (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.335	0.349	0.354	0.0114	0.279
Mo (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0013	0.0011	0.0011	< 0.0004	0.0010
Na (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	416	424	418	233	399
Ni (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.004	0.008	0.011	0.004	0.005
Pb (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0001	< 0.0001	< 0.0001	0.0006	< 0.0001
Sb (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.009	< 0.009	< 0.009	< 0.009	< 0.009
Se (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0349	0.0312	0.0294	0.225	0.0360
Sn (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Sr (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.170	0.172	0.174	0.167	0.121
Ti (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tl (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
U (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.00018	0.00018	0.00019	< 0.00002	0.00016
V (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0004	0.0004	0.0004	< 0.0001	0.0001
W (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Y (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.00010	0.00011	0.00016	0.00022	0.00007
Zn (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.02	< 0.02	< 0.02	0.03	< 0.02

SGS

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LR Report : CA12914-AUG19

Analysis	10: Si-3674-Port B-8/19/2019	11: Si-3674-Port A-8/19/2019	12: Si-3674-Influent -8/19/2019
Sample Date & Time	12-Aug-19	12-Aug-19	12-Aug-19
Temp Upon Receipt [°C]	7.0	7.0	7.0
Ag (diss) [mg/L]	< 0.0005	< 0.0005	< 0.0005
Al (diss) [mg/L]	0.01	< 0.01	< 0.01
As (diss) [mg/L]	< 0.002	< 0.002	< 0.002
Ba (diss) [mg/L]	0.0496	0.0552	0.0022
Be (diss) [mg/L]	< 0.00007	< 0.00007	< 0.00007
B (diss) [mg/L]	0.02	0.02	0.02
Bi (diss) [mg/L]	< 0.00007	< 0.00007	< 0.00007
Ca (diss) [mg/L]	174	194	274
Cd (diss) [mg/L]	< 0.00003	< 0.00003	0.00003
Co (diss) [mg/L]	0.00242	0.00281	0.00110
Cr (diss) [mg/L]	< 0.0008	< 0.0008	0.0129
Cu (diss) [mg/L]	< 0.002	< 0.002	0.003
Fe (diss) [mg/L]	0.57	0.64	0.07
K (diss) [mg/L]	153	169	157
Li (diss) [mg/L]	< 0.001	< 0.001	< 0.001
Mg (diss) [mg/L]	170	178	168
Mn (diss) [mg/L]	0.283	0.299	0.0081
Mo (diss) [mg/L]	0.0010	0.0011	< 0.0004
Na (diss) [mg/L]	403	415	289
Ni (diss) [mg/L]	0.013	0.008	0.013
Pb (diss) [mg/L]	< 0.0001	< 0.0001	0.0003
Sb (diss) [mg/L]	< 0.009	< 0.009	< 0.009
Se (diss) [mg/L]	0.0381	0.0408	0.250
Sn (diss) [mg/L]	< 0.0006	< 0.0006	< 0.0006
Sr (diss) [mg/L]	0.124	0.135	0.107
Ti (diss) [mg/L]	0.0017	< 0.0005	< 0.0005
Tl (diss) [mg/L]	< 0.00005	< 0.00005	< 0.00005
U (diss) [mg/L]	0.00017	0.00020	< 0.00002
V (diss) [mg/L]	0.0002	0.0003	0.0001
W (diss) [mg/L]	< 0.0002	< 0.0002	< 0.0002
Y (diss) [mg/L]	0.00006	0.00035	0.00007
Zn (diss) [mg/L]	< 0.02	< 0.02	0.03

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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CATHARINE ARNOLD
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CPAWS 145

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30-August-2019

SiREM Laboratory
Attn : Steve Sande

130 Stone Road W
Guelph, ON
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Date Rec. : 22 August 2019
LR Report: **CA12914-AUG19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -8/12/2019	6: Si-3674-Port B-8/12/2019	7: Si-3674-Port-A-8/12/2019	8: Si-3674-Influent -8/12/2019	9: Si-3674-Effluent -8/19/2019
Sample Date & Time					12-Aug-19	12-Aug-19	12-Aug-19	12-Aug-19	12-Aug-19
Temp Upon Receipt [°C]	---	---	---	---	7.0	7.0	7.0	7.0	7.0
Ag (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Al (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.01	< 0.01	< 0.01	0.03	< 0.01
As (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Ba (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0543	0.0540	0.0591	0.0033	0.0491
Be (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.00007	< 0.00007	< 0.00007	< 0.00007	< 0.00007
B (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.02	0.02	0.02	0.03	0.02
Bi (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.00007	< 0.00007	< 0.00007	< 0.00007	< 0.00007
Ca (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	169	175	177	262	168
Cd (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003
Co (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.00252	0.00263	0.00260	0.00084	0.00229
Cr (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0010	< 0.0008	< 0.0008	0.0015	< 0.0008
Cu (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.002	< 0.002	< 0.002	0.003	< 0.002
Fe (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	1.82	1.91	2.20	< 0.07	0.33
K (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	147	153	154	152	151
Li (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Mg (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	164	168	167	164	167
Mn (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.335	0.349	0.354	0.0114	0.279
Mo (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0013	0.0011	0.0011	< 0.0004	0.0010
Na (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	416	424	418	233	399
Ni (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.004	0.008	0.011	0.004	0.005
Pb (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0001	< 0.0001	< 0.0001	0.0006	< 0.0001
Sb (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.009	< 0.009	< 0.009	< 0.009	< 0.009
Se (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0349	0.0312	0.0294	0.225	0.0360
Sn (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.0006	< 0.0006	< 0.0006	< 0.0006	< 0.0006
Sr (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.170	0.172	0.174	0.167	0.121
Ti (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Tl (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
U (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.00018	0.00018	0.00019	< 0.00002	0.00016
V (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.0004	0.0004	0.0004	< 0.0001	0.0001
W (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Y (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	0.00010	0.00011	0.00016	0.00022	0.00007
Zn (diss) [mg/L]	28-Aug-19	15:59	30-Aug-19	14:39	< 0.02	< 0.02	< 0.02	0.03	< 0.02

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LR Report : **CA12914-AUG19**

Analysis	10: Si-3674-Port B-8/19/2019	11: Si-3674-Port A-8/19/2019	12: Si-3674-Influent -8/19/2019
Sample Date & Time	12-Aug-19	12-Aug-19	12-Aug-19
Temp Upon Receipt [°C]	7.0	7.0	7.0
Ag (diss) [mg/L]	< 0.0005	< 0.0005	< 0.0005
Al (diss) [mg/L]	0.01	< 0.01	< 0.01
As (diss) [mg/L]	< 0.002	< 0.002	< 0.002
Ba (diss) [mg/L]	0.0496	0.0552	0.0022
Be (diss) [mg/L]	< 0.00007	< 0.00007	< 0.00007
B (diss) [mg/L]	0.02	0.02	0.02
Bi (diss) [mg/L]	< 0.00007	< 0.00007	< 0.00007
Ca (diss) [mg/L]	174	194	274
Cd (diss) [mg/L]	< 0.00003	< 0.00003	0.00003
Co (diss) [mg/L]	0.00242	0.00281	0.00110
Cr (diss) [mg/L]	< 0.0008	< 0.0008	0.0129
Cu (diss) [mg/L]	< 0.002	< 0.002	0.003
Fe (diss) [mg/L]	0.57	0.64	0.07
K (diss) [mg/L]	153	169	157
Li (diss) [mg/L]	< 0.001	< 0.001	< 0.001
Mg (diss) [mg/L]	170	178	168
Mn (diss) [mg/L]	0.283	0.299	0.0081
Mo (diss) [mg/L]	0.0010	0.0011	< 0.0004
Na (diss) [mg/L]	403	415	289
Ni (diss) [mg/L]	0.013	0.008	0.013
Pb (diss) [mg/L]	< 0.0001	< 0.0001	0.0003
Sb (diss) [mg/L]	< 0.009	< 0.009	< 0.009
Se (diss) [mg/L]	0.0381	0.0408	0.250
Sn (diss) [mg/L]	< 0.0006	< 0.0006	< 0.0006
Sr (diss) [mg/L]	0.124	0.135	0.107
Ti (diss) [mg/L]	0.0017	< 0.0005	< 0.0005
Tl (diss) [mg/L]	< 0.00005	< 0.00005	< 0.00005
U (diss) [mg/L]	0.00017	0.00020	< 0.00002
V (diss) [mg/L]	0.0002	0.0003	0.0001
W (diss) [mg/L]	< 0.0002	< 0.0002	< 0.0002
Y (diss) [mg/L]	0.00006	0.00035	0.00007
Zn (diss) [mg/L]	< 0.02	< 0.02	0.03

<Original signed by>

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Project : Si-3674

11-September-2019

SiREM Laboratory
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Date Rec. : 30 August 2019
LR Report: **CA15766-AUG19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -8/27/2019	6: Si-3674-Port B-8/27/2019	7: Si-3674-Port A-8/27-2019	8: Si-3674-Influent -8/27/2019
Sample Date & Time					27-Aug-19	27-Aug-19	27-Aug-19	27-Aug-19
Temp Upon Receipt [°C]	---	---	---	---	13.0	13.0	13.0	13.0
Ag (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.006	0.001	0.003	0.005
As (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.0005	0.0032	0.0018	< 0.0002
Ba (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.0598	0.0626	0.0583	0.00754
Be (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.021	0.022	0.023	0.021
Bi (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.000008	< 0.000007	< 0.000007	< 0.000007
Ca (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	214	270	195	323
Cd (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.000013	0.000004	0.000008	0.000011
Co (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.00292	0.00402	0.00343	0.000921
Cr (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.00209	0.00059	0.00070	0.00150
Cu (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.0046	0.0013	0.0012	0.0040
Fe (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.483	2.45	5.58	0.039
K (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	159	163	164	162
Li (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.0008	0.0008	0.0008	0.0006
Mg (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	151	155	154	150
Mn (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.433	0.520	0.503	0.00606
Mo (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.00168	0.00115	0.00104	0.00069
Na (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	337	541	611	285
Ni (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.0060	0.0178	0.0193	0.0048
Pb (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.00015	0.00010	0.00007	0.00049
Sb (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.0598	0.0696	0.0487	0.260
Sn (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.00071	0.00032	0.00042	0.00070
Sr (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.160	0.143	0.117	0.0970
Ti (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.00016	0.00021	0.00026	0.00025
Tl (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.000013	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.000338	0.000220	0.000111	0.000005
V (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.00019	0.00136	0.00091	0.00003
W (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.00004	0.00004	< 0.00002	< 0.00002
Y (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.000105	0.000116	0.000191	0.000170
Zn (diss) [mg/L]	05-Sep-19	09:23	06-Sep-19	15:26	0.005	0.006	0.009	0.022

OnLine LIMS

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Project : Si-3674
LR Report : CA15766-AUG19

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11-September-2019

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Date Rec. : 05 September 2019
LR Report: **CA13195-SEP19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -9/3/2019	6: Si-3674-Port B-9/3/2019	7: Si-3674-Port A-9/3/2019	8: Si-3674-Influent -9/3/2019
Sample Date & Time					03-Sep-19	03-Sep-19	03-Sep-19	03-Sep-19
Temp Upon Receipt [°C]	---	---	---	---	2.0	2.0	2.0	2.0
Ag (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.008	0.009	0.010	0.006
As (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.0019	0.0020	0.0019	< 0.0002
Ba (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.0746	0.0734	0.0756	0.00268
Be (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.028	0.028	0.027	0.022
Bi (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Ca (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	196	198	200	303
Cd (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.000005	0.000006	0.000007	0.000014
Co (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.00547	0.00604	0.00573	0.000942
Cr (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.00083	0.00104	0.00099	0.00088
Cu (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.0010	0.0013	0.0010	0.0032
Fe (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	8.65	8.12	8.66	0.012
K (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	163	164	164	157
Li (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.0010	0.0010	0.0010	0.0006
Mg (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	155	155	155	162
Mn (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.847	0.882	0.919	0.00610
Mo (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.00117	0.00155	0.00140	0.00040
Na (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	795	806	802	302
Ni (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.0074	0.0208	0.0129	0.0048
Pb (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.00004	0.00011	0.00007	0.00026
Sb (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.0579	0.0488	0.0588	0.276
Sn (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.00017	0.00032	0.00032	< 0.00006
Sr (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.106	0.109	0.108	0.0983
Ti (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.00033	0.00035	0.00037	0.00014
Tl (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.000153	0.000151	0.000165	0.000008
V (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.00273	0.00274	0.00330	0.00005
W (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Y (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.000232	0.000193	0.000276	0.000078
Zn (diss) [mg/L]	06-Sep-19	12:45	10-Sep-19	15:38	0.006	0.010	0.009	0.019

OnLine LIMS

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CPAWS 150

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LR Report : CA13195-SEP19

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25-September-2019

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Date Rec. : 13 September 2019
LR Report: **CA13512-SEP19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SI-3674-Effluent -9/11/2019	6: SI-3674-Port A-9/11/2019	7: SI-3674-Influent-9/11/2019
Sample Date & Time					11-Sep-19	11-Sep-19	11-Sep-19
Temp Upon Receipt [°C]	---	---	---	---	11.0	11.0	11.0
Ag (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.009	0.019	0.008
As (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.0030	0.0020	< 0.0002
Ba (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.106	0.116	0.00267
Be (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.027	0.031	0.020
Bi (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	< 0.000007	0.000025	0.000016
Ca (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	191	193	238
Cd (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.000005	0.000004	0.000012
Co (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.01153	0.00694	0.000190
Cr (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.00081	0.00182	0.00143
Cu (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.0011	0.0028	0.0019
Fe (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	9.10	15.4	0.017
K (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	160	150	150
Li (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.0013	0.0013	0.0008
Mg (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	155	139	142
Mn (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	1.54	1.51	0.00421
Mo (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.00188	0.00141	0.00008
Na (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	738	696	199
Ni (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.0100	0.0235	0.0013
Pb (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.00005	0.00008	0.00017
Sb (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	< 0.0009	0.0011	< 0.0009
Se (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.0482	0.0590	0.158
Sn (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.00009	0.00027	0.00010
Sr (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.149	0.186	0.333
Ti (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.00043	0.00073	0.00017

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS Canada Inc.
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LR Report : CA13512-SEP19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: SI-3674-Effluent -9/11/2019	6: SI-3674-Port A-9/11/2019	7: SI-3674-Influent-9/11/2019
Tl (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.000472	0.000199	0.000006
V (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.00353	0.00581	0.00004
W (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.00002	0.00008	< 0.00002
Y (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.000288	0.000296	0.000030
Zn (diss) [mg/L]	23-Sep-19	21:03	24-Sep-19	13:25	0.005	0.016	0.013

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CHARTERED CATHARINE ARNOLD CHEMIST
ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

Catharine Arnold, B.Sc., C.Chem
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OnLine LIMS

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CPAWS 153

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02-October-2019

SiREM Laboratory
Attn : Steve Sande

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

<contact information removed>

Date Rec. : 20 September 2019
LR Report: **CA12513-SEP19**
Reference: Si-3674

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -9/18/2019	6: Si-3674-Port B-9/18/2019	7: Si-3674-Port A-9/18/2019	8: Si-3674-Influent -9/18/2019
Sample Date & Time					18-Sep-19	18-Sep-19	18-Sep-19	18-Sep-19
Temp Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0	4.0
Se (IV) [mg/L]	25-Sep-19	08:50	01-Oct-19	11:19	< 0.0005	---	---	< 0.0005
Se (VI) [mg/L]	25-Sep-19	08:50	01-Oct-19	11:19	< 0.0005	---	---	0.15
Ag (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.011	0.042	0.029	0.006
As (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.0029	0.0030	0.0023	< 0.0002
Ba (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.115	0.222	0.123	0.00417
Be (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	< 0.000007	0.000023	< 0.000007	< 0.000007
B (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.035	0.030	0.030	0.021
Bi (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.000009	0.000026	0.000061	0.000025
Ca (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	230	218	210	265
Cd (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.000008	0.000017	0.000007	0.000010
Co (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.0168	0.00435	0.00610	0.000215
Cr (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.00076	0.00334	0.00255	0.00128
Cu (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.0013	0.0029	0.0021	0.0019
Fe (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	8.30	21.1	11.7	0.022
K (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	165	146	144	154
Li (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.0017	0.0017	0.0017	0.0010
Mg (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	176	150	149	161
Mn (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	2.35	1.68	1.70	0.00659
Mo (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.00229	0.00153	0.00157	0.00010
Na (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	849	805	807	225
Ni (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.0138	0.122	0.0119	0.0013
Pb (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.00004	0.00101	0.00010	0.00012
Sb (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	< 0.0009	0.0014	0.0011	< 0.0009
Se (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.0619	0.0484	0.0496	0.157
Se (diss) [mg/L]	01-Oct-19	11:53	02-Oct-19	15:48	0.0558	---	---	---
Sn (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	< 0.00006	0.00043	0.00059	0.00009
Sr (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.183	0.230	0.212	0.339
Ti (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.00026	0.00215	0.00118	0.00010
Tl (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.000005	0.000009	0.000009	0.000005
U (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.000580	0.000184	0.000194	0.000012
V (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.00199	0.0138	0.0104	0.00003

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LR Report : CA12513-SEP19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -9/18/2019	6: Si-3674-Port B-9/18/2019	7: Si-3674-Port A-9/18/2019	8: Si-3674-Influent -9/18/2019
W (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.00004	0.00006	0.00006	< 0.00002
Y (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.000170	0.00166	0.000286	0.000028
Zn (diss) [mg/L]	24-Sep-19	10:40	25-Sep-19	13:41	0.006	0.132	0.014	0.010

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ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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11-October-2019

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Attn : Steve Sande

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

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Date Rec. : 27 September 2019
LR Report: **CA12876-SEP19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -9/25/2019	6: Si-3674-Port B-9/25/2019	7: Si-3674-Port A-9/25/2019	8: Si-3674-Influent -9/25/2019
Sample Date & Time					25-Sep-19	25-Sep-19	25-Sep-19	25-Sep-19
Temp Upon Receipt [°C]	---	---	---	---	5.0	5.0	5.0	5.0
Ag (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.018	0.021	0.017	0.006
As (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.0034	0.0039	0.0047	< 0.0002
Ba (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.140	0.143	0.142	0.00239
Be (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.000008	0.000009	0.000008	< 0.000007
B (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.036	0.035	0.040	0.023
Bi (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	< 0.000007	0.000010	< 0.000007	< 0.000007
Ca (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	228	229	211	271
Cd (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.000010	0.000005	< 0.000003	0.000006
Co (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.00503	0.00657	0.00533	0.000188
Cr (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.00115	0.00145	0.00130	0.00113
Cu (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.0011	0.0015	0.0006	0.0019
Fe (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	8.62	10.3	8.41	0.020
K (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	172	168	151	166
Li (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.0019	0.0018	0.0019	0.0006
Mg (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	177	170	167	167
Mn (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	2.36	2.43	2.29	0.00433
Mo (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.00167	0.00210	0.00229	0.00008
Na (diss) [mg/L]	01-Oct-19	11:53	11-Oct-19	13:29	980	976	953	243
Ni (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.0046	0.0471	0.0046	0.0012
Pb (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.00004	0.00006	0.00003	0.00070
Sb (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.0013	0.0014	0.0020	< 0.0009
Se (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.0691	0.0479	0.216	0.156
Sn (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.00020	0.00023	0.00017	0.00018
Sr (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.226	0.224	0.215	0.298
Ti (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.00054	0.00075	0.00063	0.00011
Tl (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.000008	0.000008	0.000024	< 0.000005
U (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.000477	0.000518	0.000485	0.000003
V (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.00829	0.00807	0.00762	0.00006
W (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.00003	0.00003	0.00005	< 0.00002
Y (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.000136	0.000253	0.000420	0.000022
Zn (diss) [mg/L]	01-Oct-19	11:53	03-Oct-19	13:24	0.005	0.008	0.004	0.011

OnLine LIMS

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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS Canada Inc.
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LR Report : CA12876-SEP19

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ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

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OnLine LIMS

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SGS

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17-October-2019

SiREM Laboratory
Attn : Steve Sande

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Guelph, ON
N1G 3Z2, Canada
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Date Rec. : 08 October 2019
LR Report: **CA13295-OCT19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -10/2/2019	6: Si-3674-Port B-10/2/2019	7: Si-3674-Port A-10/2/2019	8: Si-3674-Influent -10/2/2019
Sample Date & Time					02-Oct-19	02-Oct-19	02-Oct-19	02-Oct-19
Temp Upon Receipt [°C]	---	---	---	---	8.0	8.0	8.0	8.0
Ag (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.015	0.018	0.038	0.007
As (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.0032	0.0037	0.0021	< 0.0002
Ba (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.130	0.134	0.150	0.00319
Be (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	< 0.000007	< 0.000007	0.000012	< 0.000007
B (diss) [mg/L]	15-Oct-19	14:35	17-Oct-19	14:52	0.025	0.024	0.027	0.020
Bi (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.000011	0.000008	< 0.000007	0.000014
Ca (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	215	224	246	274
Cd (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.000009	0.000010	< 0.000003	0.000011
Co (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.00477	0.00561	0.00191	0.000159
Cr (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.00238	0.00262	0.00271	0.00170
Cu (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.0012	0.0015	0.0006	0.0016
Fe (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	11.8	13.0	7.40	0.019
K (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	148	149	160	147
Li (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.0014	0.0015	0.0013	0.0006
Mg (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	145	147	152	141
Mn (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	1.76	1.81	1.36	0.00411
Mo (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.00402	0.00429	0.00154	0.00006
Na (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	779	779	878	212
Ni (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.0068	0.0298	0.0029	0.0010
Pb (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.00022	0.00025	0.00007	0.00037
Sb (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.0408	0.0399	0.0454	0.157
Sn (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.00012	0.00013	0.00016	0.00148
Sr (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.234	0.234	0.272	0.336
Ti (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.00233	0.00231	0.00484	0.00120
Tl (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.000079	0.000074	0.000014	< 0.000005
U (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.000308	0.000278	0.000112	0.000005
V (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.0246	0.0239	0.0268	0.00007
W (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.00005	0.00004	0.00003	0.00007
Y (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.000213	0.000382	0.000407	0.000056
Zn (diss) [mg/L]	15-Oct-19	14:35	16-Oct-19	12:03	0.007	0.007	0.004	0.008

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LR Report : **CA13295-OCT19**

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OnLine LIMS

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23-October-2019

SiREM Laboratory
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Guelph, ON
N1G 3Z2, Canada

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Date Rec. : 11 October 2019
LR Report: **CA13504-OCT19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-10/7/2019	6: Si-3674-EffluentFilt-10/7/2019
Sample Date & Time					07-Oct-19	07-Oct-19
Temp Upon Receipt [°C]	---	---	---	---	3.5	3.5
Ag (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	< 0.00005	< 0.00005
Al (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.011	0.011
As (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.0042	0.0040
Ba (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.144	0.144
Be (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.000008	0.000010
B (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.031	0.029
Bi (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.000011	< 0.000007
Ca (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	237	240
Cd (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.000003	0.000006
Co (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.00585	0.00587
Cr (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.00118	0.00101
Cu (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.0004	0.0005
Fe (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	15.0	15.2
K (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	159	161
Li (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.0022	0.0021
Mg (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	158	155
Mn (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	2.37	2.41
Mo (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.00368	0.00326
Na (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	750	748
Ni (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.0052	0.0052
Pb (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.00014	0.00015
Sb (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	< 0.0009	< 0.0009
Se (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.0340	0.0304
Sn (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	< 0.00006	< 0.00006
Sr (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.242	0.244
Ti (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.00040	0.00040
Tl (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.000048	0.000050

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LR Report : CA13504-OCT19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-10/7/2019	6: Si-3674-EffluentFilt-10/7/2019
U (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.000467	0.000445
V (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.00582	0.00593
W (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.00005	0.00003
Y (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.000163	0.000169
Zn (diss) [mg/L]	18-Oct-19	10:57	22-Oct-19	14:44	0.006	0.023

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ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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CPAWS 161

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Project : Si-3674

23-October-2019

SiREM Laboratory
Attn : Steve Sande

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Date Rec. : 17 October 2019
LR Report: **CA12512-OCT19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effleunt-10/15/2019	6: Si-3674-Port-B-10/15/2019	7: Si-3674-Port-A-10/15/2019	8: Si-3674-Influent-10/15/2019	9: Cont Test F-Speeder	10: Cont Test U-Speeder	11: Cont Test Blk-Speeder
Sample Date & Time					15-Oct-19	15-Oct-19	15-Oct-19	15-Oct-19	16-Oct-19	16-Oct-19	16-Oct-19
Temp Upon Receipt [°C]	---	---	---	---	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Ag (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.023	0.024	0.029	0.097	< 0.001	0.007	< 0.001
As (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.0033	0.0032	0.0026	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Ba (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.138	0.142	0.136	0.00246	0.00140	0.00181	0.00037
Be (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	< 0.000007	0.000008	0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.024	0.025	0.025	0.020	< 0.002	< 0.002	< 0.002
Bi (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.000022	< 0.000007	0.000007	< 0.000007	< 0.000007	0.000009	< 0.000007
Ca (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	217	232	208	284	2.04	2.14	< 0.01
Cd (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	< 0.000003	0.000003	0.000004	0.000004	< 0.000003	0.000004	< 0.000003
Co (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.00245	0.00294	0.00202	0.000174	0.0297	0.0634	0.000013
Cr (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.00276	0.00229	0.00246	0.00106	0.00032	0.00036	0.00014
Cu (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.0008	0.0006	0.0014	0.0025	0.0006	0.0032	0.0003
Fe (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	6.92	7.28	6.27	0.008	< 0.007	0.014	< 0.007
K (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	140	152	138	145	28.6	28.7	30.3
Li (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.0013	0.0014	0.0014	0.0007	0.0002	0.0002	< 0.0001
Mg (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	153	168	156	159	0.063	0.060	0.001
Mn (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	1.54	1.87	1.70	0.00433	0.00054	0.00066	0.00002
Mo (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.00262	0.00235	0.00254	0.00008	0.00010	0.00012	< 0.00004
Na (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	761	841	786	216	0.44	0.30	0.02

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Project : Si-3674

LR Report : CA12512-OCT19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effleunt-10/15/2019	6: Si-3674-Port-B-10/15/2019	7: Si-3674-Port-A-10/15/2019	8: Si-3674-Influent-10/15/2019	9: Cont Test F-Speeder	10: Cont Test U-Speeder	11: Cont Test Blk-Speeder
Ni (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.0029	0.0432	0.0028	0.0010	0.0003	0.0007	< 0.0001
Pb (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.00002	< 0.00001	0.00002	0.00007	0.00005	0.00014	< 0.00001
Sb (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.0420	0.0454	0.0381	0.165	0.00057	0.00016	< 0.00004
Sn (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.00016	< 0.00006	0.00034	0.00008	0.00012	0.00016	< 0.00006
Sr (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.260	0.277	0.257	0.364	0.00134	0.00150	0.00003
Ti (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.00264	0.00254	0.00231	0.00012	0.00006	0.00398	< 0.00005
Tl (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.000010	0.000010	0.000010	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.000273	0.000261	0.000236	0.000005	0.000004	0.000011	< 0.000002
V (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.0298	0.0226	0.0205	0.00004	0.00001	0.00001	< 0.00001
W (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.00006	0.00002	0.00004	< 0.00002	0.00016	0.00030	< 0.00002
Y (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.000406	0.000384	0.000418	0.000026	< 0.000002	0.000002	< 0.000002
Zn (diss) [mg/L]	18-Oct-19	12:24	22-Oct-19	09:52	0.007	0.004	0.010	0.008	0.096	0.168	< 0.002

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ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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01-November-2019

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Date Rec. : 24 October 2019
LR Report: **CA13934-OCT19**

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -10/21/2019	6: Si-3674-Port B-10/21/2019	7: Si-3674-Port A-10/21/2019	8: Si-3674-Influent -0/21/2019
Sample Date & Time					21-Oct-19	21-Oct-19	21-Oct-19	21-Oct-19
Temp Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0	4.0
Ag (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.024	0.018	0.019	0.023
As (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.0047	0.0050	0.0041	< 0.0002
Ba (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.150	0.139	0.144	0.00264
Be (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.000013	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.030	0.028	0.032	0.040
Bi (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.000007	< 0.000007	0.000008	< 0.000007
Ca (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	230	223	212	280
Cd (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	< 0.000003	0.000004	< 0.000003	0.000003
Co (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.001068	0.002567	0.001904	0.000197
Cr (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.00127	0.00140	0.00122	0.00273
Cu (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.0002	0.0009	0.0009	0.0010
Fe (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	1.51	4.42	3.77	0.007
K (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	160	156	150	152
Li (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.0016	0.0014	0.0015	0.0007
Mg (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	155	151	145	152
Mn (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	1.58	1.59	1.49	0.00472
Mo (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.00170	0.00293	0.00276	< 0.00004
Na (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	690	684	657	219
Ni (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.0027	0.0245	0.0029	0.0012
Pb (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.00003	0.00004	0.00005	0.00013
Sb (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	< 0.0009	< 0.0009	< 0.0009	< 0.0009
Se (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.108	0.0363	0.0350	0.170
Sn (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	< 0.00006	0.00015	0.00015	0.00007
Sr (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.308	0.296	0.287	0.396
Ti (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.00066	0.00060	0.00063	0.00010
Tl (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.000012	0.000009	0.000015	< 0.000005
U (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.000433	0.000662	0.000704	0.000008
V (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.0103	0.00961	0.00965	0.00005
W (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.00005	0.00004	0.00005	< 0.00002
Y (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.000478	0.000346	0.000370	0.000052
Zn (diss) [mg/L]	30-Oct-19	15:24	31-Oct-19	12:17	0.007	0.007	0.010	0.008

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LR Report : CA13934-OCT19

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Project : Si-3674

12-November-2019

SiREM Laboratory
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Date Rec. : 05 November 2019
LR Report: **CA14105-NOV19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent 2-10/28/2019	6: Si-3674-Effluent F-10/28/2019	7: Si-3674-Effluent C-10/28/2019	8: Si-3674-Port B-10/28/2019	9: Si-3674-Port A-10/28/2019	10: Si-3674-Influent -10/28/2019
Sample Date & Time					28-Oct-19	28-Oct-19	28-Oct-19	28-Oct-19	28-Oct-19	28-Oct-19
Temp Upon Receipt [°C]	---	---	---	---	2.0	2.0	2.0	2.0	2.0	2.0
Ag (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.025	0.021	0.017	0.039	0.115	0.011
As (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.0041	0.0037	0.0030	0.0040	0.0043	< 0.0002
Ba (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.0727	0.0560	0.0439	0.148	0.168	0.00254
Be (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	< 0.000007	< 0.000007	< 0.000007	0.000007	0.000014	< 0.000007
B (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.021	0.021	0.022	0.022	0.020	0.020
Bi (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.000009	< 0.000007	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Ca (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	158	133	119	221	222	281
Cd (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	< 0.000003	< 0.000003	0.000015	0.000003	< 0.000003	0.000018
Co (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.00361	0.00298	0.00289	0.00283	0.000738	0.000283
Cr (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.00168	0.00168	0.00136	0.00286	0.00551	0.00159
Cu (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.0056	0.0020	0.0032	0.0004	0.0002	0.0017
Fe (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	3.51	1.26	0.972	6.47	1.48	0.014
K (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	139	141	146	140	144	153
Li (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.0018	0.0019	0.0020	0.0018	0.0015	0.0006
Mg (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	175	180	192	184	190	187
Mn (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	1.35	1.19	1.17	1.85	1.27	0.00465
Mo (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.00530	0.00423	0.00461	0.00458	0.00294	0.00005
Na (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	857	909	934	957	1050	276

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Project : Si-3674
LR Report : CA14105-NOV19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent 2-10/28/2019	6: Si-3674-Effluent F-10/28/2019	7: Si-3674-Effluent C-10/28/2019	8: Si-3674-Port B-10/28/2019	9: Si-3674-Port A-10/28/2019	10: Si-3674-Influent -10/28/2019
Ni (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.0053	0.0044	0.0047	0.0067	0.0021	0.0014
Pb (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.00012	0.00008	0.00004	0.00004	0.00008	0.00022
Sb (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	< 0.0009	< 0.0009	< 0.0009	< 0.0009	0.0011	< 0.0009
Se (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.0251	0.0188	0.0207	0.0483	0.0817	0.171
Sn (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.00026	0.00025	0.00019	< 0.00006	< 0.00006	0.00010
Sr (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.239	0.200	0.177	0.358	0.384	0.481
Ti (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.00051	0.00022	0.00016	0.00429	0.0126	0.00016
Tl (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.000010	< 0.000005	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.000470	0.000389	0.000360	0.000248	0.000079	0.000019
V (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.00682	0.00487	0.00421	0.0421	0.0598	0.00004
W (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.00018	0.00007	0.00005	0.00012	0.00014	< 0.00002
Y (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.000153	0.000030	0.000034	0.000424	0.000381	0.000053
Zn (diss) [mg/L]	08-Nov-19	13:44	12-Nov-19	13:29	0.019	0.015	0.008	0.004	0.005	0.010

<Original signed by>

CHARTERED CATHARINE ARNOLD CHEMIST ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
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OnLine LIMS

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CPAWS 167

SGS Canada Inc.
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14-November-2019

SiREM Laboratory
Attn : Steve Sande

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada
<contact information removed>

Date Rec. : 08 November 2019
LR Report: **CA12352-NOV19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-11/7/2019	6: Si-3674-Influent-11/7/2019
Sample Date & Time					06-Nov-19	06-Nov-19
It [°C]	---	---	---	---	1.0	1.0
Ag (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	< 0.00005	0.00006
Al (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.022	0.024
As (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	< 0.0002	0.0047
Ba (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.00290	0.179
Be (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	< 0.000007	< 0.000007
B (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.019	0.025
Bi (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	< 0.000007	0.000011
Ca (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	296	182
Cd (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.000008	0.000005
Co (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.000197	0.00122
Cr (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.00127	0.00282
Cu (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.0022	0.0009
Fe (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.012	2.54
K (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	144	147
Li (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.0006	0.0023
Mg (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	147	154
Mn (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.00390	2.13
Mo (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.00005	0.00248
Na (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	231	851
Ni (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.0013	0.0025
Pb (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.00018	0.00004
Sb (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	< 0.0009	0.0013
Se (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.156	0.0455
Sn (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.00011	< 0.00006
Sr (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.511	0.350
Ti (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.00023	0.00223
Tl (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	< 0.000005	< 0.000005

OnLine LIMS

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LR Report : CA12352-NOV19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-11/7/2019	6: Si-3674-Influent-11/7/2019
U (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.000006	0.000299
V (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.00016	0.0375
W (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	< 0.00002	0.00007
Y (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.000025	0.000269
Zn (diss) [mg/L]	12-Nov-19	14:58	13-Nov-19	16:22	0.008	0.005

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

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CPAWS 169

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26-November-2019

SiREM Laboratory
Attn : Steve Sande

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Guelph, ON
N1G 3Z2, Canada

<contact information removed>

Date Rec. : 15 November 2019
LR Report: **CA12625-NOV19**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Eflfuent U-11/13/19	6: Si-3674-Eflfuent -11/13/19	7: Si-3674-Influentt -11/13/19
Sample Date & Time					13-Nov-19	13-Nov-19	13-Nov-19
Temp Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0
Ag (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.025	0.023	0.007
As (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.0316	0.0266	< 0.0002
Ba (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.232	0.213	0.00297
Be (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.000011	0.000007	< 0.000007
B (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.032	0.033	0.040
Bi (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.000009	< 0.000007	< 0.000007
Ca (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	253	248	372
Cd (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	< 0.000003	< 0.000003	< 0.000003
Co (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.000762	0.000725	0.000172
Cr (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.00283	0.00342	0.00122
Cu (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.0004	0.0013	0.0015
Fe (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.505	0.467	0.010
K (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	201	194	190
Li (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.0025	0.0027	0.0006
Mg (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	166	163	160
Mn (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	1.63	1.62	0.00329
Mo (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.00740	0.00696	0.00008
Na (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	907	901	236
Ni (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.0032	0.0030	0.0012
Pb (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.00015	0.00008	0.00013
Sb (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.0045	0.0040	< 0.0009
Se (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.0239	0.0212	1.08
Sn (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	< 0.00006	0.00021	0.00006
Sr (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.317	0.324	0.557
Ti (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.00239	0.00249	0.00011

OnLine LIMS

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LR Report : CA12625-NOV19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Eflfuent U-11/13/19	6: Si-3674-Eflfuent -11/13/19	7: Si-3674-Influentt -11/13/19
Tl (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.000006	< 0.000005	< 0.000005
U (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.000960	0.000838	0.000007
V (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.0394	0.0381	0.00007
W (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.00013	0.00011	< 0.00002
Y (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.000412	0.000398	0.000021
Zn (diss) [mg/L]	20-Nov-19	17:39	21-Nov-19	15:01	0.005	0.009	0.008

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
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CATHARINE ARNOLD
CHEMIST

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02-December-2019

SiREM Laboratory
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130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

<contact information removed>

Date Rec. : 21 November 2019
LR Report: **CA13514-NOV19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -11/18/2019	6: Si-3674-Port B-11/18/2019	7: Si-3674-Port A-11/18/2019	8: Si-3674-Influent -11/18/2019
Sample Date & Time					18-Nov-19	18-Nov-19	18-Nov-19	18-Nov-19
Temp Upon Receipt [°C]	---	---	---	---	3.0	3.0	3.0	3.0
Ag (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.044	0.032	0.037	0.008
As (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.0384	0.0289	0.0242	< 0.0002
Ba (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.181	0.171	0.147	0.00279
Be (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.000008	< 0.000007	0.000007	< 0.000007
B (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.036	0.021	0.020	0.021
Bi (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.000019	0.000007	0.000009	< 0.000007
Ca (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	250	260	261	345
Cd (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.000013	0.000020	0.000020	0.000006
Co (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.00232	0.00252	0.00214	0.000164
Cr (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.00390	0.00265	0.00292	0.00143
Cu (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.0019	0.0011	0.0011	0.0026
Fe (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	2.54	2.20	2.04	0.010
K (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	163	174	174	166
Li (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.0011	0.0013	0.0011	0.0006
Mg (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	164	174	172	170
Mn (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.657	0.575	0.528	0.00335
Mo (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:37	0.00804	0.00630	0.00570	0.00005
Na (diss) [mg/L]	29-Nov-19	13:46	02-Dec-19	15:18	612	620	600	252
Ni (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.0050	0.0168	0.0056	0.0012
Pb (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.00044	0.00006	0.00009	0.00017
Sb (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.0077	0.0040	0.0032	< 0.0009
Se (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.0918	0.0599	0.0459	1.07
Sn (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.00619	0.00032	0.00086	0.00071
Sr (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.364	0.387	0.386	0.518
Ti (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.00489	0.00149	0.00196	0.00014
Tl (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.00101	0.000942	0.000937	0.000011
V (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.0454	0.0327	0.0299	0.00010
W (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.00012	0.00006	0.00007	< 0.00002
Y (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.000585	0.000450	0.000477	0.000014
Zn (diss) [mg/L]	27-Nov-19	23:42	28-Nov-19	15:38	0.012	0.006	0.010	0.007

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LR Report : **CA13514-NOV19**

<Original signed by>

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CATHARINE ARNOLD
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18-December-2019

SiREM Laboratory
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Date Rec. : 03 December 2019
LR Report: **CA12021-DEC19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -11/25/2019	6: Si-3674-Pot B-11/25/2019	7: Si-3674-Port A-11/25/2019	8: Si-3674-Influent -11/25/2019
Sample Date & Time					25-Nov-19	25-Nov-19	25-Nov-19	25-Nov-19
Temp Upon Receipt [°C]	---	---	---	---	1.0	1.0	1.0	1.0
Ag (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.015	0.015	0.021	0.007
As (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.0302	0.0323	0.0193	< 0.0002
Ba (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.168	0.178	0.107	0.00240
Be (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.020	0.021	0.019	0.020
Bi (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.000009	0.000008	< 0.000007	0.000034
Ca (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	219	219	226	290
Cd (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	< 0.000003	0.000003	0.000004	0.000009
Co (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.000336	0.000523	0.000376	0.000120
Cr (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.00214	0.00222	0.00195	0.00151
Cu (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.0010	0.0004	0.0009	0.0015
Fe (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.350	0.464	0.364	< 0.007
K (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	169	165	163	162
Li (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.0015	0.0016	0.0013	0.0006
Mg (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	144	142	149	150
Mn (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.563	0.577	0.330	0.00317
Mo (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.00331	0.00221	0.00099	0.00008
Na (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	543	527	541	227
Ni (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.0047	0.0306	0.0046	0.0006
Pb (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Sb (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.0063	0.0079	0.0044	< 0.0009
Se (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.0406	0.0414	0.173	1.02
Sn (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.00017	0.00018	0.00014	0.00014
Sr (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.320	0.335	0.255	0.213
Ti (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.00111	0.00111	0.00102	0.00015
Tl (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.001080	0.00113	0.000649	0.000006
V (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.0175	0.0172	0.0126	0.00020
W (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.00002	0.00003	0.00002	0.00003
Y (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.000178	0.000203	0.000232	0.000067
Zn (diss) [mg/L]	05-Dec-19	11:37	06-Dec-19	14:35	0.007	0.010	0.005	0.011

OnLine LIMS

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Project : Si-3674

18-December-2019

SiREM Laboratory
Attn : Steve Sande

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada
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Date Rec. : 06 December 2019
LR Report: **CA13183-DEC19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -12/2/2019	6: Si-3674-Port B-12/2/2019	7: Si-3674-Port A-12/2/2019	8: Si-3674-Influent -12/2/2019
Sample Date & Time					02-Dec-19	02-Dec-19	02-Dec-19	02-Dec-19
Temp Upon Receipt [°C]	---	---	---	---	10.0	10.0	10.0	10.0
Ag (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.020	0.015	0.016	0.006
As (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.0079	0.0178	0.0213	< 0.0002
Ba (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.125	0.130	0.143	0.00244
Be (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.015	0.018	0.018	0.017
Bi (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	< 0.000007	0.000016	0.000007	< 0.000007
Ca (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	195	197	219	289
Cd (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.000003	< 0.000003	0.000003	0.000016
Co (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.000235	0.000317	0.000349	0.000130
Cr (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.00222	0.00218	0.00224	0.00140
Cu (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.0006	0.0017	0.0015	0.0017
Fe (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.113	0.286	0.261	0.009
K (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	144	143	159	149
Li (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.0011	0.0012	0.0014	0.0007
Mg (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	138	138	156	140
Mn (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.378	0.427	0.442	0.00316
Mo (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.00142	0.00201	0.00361	0.00009
Na (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	489	498	562	202
Ni (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.0019	0.0120	0.0042	0.0006
Pb (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.00006	0.00005	0.00003	0.00008
Sb (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	< 0.0009	0.0040	0.0057	< 0.0009
Se (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.0214	0.0487	0.0414	1.07
Sn (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.00016	0.00020	0.00023	0.00013
Sr (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.251	0.261	0.290	0.226
Ti (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.00098	0.00098	0.00093	0.00013
Tl (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.000742	0.000848	0.000859	0.000031
V (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.0140	0.0144	0.0158	0.00005
W (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.00002	0.00005	< 0.00002	< 0.00002
Y (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.000160	0.000226	0.000185	0.000050
Zn (diss) [mg/L]	10-Dec-19	12:28	11-Dec-19	14:15	0.005	0.007	0.006	0.008

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Project : Si-3674

LR Report : CA13183-DEC19

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18-December-2019

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Date Rec. : 12 December 2019
LR Report: **CA13318-DEC19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent -12/9/2019	6: Si-3674-Port B-12/9/2019	7: Si-3674-Port A-12/9/2019	8: Si-3674-Influent -12/9/2019
Sample Date & Time					09-Dec-19	09-Dec-19	09-Dec-19	09-Dec-19
Temp Upon Receipt [°C]	---	---	---	---	2.0	2.0	2.0	2.0
Ag (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.020	0.025	0.025	0.063
As (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.0060	0.0110	0.0114	< 0.0002
Ba (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.147	0.121	0.105	0.00185
Be (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	13-Dec-19	12:53	18-Dec-19	10:20	0.019	0.020	0.020	0.022
Bi (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Ca (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	179	182	175	289
Cd (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	< 0.000003	0.000004	0.000011	0.000015
Co (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.000108	0.000324	0.00902	0.000089
Cr (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.00300	0.00158	0.00232	0.00147
Cu (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.0007	< 0.0002	0.0014	0.0038
Fe (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.115	0.374	0.407	0.011
K (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	160	161	179	156
Li (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.0013	0.0012	0.0012	0.0008
Mg (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	144	143	160	143
Mn (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.563	0.363	0.369	0.00260
Mo (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.00157	0.00117	0.0148	< 0.00004
Na (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	557	514	579	212
Ni (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.0015	0.0028	0.0107	0.0003
Pb (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.00004	0.00005	0.00022	0.00016
Sb (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.0016	0.0039	0.0027	< 0.0009
Se (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.0890	0.273	0.248	1.46
Sn (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.00015	< 0.00006	0.00022	0.00016
Sr (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.235	0.199	0.205	0.120
Ti (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.00255	0.00133	0.00124	0.00024
Tl (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.000429	0.000392	0.000485	0.000006
V (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.0244	0.0141	0.0145	0.00004
W (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Y (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.000222	0.000274	0.000198	0.000151
Zn (diss) [mg/L]	13-Dec-19	12:53	16-Dec-19	16:20	0.006	0.004	0.028	0.007

SGS

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LR Report : CA13318-DEC19

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Project : Si-3674

31-December-2019

SiREM Laboratory
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Date Rec. : 24 December 2019
LR Report: **CA15405-DEC19**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-12/19/2019	6: Si-3674-Port B-12/19/2019	7: Si-3674-Port A-12/19/2019	8: Si-3674-Influent-12/19/2019
Sample Date & Time					19-Dec-19	19-Dec-19	19-Dec-19	19-Dec-19
Temp Upon Receipt [°C]	---	---	---	---	1.0	1.0	1.0	1.0
Ag (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.018	0.022	0.046	0.011
As (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.0109	0.0093	0.0075	< 0.0002
Ba (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.129	0.137	0.0854	0.00223
Be (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.027	0.026	0.023	0.026
Bi (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	< 0.000007	< 0.000007	0.000031	< 0.000007
Ca (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	170	180	188	289
Cd (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	< 0.000003	< 0.000003	< 0.000003	0.000004
Co (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.000103	0.000059	0.000288	0.000063
Cr (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.00269	0.00259	0.00250	0.00172
Cu (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.0005	0.0011	0.0009	0.0025
Fe (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.127	0.187	0.233	0.012
K (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	144	154	156	148

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Project : Si-3674
LR Report : CA15405-DEC19

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-12/19/2019	6: Si-3674-Port B-12/19/2019	7: Si-3674-Port A-12/19/2019	8: Si-3674-Influent-12/19/2019
Li (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.0019	0.0020	0.0012	0.0010
Mg (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	148	152	155	154
Mn (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.539	0.561	0.186	0.00281
Mo (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.00188	0.00116	0.00112	0.00006
Na (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	572	581	632	236
Ni (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.0010	0.0015	0.0004	< 0.0001
Pb (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.00005	0.00003	0.00005	0.00011
Sb (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.0017	0.0014	0.0020	< 0.0009
Se (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.128	0.136	0.814	1.52
Sn (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.00012	0.00020	0.00026	0.00022
Sr (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.189	0.196	0.137	0.124
Ti (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.00159	0.00167	0.00170	0.00022
Tl (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.000502	0.000473	0.000238	< 0.000002
V (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.0150	0.0154	0.00929	0.00010
W (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	< 0.00002	< 0.00002	0.00002	< 0.00002
Y (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.000260	0.000320	0.000293	0.000084
Zn (diss) [mg/L]	30-Dec-19	13:22	31-Dec-19	09:58	0.006	0.006	0.008	0.009

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Project : Si-3674

13-January-2020

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Date Rec. : 03 January 2020
LR Report: **CA12008-JAN20**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-12/30/2019	6: Si-3674-Port B-12/30/2019	7: Si-3674-Port A-12/30/2019	8: Si-3674-Influent-12/30/2019
Sample Date & Time					30-Dec-19	30-Dec-19	30-Dec-19	30-Dec-19
Temp Upon Receipt [°C]	---	---	---	---	-1	-1	-1	-1
Ag (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.012	0.042	0.021	0.015
As (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.0149	0.0070	0.0045	< 0.0002
Ba (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.121	0.118	0.108	0.00238
Be (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	< 0.000007	< 0.000007	< 0.000007	< 0.000007
B (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.020	0.021	0.023	0.021
Bi (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.000017	0.000025	0.000027	< 0.000007
Ca (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	149	151	172	293
Cd (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	< 0.000003	< 0.000003	< 0.000003	0.000008
Co (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.000113	0.000101	0.000095	0.000093
Cr (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.00211	0.00242	0.00137	0.00076
Cu (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.0005	0.0005	< 0.0002	0.0010
Fe (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.148	0.240	0.122	< 0.007
K (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	131	134	150	150

Test method information available upon request. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.

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Project : Si-3674
LR Report : CA12008-JAN20

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-12/30/2019	6: Si-3674-Port B-12/30/2019	7: Si-3674-Port A-12/30/2019	8: Si-3674-Influent-12/30/2019
Li (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.0018	0.0017	0.0014	0.0009
Mg (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	136	144	154	158
Mn (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.503	0.505	0.313	0.00309
Mo (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.00239	0.00130	0.00067	0.00006
Na (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	488	512	552	225
Ni (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.0024	0.0043	0.0013	0.0003
Pb (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.00001	0.00002	< 0.00001	0.00014
Sb (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.0032	0.0015	0.0019	< 0.0009
Se (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.199	0.180	0.237	1.06
Sn (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.00019	0.00029	0.00009	< 0.00006
Sr (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.162	0.160	0.131	0.103
Ti (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.00099	0.00136	0.00083	0.00014
Tl (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.000593	0.000473	0.000110	0.000004
V (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.0125	0.0120	0.00644	0.00015
W (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Y (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.000243	0.000252	0.000229	0.000153
Zn (diss) [mg/L]	07-Jan-20	10:27	08-Jan-20	11:47	0.007	0.007	< 0.002	0.004

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

000010214

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

15-January-2020

SiREM Laboratory
Attn : Steve Sande

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

<contact information removed>

Date Rec. : 10 January 2020
LR Report: **CA12147-JAN20**
Reference: Si-3674

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Efluent -1/7/2020	6: Si-3674-Port B-1/7/2020	7: Si-3674-Port A-1/7/2020	8: Si-3674-Influent -1/7/2020
Sample Date & Time					07-Jan-20	07-Jan-20	07-Jan-20	07-Jan-20
Temp Upon Receipt [°C]	---	---	---	---	3.0	3.0	3.0	3.0
Ag (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.021	0.022	0.024	0.006
As (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.0056	0.0095	0.0073	0.0002
Ba (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.0971	0.117	0.119	0.00253
Be (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	< 0.000007	< 0.000007	0.000009	< 0.000007
B (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.022	0.025	0.023	0.023
Bi (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	< 0.000007	< 0.000007	< 0.000007	< 0.000007
Ca (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	155	168	170	279
Cd (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	< 0.000003	< 0.000003	0.000003	0.000014
Co (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.000136	0.000105	0.000140	0.000092
Cr (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.00129	0.00137	0.00151	0.00064
Cu (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	< 0.0002	< 0.0002	< 0.0002	0.0012
Fe (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.084	0.315	0.376	< 0.007
K (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	159	154	155	155
Li (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.0012	0.0014	0.0013	0.0008
Mg (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	143	149	142	149
Mn (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.239	0.368	0.365	0.00295
Mo (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.00105	0.00211	0.00137	0.00060
Na (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	548	570	542	223
Ni (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.0013	0.0030	0.0027	0.0005
Pb (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.00002	0.00002	0.00001	0.00011
Sb (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.0028	0.0059	0.0036	0.0017
Se (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.435	0.450	0.432	1.15
Sn (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	< 0.00006	< 0.00006	< 0.00006	< 0.00006
Sr (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.119	0.128	0.130	0.0923
Ti (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.00118	0.00105	0.00109	0.00031
Tl (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.000329	0.000373	0.000339	0.000015
V (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.0169	0.0170	0.0170	0.000151
W (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	< 0.00002	0.00005	< 0.00002	< 0.00002
Y (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.000156	0.000240	0.000221	0.000092
Zn (diss) [mg/L]	13-Jan-20	22:59	14-Jan-20	12:26	0.002	< 0.002	< 0.002	0.005

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LR Report : CA12147-JAN20

<Original signed by>

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
CATHARINE ARNOLD
CHEMIST

Catharine Arnold, B.Sc., C.Chem
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Environment, Health & Safety

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Phone: 705-652-2000 FAX: 705-652-6365

Project : Si-3674

28-January-2020

SiREM Laboratory
Attn : Steve Sande

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada

<contact information removed>

Date Rec. : 22 January 2020
LR Report: CA12518-JAN20

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-1/16/2020	6: Si-3674-Port B-1/16/2020	7: Si-3674-Port A-1/16/2020	8: Si-3674-Influent-1/16/2020
Sample Date & Time					16-Jan-20	16-Jan-20	16-Jan-20	16-Jan-20
Temp Upon Receipt [°C]	---	---	---	---	3.0	3.0	3.0	3.0
Ag (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.020	0.034	0.071	0.683
As (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.0185	0.0168	0.0069	0.0003
Ba (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.138	0.138	0.118	0.00288
Be (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	< 0.000007	0.000007	0.000012	< 0.000007
B (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.021	0.025	0.024	0.023
Bi (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.000025	0.000011	0.000011	0.000015
Ca (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	178	184	191	296
Cd (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.000004	< 0.000003	< 0.000003	0.000012
Co (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.000131	0.000142	0.000168	0.000101
Cr (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.00186	0.00192	0.00263	0.00094
Cu (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	< 0.0002	< 0.0002	< 0.0002	0.0140
Fe (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.188	0.416	0.232	0.029
K (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	168	176	168	168

OnLine LIMS

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Project : Si-3674
LR Report : CA12518-JAN20

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-1/16/2020	6: Si-3674-Port B-1/16/2020	7: Si-3674-Port A-1/16/2020	8: Si-3674-Influent-1/16/2020
Li (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.0018	0.0026	0.0015	0.0009
Mg (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	156	162	162	159
Mn (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.593	0.569	0.358	0.00663
Mo (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.00310	0.00184	0.00123	0.00009
Na (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	578	640	746	227
Ni (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.0032	0.0076	0.0032	0.0006
Pb (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.00002	0.00002	0.00003	0.00019
Sb (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.0046	0.0046	0.0019	< 0.0009
Se (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.197	0.254	0.164	1.16
Sn (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.00007	0.00011	0.00010	< 0.00006
Sr (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.160	0.150	0.126	0.0917
Ti (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.00117	0.00224	0.00318	0.00075
Tl (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.000534	0.000327	0.000149	0.000013
V (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.0211	0.0220	0.0146	0.00021
W (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	< 0.00002	< 0.00002	0.00004	< 0.00002
Y (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.000281	0.000296	0.000229	0.000141
Zn (diss) [mg/L]	27-Jan-20	10:03	28-Jan-20	13:09	0.002	< 0.002	< 0.002	0.006

<Original signed by>

CHARTERED CATHARINE ARNOLD CHEMIST ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

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CPAWS 187

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Project : Si-3674

06-February-2020

SiREM Laboratory
Attn : Steve Sande

130 Stone Road W
Guelph, ON
N1G 3Z2, Canada
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Date Rec. : 30 January 2020
LR Report: **CA12727-JAN20**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-1/27/2020	6: Si-3674-Port B-1/27/2020	7: Si-3674-Port A-1/27/2020	8: Si-3674-Influent-1/27/2020
Sample Date & Time					27-Jan-20	27-Jan-20	27-Jan-20	27-Jan-20
Temp Upon Receipt [°C]	---	---	---	---	1.0	1.0	1.0	1.0
Ag (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Al (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.148	0.279	0.416	0.025
As (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.0247	0.0199	0.0079	< 0.0002
Ba (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.135	0.158	0.119	0.00268
Be (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	< 0.000007	0.000008	0.000009	< 0.000007
B (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.026	0.036	0.037	0.028
Bi (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.000008	< 0.000007	0.000023	< 0.000007
Ca (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	149	197	186	286
Cd (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	< 0.000003	< 0.000003	< 0.000003	0.000003
Co (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.000239	0.000351	0.000367	0.000089
Cr (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.00522	0.00491	0.00355	0.00082
Cu (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.0009	0.0004	0.0003	0.0012
Fe (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.200	0.562	0.532	< 0.007
K (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	162	160	160	156

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Project : Si-3674
LR Report : CA12727-JAN20

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Completed Date	4: Analysis Completed Time	5: Si-3674-Effluent-1/27/2020	6: Si-3674-Port B-1/27/2020	7: Si-3674-Port A-1/27/2020	8: Si-3674-Influent-1/27/2020
Li (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.0026	0.0019	0.0014	0.0015
Mg (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	152	151	152	143
Mn (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.539	0.688	0.274	0.00303
Mo (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.00438	0.00211	0.00106	0.00059
Na (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	745	751	805	215
Ni (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.0048	0.0105	0.0051	0.0005
Pb (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.00026	0.00020	0.00017	0.00012
Sb (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.0038	0.0052	0.0022	< 0.0009
Se (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.0685	0.400	0.443	1.05
Sn (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	< 0.00006	0.00010	0.00007	< 0.00006
Sr (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.166	0.159	0.108	0.0897
Ti (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.00265	0.0102	0.00445	0.00019
Tl (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	< 0.000005	< 0.000005	< 0.000005	< 0.000005
U (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.000512	0.000374	0.000242	0.000097
V (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.0506	0.0460	0.0215	0.00006
W (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.00006	0.00025	0.00028	0.00014
Y (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.000258	0.000550	0.000324	0.000079
Zn (diss) [mg/L]	04-Feb-20	12:31	05-Feb-20	16:06	0.004	0.023	0.008	0.003

<Original signed by>

CHARTERED CATHARINE ARNOLD CHEMIST — ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO

Catharine Arnold, B.Sc., C.Chem
Project Specialist,
Environment, Health & Safety

OnLine LIMS

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APPENDIX D:

BROOKS APPLIED LABORATORY REPORTS

BROOKS APPLIED LABS
18804 North Creek Parkway, Ste 100, Bothell, WA 98011 • USA • T: 206 632 6206 F: 206 632 6017 • info@brooksapplied.com

October 25, 2019

SiREM
ATTN: Steve Sande
130 Stone Road West
Ontario, Canada N1G 3Z2
<email address removed>

RE: Project SIR-GU1901 Client Project ID: Si-3674

Dear Mr. Sande,

On September 24, 2019, Brooks Applied Labs (BAL) received two (2) water samples in a sealed cooler at an acceptable temperature of 3.7°C. On October 11, 2019, BAL received five (5) additional water samples in a sealed cooler. The samples received on October 11 were received in a cooler at an elevated temperature of 8.7^{0}C. Brooks Applied Labs strongly recommends that all samples submitted for selenium speciation quantitation remain at a temperature of ≤6°C to maintain sample integrity prior to analysis. All selenium speciation results for these samples (1939044-05, 1939044-07, 1939044-09, 1939044-11, and 1939044-13) were qualified (**H**) as a result of the cooler temperature outlier.

The samples were logged-in for total recoverable selenium [Se], selenite [Se(IV)], selenate [Se(VI)], selenocyanate [SeCN], selenomethionine [SeMet], methylseleninic acid [MeSe(IV)], selenosulfate [SeSO3], and unknown Se species [Unk Se Sp]. The abbreviation for unknown selenium species [Unk Se Sp] correlates to the total concentration of all unknown Se species observed during the analysis.

Samples requiring filtration were filtered by the client at collection. All samples were received, prepared, analyzed, and stored according to BAL SOPs and EPA methodology. Reagent water for dilutions and sample preservatives is monitored for contamination to account for any biases associated with the sample results.

Selenium Speciation Quantitation by IC-ICP-CRC-MS

Selenium speciation analysis was performed by ion chromatography coupled to an inductively coupled plasma collision reaction cell mass spectrometer (IC-ICP-CRC-MS). Prior to analysis, an aliquot of each sample was filtered again with a syringe filter (0.45-µm) and injected directly into a sealed autosampler vial. No further sample preparation was performed as any chemical alteration of a sample may shift the equilibrium of the system, resulting in changes in speciation ratios.

The selenium speciation results were *not* method blank corrected as described in the calculations section of the relevant BAL SOPs and were evaluated using reporting limits adjusted to account for sample aliquot size. The calibration does not contain MeSe(IV), SeMet, or $SeSO_3$ due to impurities in these standards which would bias the results for other Se species. The MDL value for Se(IV) is used as the MDL for MeSe(IV) and SeMet since Se(IV) is the nearest eluting Se species included in the calibration. The MDL value for Se(VI) used as the MDL for $SeSO_3$ since it is the nearest eluting Se species included in the calibration. Please refer to the *Sample Results* page for sample-specific MDLs, MRLs, and other details.

SeMet and MeSe(IV) elute early in the chromatographic run due to the nature of the molecules and the applied chromatographic separation method, and as such, additional Se species may co-elute. Alternate methods can be applied, upon client request, to increase the separation of SeMet and MeSe(IV) from potentially co-eluting Se species.

Selenium speciation results for 1939044-05, 1939044-07, 1939044-09, 1939044-11, and 1939044-13 were qualified (**H**) as a result of the cooler temperature outlier.

Total Recoverable Selenium Analysis by EPA Method 1638, Mod.

The original bottles were preserved with 1% HNO_3 (v/v) and 1% HCl (v/v). All sample fractions for total recoverable selenium analyses were digested in the original sample containers in a laboratory oven for a minimum of 3 hours at 85^{o}C.

Total recoverable selenium quantitation was performed by inductively coupled plasma triple quadrupole mass spectrometry (ICP-QQQ-MS). The ICP-QQQ-MS uses advanced interference removal techniques to ensure accuracy of the sample results. For more information, please visit the *Interference Reduction Technology* section on our website, brooksapplied.com.

The selenium results were *not* method blank corrected as described in the calculations section of the relevant BAL SOP(s) and were evaluated using reporting limits adjusted to account for sample aliquot size. Please refer to the *Sample Results* page for sample-specific MDLs, MRLs, and other details.

If the native sample result and/or the DUP result is not detected (ND) above the MDL, then the associated RPD is not calculated (N/C).

All data was reported without qualification (aside from concentration qualifiers and the (**H**) qualifiers awarded for the elevated cooler temperature). All associated quality control sample results met the acceptance criteria. BAL, an accredited laboratory, certifies that the reported results of all analyses for which BAL is NELAP accredited meet all NELAP requirements. For more information please see the *Report Information* page in your report.

Please feel free to contact me if you have any questions regarding this report.

Sincerely,

<Original signed by>

Jeremy Maute
Senior Project Manager
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Report Information

Laboratory Accreditation

BAL is accredited by the *National Environmental Laboratory Accreditation Program* (NELAP) through the State of Florida Department of Health, Bureau of Laboratories (E87982) and is certified to perform many environmental analyses. BAL is also certified by many other states to perform environmental analyses. For a current list of our accreditations/certifications, please visit our website at <http://www.brooksapplied.com/resources/certificates-permits/>. Results reported relate only to the samples listed in the report.

Field Quality Control Samples

Please be notified that certain EPA methods require the collection of field quality control samples of an appropriate type and frequency; failure to do so is considered a deviation from some methods and for compliance purposes should only be done with the approval of regulatory authorities. Please see the specific EPA methods for details regarding required field quality control samples.

Common Abbreviations

AR	as received
BAL	Brooks Applied Labs
BLK	method blank
BS	blank spike
CAL	calibration standard
CCB	continuing calibration blank
CCV	continuing calibration verification
COC	chain of custody record
D	dissolved fraction
DUP	duplicate
IBL	instrument blank
ICV	initial calibration verification
MDL	method detection limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
NR	non-reportable
N/C	not calculated
PS	post preparation spike
REC	percent recovery
RPD	relative percent difference
SCV	secondary calibration verification
SOP	standard operating procedure
SRM	reference material
T	total fraction
TR	total recoverable fraction

Definition of Data Qualifiers

(Effective 9/23/09)

E	An estimated value due to the presence of interferences. A full explanation is presented in the narrative.
H	Holding time and/or preservation requirements not met. Please see narrative for explanation.
J	Detected by the instrument, the result is > the MDL but ≤ the MRL. Result is reported and considered an estimate.
J-1	Estimated value. A full explanation is presented in the narrative.
M	Duplicate precision (RPD) was not within acceptance criteria. Please see narrative for explanation.
N	Spike recovery was not within acceptance criteria. Please see narrative for explanation.
R	Rejected, unusable value. A full explanation is presented in the narrative.
U	Result is ≤ the MDL or client requested reporting limit (CRRL). Result reported as the MDL or CRRL.
X	Result is not BLK-corrected and is within 10x the absolute value of the highest detectable BLK in the batch. Result is estimated.

These qualifiers are based on those previously utilized by Brooks Applied Labs, those found in the EPA SOW ILM03.0, Exhibit B, Section III, pg. B-18, and the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review; USEPA; January 2010. These supersede all previous qualifiers ever employed by BAL.

Sample Information

Sample	Lab ID	Report Matrix	Type	Sampled	Received
Si-3674-Effluent-9/18/19	1939044-01	water	Sample	09/20/2019	09/24/2019
Si-3674-Influent-9/18/19	1939044-02	water	Sample	09/20/2019	09/24/2019
Si-3674-Effluent-9/18/19	1939044-03	Water	Sample	09/20/2019	09/24/2019
Si-3674-Influent-9/18/19	1939044-04	Water	Sample	09/20/2019	09/24/2019
Si-3674-Effluent-10/7/19	1939044-05	water	Sample	10/07/2019	10/11/2019
Si-3674-Effluent-10/7/19	1939044-06	Water	Sample	10/07/2019	10/11/2019
Si-3674-Port B-10/7/19	1939044-07	water	Sample	10/07/2019	10/11/2019
Si-3674-Port B-10/7/19	1939044-08	Water	Sample	10/07/2019	10/11/2019
Si-3674-Port A-10/7/19	1939044-09	water	Sample	10/07/2019	10/11/2019
Si-3674-Port A-10/7/19	1939044-10	Water	Sample	10/07/2019	10/11/2019
Si-3674-Influent-10/7/19	1939044-11	water	Sample	10/07/2019	10/11/2019
Si-3674-Influent-10/7/19	1939044-12	Water	Sample	10/07/2019	10/11/2019
Si-3674-EffluentF-10/7/19	1939044-13	water	Sample	10/07/2019	10/11/2019

Batch Summary

Analyte	Lab Matrix	Method	Prepared	Analyzed	Batch	Sequence
MeSe(IV)	Water	SOP BAL-4200	10/18/2019	10/19/2019	B192947	1901344
Se	Water	EPA 1638 Mod	10/21/2019	10/23/2019	B192966	1901366
Se(IV)	Water	SOP BAL-4200	10/18/2019	10/19/2019	B192947	1901344
Se(VI)	Water	SOP BAL-4200	10/18/2019	10/19/2019	B192947	1901344
SeCN	Water	SOP BAL-4200	10/18/2019	10/19/2019	B192947	1901344
SeMet	Water	SOP BAL-4200	10/18/2019	10/19/2019	B192947	1901344
SeSO3	Water	SOP BAL-4200	10/18/2019	10/19/2019	B192947	1901344
Unk Se Sp	Water	SOP BAL-4200	10/18/2019	10/19/2019	B192947	1901344

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
Si-3674-Effluent-9/18/19										
1939044-01	MeSe(IV)	water	D	0.940		0.175	0.625	µg/L	B192947	1901344
1939044-01	Se(IV)	water	D	0.816		0.175	0.625	µg/L	B192947	1901344
1939044-01	Se(VI)	water	D	0.184	J	0.150	0.625	µg/L	B192947	1901344
1939044-01	SeCN	water	D	0.517	J	0.125	0.625	µg/L	B192947	1901344
1939044-01	SeMet	water	D	≤ 0.175	U	0.175	0.625	µg/L	B192947	1901344
1939044-01	SeSO3	water	D	0.209	J	0.150	0.625	µg/L	B192947	1901344
1939044-01	Unk Se Sp	water	D	8.61		0.175	0.625	µg/L	B192947	1901344
Si-3674-Influent-9/18/19										
1939044-02	MeSe(IV)	water	D	≤ 0.175	U	0.175	0.625	µg/L	B192947	1901344
1939044-02	Se(IV)	water	D	≤ 0.175	U	0.175	0.625	µg/L	B192947	1901344
1939044-02	Se(VI)	water	D	156		0.150	0.625	µg/L	B192947	1901344
1939044-02	SeCN	water	D	≤ 0.125	U	0.125	0.625	µg/L	B192947	1901344
1939044-02	SeMet	water	D	≤ 0.175	U	0.175	0.625	µg/L	B192947	1901344
1939044-02	SeSO3	water	D	≤ 0.150	U	0.150	0.625	µg/L	B192947	1901344
1939044-02	Unk Se Sp	water	D	≤ 0.175	U	0.175	0.625	µg/L	B192947	1901344
Si-3674-Effluent-9/18/19										
1939044-03	Se	Water	TR	61.2		0.367	1.14	µg/L	B192966	1901366
Si-3674-Influent-9/18/19										
1939044-04	Se	Water	TR	167		0.367	1.14	µg/L	B192966	1901366
Si-3674-Effluent-10/7/19										
1939044-05	MeSe(IV)	water	D	0.704	H	0.175	0.625	µg/L	B192947	1901344
1939044-05	Se(IV)	water	D	0.652	H	0.175	0.625	µg/L	B192947	1901344
1939044-05	Se(VI)	water	D	≤ 0.150	H U	0.150	0.625	µg/L	B192947	1901344
1939044-05	SeCN	water	D	0.150	H J	0.125	0.625	µg/L	B192947	1901344
1939044-05	SeMet	water	D	≤ 0.175	H U	0.175	0.625	µg/L	B192947	1901344
1939044-05	SeSO3	water	D	≤ 0.150	H U	0.150	0.625	µg/L	B192947	1901344
1939044-05	Unk Se Sp	water	D	5.13	H	0.175	0.625	µg/L	B192947	1901344
Si-3674-Effluent-10/7/19										
1939044-06	Se	Water	TR	50.9		0.367	1.14	µg/L	B192966	1901366

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
Si-3674-Port B-10/7/19										
1939044-07	MeSe(IV)	water	D	0.857	H	0.175	0.625	µg/L	B192947	1901344
1939044-07	Se(IV)	water	D	0.556	H J	0.175	0.625	µg/L	B192947	1901344
1939044-07	Se(VI)	water	D	≤ 0.150	H U	0.150	0.625	µg/L	B192947	1901344
1939044-07	SeCN	water	D	0.181	H J	0.125	0.625	µg/L	B192947	1901344
1939044-07	SeMet	water	D	≤ 0.175	H U	0.175	0.625	µg/L	B192947	1901344
1939044-07	SeSO3	water	D	≤ 0.150	H U	0.150	0.625	µg/L	B192947	1901344
1939044-07	Unk Se Sp	water	D	6.57	H	0.175	0.625	µg/L	B192947	1901344
Si-3674-Port B-10/7/19										
1939044-08	Se	Water	TR	47.5		0.367	1.14	µg/L	B192966	1901366
Si-3674-Port A-10/7/19										
1939044-09	MeSe(IV)	water	D	0.935	H	0.175	0.625	µg/L	B192947	1901344
1939044-09	Se(IV)	water	D	0.580	H J	0.175	0.625	µg/L	B192947	1901344
1939044-09	Se(VI)	water	D	≤ 0.150	H U	0.150	0.625	µg/L	B192947	1901344
1939044-09	SeCN	water	D	0.185	H J	0.125	0.625	µg/L	B192947	1901344
1939044-09	SeMet	water	D	≤ 0.175	H U	0.175	0.625	µg/L	B192947	1901344
1939044-09	SeSO3	water	D	≤ 0.150	H U	0.150	0.625	µg/L	B192947	1901344
1939044-09	Unk Se Sp	water	D	6.22	H	0.175	0.625	µg/L	B192947	1901344
Si-3674-Port A-10/7/19										
1939044-10	Se	Water	TR	58.1		0.367	1.14	µg/L	B192966	1901366
Si-3674-Influent-10/7/19										
1939044-11	MeSe(IV)	water	D	≤ 0.175	H U	0.175	0.625	µg/L	B192947	1901344
1939044-11	Se(IV)	water	D	≤ 0.175	H U	0.175	0.625	µg/L	B192947	1901344
1939044-11	Se(VI)	water	D	146	H	0.150	0.625	µg/L	B192947	1901344
1939044-11	SeCN	water	D	≤ 0.125	H U	0.125	0.625	µg/L	B192947	1901344
1939044-11	SeMet	water	D	≤ 0.175	H U	0.175	0.625	µg/L	B192947	1901344
1939044-11	SeSO3	water	D	≤ 0.150	H U	0.150	0.625	µg/L	B192947	1901344
1939044-11	Unk Se Sp	water	D	≤ 0.175	H U	0.175	0.625	µg/L	B192947	1901344
Si-3674-Influent-10/7/19										
1939044-12	Se	Water	TR	162		0.367	1.14	µg/L	B192966	1901366

Project ID: SIR-GU1901
PM: Jeremy Maute

Client PM: Steve Sande
Client Project: Si-3674

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
Si-3674-EffluentF-10/7/19										
1939044-13	MeSe(IV)	water	D	0.903	H	0.175	0.625	µg/L	B192947	1901344
1939044-13	Se(IV)	water	D	0.493	H J	0.175	0.625	µg/L	B192947	1901344
1939044-13	Se(VI)	water	D	≤ 0.150	H U	0.150	0.625	µg/L	B192947	1901344
1939044-13	SeCN	water	D	0.174	H J	0.125	0.625	µg/L	B192947	1901344
1939044-13	SeMet	water	D	≤ 0.175	H U	0.175	0.625	µg/L	B192947	1901344
1939044-13	SeSO3	water	D	≤ 0.150	H U	0.150	0.625	µg/L	B192947	1901344
1939044-13	Unk Se Sp	water	D	5.46	H	0.175	0.625	µg/L	B192947	1901344

Project ID: SIR-GU1901
PM: Jeremy Maute

Client PM: Steve Sande
Client Project: Si-3674

Accuracy & Precision Summary

Batch: B192947
Lab Matrix: Water
Method: SOP BAL-4200

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B192947-BS1	**Blank Spike, (1923027)**								
	MeSe(IV)		5.095	4.954	µg/L	97%	75-125		
	Se(IV)		5.000	4.854	µg/L	97%	75-125		
	Se(VI)		5.000	4.749	µg/L	95%	75-125		
	SeCN		5.015	4.782	µg/L	95%	75-125		
	SeMet		4.932	4.677	µg/L	95%	75-125		
B192947-DUP3	**Duplicate, (1939044-05)**								
	MeSe(IV)	0.704		0.646	µg/L			9%	25
	Se(IV)	0.652		0.649	µg/L			0.4%	25
	Se(VI)	ND		ND	µg/L			N/C	25
	SeCN	0.150		0.162	µg/L			7%	25
	SeMet	ND		ND	µg/L			N/C	25
	SeSO3	ND		ND	µg/L			N/C	25
	Unk Se Sp	5.127		5.337	µg/L			4%	25
B192947-MS3	**Matrix Spike, (1939044-05)**								
	Se(IV)	0.652	122.5	118.5	µg/L	96%	75-125		
	Se(VI)	ND	127.5	121.8	µg/L	96%	75-125		
	SeCN	0.150	122.6	119.5	µg/L	97%	75-125		
	SeMet	ND	24.71	24.94	µg/L	101%	75-125		
B192947-MSD3	**Matrix Spike Duplicate, (1939044-05)**								
	Se(IV)	0.652	122.5	121.6	µg/L	99%	75-125	3%	25
	Se(VI)	ND	127.5	125.7	µg/L	99%	75-125	3%	25
	SeCN	0.150	122.6	123.6	µg/L	101%	75-125	3%	25
	SeMet	ND	24.71	25.13	µg/L	102%	75-125	0.8%	25

Accuracy & Precision Summary

Batch: B192966
Lab Matrix: Water
Method: EPA 1638 Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits	RPD & Limits
B192966-BS1	**Blank Spike, (1850082)**						
	Se		20.00	20.85	µg/L	104% 75-125	
B192966-DUP1	**Duplicate, (1939044-03)**						
	Se	61.16		59.35	µg/L		3% 20
B192966-MS1	**Matrix Spike, (1939044-03)**						
	Se	61.16	204.1	268.2	µg/L	101% 75-125	
B192966-MSD1	**Matrix Spike Duplicate, (1939044-03)**						
	Se	61.16	204.1	267.4	µg/L	101% 75-125	0.3% 20

Method Blanks & Reporting Limits

Batch: B192947
Matrix: Water
Method: SOP BAL-4200
Analyte: MeSe(IV)

Sample	Result	Units
B192947-BLK1	0.00	µg/L
B192947-BLK2	0.00	µg/L
B192947-BLK3	0.00	µg/L
B192947-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.007
MRL: 0.025

Analyte: Se(IV)

Sample	Result	Units
B192947-BLK1	0.00	µg/L
B192947-BLK2	0.00	µg/L
B192947-BLK3	0.00	µg/L
B192947-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.007
MRL: 0.025

Analyte: Se(VI)

Sample	Result	Units
B192947-BLK1	0.00	µg/L
B192947-BLK2	0.00	µg/L
B192947-BLK3	0.00	µg/L
B192947-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.006
MRL: 0.025

Method Blanks & Reporting Limits

Analyte: SeCN

Sample	Result	Units
B192947-BLK1	0.00	µg/L
B192947-BLK2	0.00	µg/L
B192947-BLK3	0.00	µg/L
B192947-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.005
MRL: 0.025

Analyte: SeMet

Sample	Result	Units
B192947-BLK1	0.00	µg/L
B192947-BLK2	0.00	µg/L
B192947-BLK3	0.00	µg/L
B192947-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.007
MRL: 0.025

Analyte: SeSO3

Sample	Result	Units
B192947-BLK1	0.00	µg/L
B192947-BLK2	0.00	µg/L
B192947-BLK3	0.00	µg/L
B192947-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.006
MRL: 0.025

Analyte: Unk Se Sp

Sample	Result	Units
B192947-BLK1	0.00	µg/L
B192947-BLK2	0.00	µg/L
B192947-BLK3	0.00	µg/L
B192947-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.007
MRL: 0.025

Project ID: SIR-GU1901
PM: Jeremy Maute

Client PM: Steve Sande
Client Project: Si-3674

Method Blanks & Reporting Limits

Batch: B192966
Matrix: Water
Method: EPA 1638 Mod
Analyte: Se

Sample	Result	Units
B192966-BLK1	0.009	µg/L
B192966-BLK2	0.007	µg/L
B192966-BLK3	0.008	µg/L
B192966-BLK4	0.005	µg/L
Average:	0.007	
Limit:	0.056	

MDL: 0.018
MRL: 0.056

Sample Containers

Lab ID: 1939044-01
Sample: Si-3674-Effluent-9/18/19
Report Matrix: water
Sample Type: Sample
Collected: 09/20/2019
Received: 09/24/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Cent Tube 15mL Se-Sp	15 mL	n/a	none	n/a	n/a	StyroCooler - 1939044
B	EXTRA_VOL	40 mL	n/a	none	n/a	n/a	StyroCooler - 1939044

Lab ID: 1939044-02
Sample: Si-3674-Influent-9/18/19
Report Matrix: water
Sample Type: Sample
Collected: 09/20/2019
Received: 09/24/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Cent Tube 15mL Se-Sp	15 mL	n/a	none	n/a	n/a	StyroCooler - 1939044
B	EXTRA_VOL	40 mL	n/a	none	n/a	n/a	StyroCooler - 1939044

Lab ID: 1939044-03
Sample: Si-3674-Effluent-9/18/19
Report Matrix: Water
Sample Type: Sample
Collected: 09/20/2019
Received: 09/24/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250 mL	n/a	Unk. HNO3 (Client)	n/a	1	StyroCooler - 1939044

Lab ID: 1939044-04
Sample: Si-3674-Influent-9/18/19
Report Matrix: Water
Sample Type: Sample
Collected: 09/20/2019
Received: 09/24/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250 mL	n/a	Unk. HNO3 (Client)	n/a	1	StyroCooler - 1939044

Lab ID: 1939044-05
Sample: Si-3674-Effluent-10/7/19
Report Matrix: water
Sample Type: Sample
Collected: 10/07/2019
Received: 10/11/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Cent Tube 15mL Se-Sp	15 mL	n/a	none	n/a	n/a	Cooler - 1939044
B	EXTRA_VOL	40 mL	n/a	none	n/a	n/a	Cooler - 1939044

Sample Containers

Lab ID: 1939044-06
Sample: Si-3674-Effluent-10/7/19
Report Matrix: Water
Sample Type: Sample
Collected: 10/07/2019
Received: 10/11/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250 mL	n/a	Unk. HNO3 (Client)	n/a	1	Cooler - 1939044

Lab ID: 1939044-07
Sample: Si-3674-Port B-10/7/19
Report Matrix: water
Sample Type: Sample
Collected: 10/07/2019
Received: 10/11/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Cent Tube 15mL Se-Sp	15 mL	n/a	none	n/a	n/a	Cooler - 1939044
B	EXTRA_VOL	40 mL	n/a	none	n/a	n/a	Cooler - 1939044

Lab ID: 1939044-08
Sample: Si-3674-Port B-10/7/19
Report Matrix: Water
Sample Type: Sample
Collected: 10/07/2019
Received: 10/11/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250 mL	n/a	Unk. HNO3 (Client)	n/a	1	Cooler - 1939044

Lab ID: 1939044-09
Sample: Si-3674-Port A-10/7/19
Report Matrix: water
Sample Type: Sample
Collected: 10/07/2019
Received: 10/11/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Cent Tube 15mL Se-Sp	15 mL	n/a	none	n/a	n/a	Cooler - 1939044
B	EXTRA_VOL	40 mL	n/a	none	n/a	n/a	Cooler - 1939044

Lab ID: 1939044-10
Sample: Si-3674-Port A-10/7/19
Report Matrix: Water
Sample Type: Sample
Collected: 10/07/2019
Received: 10/11/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250 mL	n/a	Unk. HNO3 (Client)	n/a	1	Cooler - 1939044

Sample Containers

Lab ID: 1939044-11
Sample: Si-3674-Influent-10/7/19
Report Matrix: water
Sample Type: Sample
Collected: 10/07/2019
Received: 10/11/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Cent Tube 15mL Se-Sp	15 mL	n/a	none	n/a	n/a	Cooler - 1939044
B	EXTRA_VOL	40 mL	n/a	none	n/a	n/a	Cooler - 1939044

Lab ID: 1939044-12
Sample: Si-3674-Influent-10/7/19
Report Matrix: Water
Sample Type: Sample
Collected: 10/07/2019
Received: 10/11/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	250 mL	n/a	Unk. HNO3 (Client)	n/a	1	Cooler - 1939044

Lab ID: 1939044-13
Sample: Si-3674-EffluentF-10/7/19
Report Matrix: water
Sample Type: Sample
Collected: 10/07/2019
Received: 10/11/2019

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Cent Tube 15mL Se-Sp	15 mL	n/a	none	n/a	n/a	Cooler - 1939044
B	EXTRA_VOL	40 mL	n/a	none	n/a	n/a	Cooler - 1939044

Shipping Containers

Cooler - 1939044

Received: October 11, 2019 9:55
Tracking No: 7766 7327 9760 via FedEx
Coolant Type: Blue Ice
Temperature: 8.7 °C

Description: Cooler
Damaged in transit? No
Returned to client? No
Comments: IR #19

Custody seals present? No
Custody seals intact? No
COC present? Yes

StyroCooler - 1939044

Received: September 24, 2019 10:20
Tracking No: 776310074807 via FedEx
Coolant Type: Blue Ice
Temperature: 3.7 °C

Description: StyroCooler
Damaged in transit? No
Returned to client? No
Comments: IR #19

Custody seals present? No
Custody seals intact? No
COC present? Yes

BROOKS APPLIED LABS

Chain -of-Custody Form

BAL Report 1939044

For BAL use only

Received by: <Signature removed> Date: 09/24/19

Work Order ID: Time: 10:20

Project ID:

Ship samples to:

<contact information removed>

Client: SiREM
Contact: Steve Sande
Client Project ID: Si-3674
Samples Collected By: Steve Sande

Mailing Address:

Email Receipt Confirmation? Yes

BAL PM:

Requested TAT (business days)

☑ 20 (standard)
☐ 15*
☐ 10*
☐ 5*
☐ Other ____

*Surcharges may apply to expedited TATs

	Sample ID	Collection: Date	Collection: Time	Client Sample Info: Matrix Type	Number of Containers	Field Filtered?	Preservation Type	BAL Analyses Required: Total Hg, EPA 1631	Methyl Hg, EPA 1630	ICP-MS Metals (specify)	As Species (specify)	Se Species (specify)	Filtration	Other (Total Se)	Other (specify here)	Comments: Specify Here
1	Si-3674-Effluent-9/18/19	9/20/19		Groundwater	2	Yes	HNO3					✓		✓		Hold speciation
2	Si-3674-Influent-9/18/19	9/20/19		Groundwater	2	Yes	HNO3					✓		✓		samples
3																Speciation samples
4																filtered, unpreserve
5																Total Se samples
6																preserved, unfiltere
7																
8																
9																
10																
	Trip Blank (specify)															

Relinquished By: Steve Sande	Date: 23 Sep	Time: 12:00	Relinquished By:	Date:	Time:
Received By:	Date:	Time:	Total Number of Packages:		

Page____of____ List Hazardous Contaminants: ____

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BROOKS APPLIED LABS

Chain -of-Custody Form

Ship samples to:
<contact information removed>

For BAL use only
Received by: <Signature removed> *Date:* 10/11/19
Work Order ID: *Time:* 0955
Project ID:

Client: SiREM
Contact: Steve Sande
Client Project ID: Si-3674
Samples Collected By: Steve Sande

Mailing Address:

Email Receipt Confirmation? Yes

BAL PM:

Requested TAT (business days)
☑ 20 (standard)
☐ 15*
☐ 10*
☐ 5*
☐ Other ____
*Surcharges may apply to expedited TATs

	Sample ID	Collection: Date	Time	Client Sample Info: Matrix Type	Number of Containers	Field Filtered?	Preservation Type	BAL Analyses Required: Total Hg, EPA 1631	Methyl Hg, EPA 1630	ICP-MS Metals (specify)	As Species (specify)	Se Species (specify)	Filtration	Other (Total Se)	Other (specify here)	Comments: Specify Here
1	Si-3674-Effluent-10/7/19	10/7/19		Groundwater	2	Yes	HNO3					✓		✓		Speciation samples
2	Si-3674-Port B-10/7/19	10/7/19		Groundwater	2	Yes	HNO3					✓		✓		filtered, unpreserve
3	Si-3674-Port A-10/7/19	10/7/19		Groundwater	2	Yes	HNO3					✓		✓		Total Se samples
4	Si-3674-Influent-10/7/19	10/7/19		Groundwater	2	Yes	HNO3					✓		✓		preserved, unfiltere
5	Si-3674-EffluentF-10/7/19	10/7/19		Groundwater	1	Yes	None					✓				
6																
7																
8																
9																
10																
	Trip Blank (specify)															

Relinquished By: Steve Sande	Date: 10Oct19	Time: 1100	Relinquished By:	Date:	Time:
Received By:	Date:	Time:	Total Number of Packages:		

Page____of____ List Hazardous Contaminants: ____________

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18804 North Creek Parkway, Ste 100, Bothell, WA 98011 • USA • T: 206 632 6206 F: 206 632 6017 • info@brooksapplied.com

February 13, 2020

SiREM
ATTN: Steve Sande
130 Stone Road West
Ontario, Canada N1G 3Z2
<email address removed>

RE: Project SIR-GU1901 Client Project ID: Si-3674

Dear Mr. Sande,

On January 31, 2020, Brooks Applied Labs (BAL) received two (2) water samples in a cooler at an acceptable temperature of 1.3°C. The samples were logged-in for total recoverable selenium [Se], selenite [Se(IV)], selenate [Se(VI)], selenocyanate [SeCN], selenomethionine [SeMet], methylseleninic acid [MeSe(IV)], selenosulfate [SeSO3], and unknown Se species [Unk Se Sp]. The abbreviation for unknown selenium species [Unk Se Sp] correlates to the total concentration of all unknown Se species observed during the analysis.

Samples requiring filtration were filtered by the client at collection. All samples were received, prepared, analyzed, and stored according to BAL SOPs and EPA methodology. Reagent water for dilutions and sample preservatives is monitored for contamination to account for any biases associated with the sample results.

<u>Selenium Speciation Quantitation by IC-ICP-CRC-MS</u>

Selenium speciation analysis was performed by ion chromatography coupled to an inductively coupled plasma collision reaction cell mass spectrometer (IC-ICP-CRC-MS). Prior to analysis, an aliquot of each sample was filtered again with a syringe filter (0.45-µm) and injected directly into a sealed autosampler vial. No further sample preparation was performed as any chemical alteration of a sample may shift the equilibrium of the system, resulting in changes in speciation ratios.

The selenium speciation results were *not* method blank corrected as described in the calculations section of the relevant BAL SOPs and were evaluated using reporting limits adjusted to account for sample aliquot size. The calibration does not contain MeSe(IV), SeMet, or $SeSO_3$ due to impurities in these standards which would bias the results for other Se species. The MDL value for Se(IV) is used as the MDL for MeSe(IV) and SeMet since Se(IV) is the nearest eluting Se species included in the calibration. The MDL value for Se(VI) used as the MDL for $SeSO_3$ since it is the nearest eluting Se species included in the calibration. Please refer to the *Sample Results* page for sample-specific MDLs, MRLs, and other details.

SeMet and MeSe(IV) elute early in the chromatographic run due to the nature of the molecules and the applied chromatographic separation method, and as such, additional Se species may co-elute. Alternate methods can be applied, upon client request, to increase the separation of SeMet and MeSe(IV) from potentially co-eluting Se species.

Sample 2005058-02 yielded poor precision for MeSe(IV) in B200320-DUP2. B200320-DUP2 was re-analyzed as B200320-DUP4, producing an acceptable relative percent difference. Results for B200320-DUP4 are reported. However, the MeSe(IV) result for 2005058-02 is qualified as estimated (**J-1**) due to poor precision between separate injections.

Total Recoverable Selenium Analysis by EPA Method 1638, Mod.

The original bottles were preserved with 1% HNO_3 (v/v) and 1% HCl (v/v). All sample fractions for total recoverable selenium analyses were digested in the original sample containers in a laboratory oven for a minimum of 3 hours at 85^{o}C.

Total recoverable selenium quantitation was performed by inductively coupled plasma triple quadrupole mass spectrometry (ICP-QQQ-MS). The ICP-QQQ-MS uses advanced interference removal techniques to ensure accuracy of the sample results. For more information, please visit the *Interference Reduction Technology* section on our website, brooksapplied.com.

The selenium results were *not* method blank corrected as described in the calculations section of the relevant BAL SOP(s) and were evaluated using reporting limits adjusted to account for sample aliquot size. Please refer to the *Sample Results* page for sample-specific MDLs, MRLs, and other details.

If the native sample result and/or the DUP result is not detected (ND) above the MDL, then the associated RPD is not calculated (N/C).

Except for the item noted above, all data was reported without qualification (aside from concentration qualifiers). All associated quality control sample results met the acceptance criteria. BAL, an accredited laboratory, certifies that the reported results of all analyses for which BAL is NELAP accredited meet all NELAP requirements. For more information please see the *Report Information* page in your report.

Please feel free to contact me if you have any questions regarding this report.

Sincerely,

<Original signed by>

Jeremy Maute
Senior Project Manager
Brooks Applied Labs, LLC
<email address removed>

Project ID: SIR-GU1901
PM: Jeremy Maute

Client PM: Steve Sande
Client Project: Si-3674

Report Information

Laboratory Accreditation

BAL is accredited by the *National Environmental Laboratory Accreditation Program* (NELAP) through the State of Florida Department of Health, Bureau of Laboratories (E87982) and is certified to perform many environmental analyses. BAL is also certified by many other states to perform environmental analyses. For a current list of our accreditations/certifications, please visit our website at <http://www.brooksapplied.com/resources/certificates-permits/>. Results reported relate only to the samples listed in the report.

Field Quality Control Samples

Please be notified that certain EPA methods require the collection of field quality control samples of an appropriate type and frequency; failure to do so is considered a deviation from some methods and for compliance purposes should only be done with the approval of regulatory authorities. Please see the specific EPA methods for details regarding required field quality control samples.

Common Abbreviations

AR	as received
BAL	Brooks Applied Labs
BLK	method blank
BS	blank spike
CAL	calibration standard
CCB	continuing calibration blank
CCV	continuing calibration verification
COC	chain of custody record
D	dissolved fraction
DUP	duplicate
IBL	instrument blank
ICV	initial calibration verification
MDL	method detection limit
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
ND	non-detect
NR	non-reportable
N/C	not calculated
PS	post preparation spike
REC	percent recovery
RPD	relative percent difference
SCV	secondary calibration verification
SOP	standard operating procedure
SRM	reference material
T	total fraction
TR	total recoverable fraction

Definition of Data Qualifiers

(Effective 9/23/09)

E	An estimated value due to the presence of interferences. A full explanation is presented in the narrative.
H	Holding time and/or preservation requirements not met. Please see narrative for explanation.
J	Detected by the instrument, the result is > the MDL but ≤ the MRL. Result is reported and considered an estimate.
J-1	Estimated value. A full explanation is presented in the narrative.
M	Duplicate precision (RPD) was not within acceptance criteria. Please see narrative for explanation.
N	Spike recovery was not within acceptance criteria. Please see narrative for explanation.
R	Rejected, unusable value. A full explanation is presented in the narrative.
U	Result is ≤ the MDL or client requested reporting limit (CRRL). Result reported as the MDL or CRRL.
X	Result is not BLK-corrected and is within 10x the absolute value of the highest detectable BLK in the batch. Result is estimated.

These qualifiers are based on those previously utilized by Brooks Applied Labs, those found in the EPA SOW ILM03.0, Exhibit B, Section III, pg. B-18, and the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review; USEPA; January 2010. These supersede all previous qualifiers ever employed by BAL.

Sample Information

Sample	Lab ID	Report Matrix	Type	Sampled	Received
Si-3674-Effluent-1/16/20	2005058-01	Groundwater	Sample	01/16/2020	01/31/2020
Si-3674-Effluent-1/28/20	2005058-02	Groundwater	Sample	01/28/2020	01/31/2020
Si-3674-Effluent-1/16/20	2005058-03	Groundwater	Sample	01/16/2020	01/31/2020
Si-3674-Effluent-1/28/20	2005058-04	Groundwater	Sample	01/28/2020	01/31/2020

Batch Summary

Analyte	Lab Matrix	Method	Prepared	Analyzed	Batch	Sequence
MeSe(IV)	Water	SOP BAL-4200	02/03/2020	02/04/2020	B200320	2000168
Se	Water	EPA 1638 Mod	02/03/2020	02/07/2020	B200340	2000188
Se(IV)	Water	SOP BAL-4200	02/03/2020	02/04/2020	B200320	2000168
Se(VI)	Water	SOP BAL-4200	02/03/2020	02/04/2020	B200320	2000168
SeCN	Water	SOP BAL-4200	02/03/2020	02/04/2020	B200320	2000168
SeMet	Water	SOP BAL-4200	02/03/2020	02/04/2020	B200320	2000168
SeSO3	Water	SOP BAL-4200	02/03/2020	02/04/2020	B200320	2000168
Unk Se Sp	Water	SOP BAL-4200	02/03/2020	02/04/2020	B200320	2000168

Sample Results

Sample	Analyte	Report Matrix	Basis	Result	Qualifier	MDL	MRL	Unit	Batch	Sequence
Si-3674-Effluent-1/16/20										
2005058-01	MeSe(IV)	Groundwater	D	2.61		0.175	0.625	µg/L	B200320	2000168
2005058-01	Se(IV)	Groundwater	D	≤ 0.175	U	0.175	0.625	µg/L	B200320	2000168
2005058-01	Se(VI)	Groundwater	D	124		0.150	0.625	µg/L	B200320	2000168
2005058-01	SeCN	Groundwater	D	0.718		0.125	0.625	µg/L	B200320	2000168
2005058-01	SeMet	Groundwater	D	≤ 0.175	U	0.175	0.625	µg/L	B200320	2000168
2005058-01	SeSO3	Groundwater	D	0.631		0.150	0.625	µg/L	B200320	2000168
2005058-01	Unk Se Sp	Groundwater	D	11.3		0.175	0.625	µg/L	B200320	2000168
Si-3674-Effluent-1/28/20										
2005058-02	MeSe(IV)	Groundwater	D	≤ 0.175	J-1 U	0.175	0.625	µg/L	B200320	2000168
2005058-02	Se(IV)	Groundwater	D	≤ 0.175	U	0.175	0.625	µg/L	B200320	2000168
2005058-02	Se(VI)	Groundwater	D	31.3		0.150	0.625	µg/L	B200320	2000168
2005058-02	SeCN	Groundwater	D	0.240	J	0.125	0.625	µg/L	B200320	2000168
2005058-02	SeMet	Groundwater	D	≤ 0.175	U	0.175	0.625	µg/L	B200320	2000168
2005058-02	SeSO3	Groundwater	D	≤ 0.150	U	0.150	0.625	µg/L	B200320	2000168
2005058-02	Unk Se Sp	Groundwater	D	11.3		0.175	0.625	µg/L	B200320	2000168
Si-3674-Effluent-1/16/20										
2005058-03	Se	Groundwater	TR	192		0.459	1.43	µg/L	B200340	2000188
Si-3674-Effluent-1/28/20										
2005058-04	Se	Groundwater	TR	79.7		0.459	1.43	µg/L	B200340	2000188

Project ID: SIR-GU1901
PM: Jeremy Maute

Client PM: Steve Sande
Client Project: Si-3674

Accuracy & Precision Summary

Batch: B200320
Lab Matrix: Water
Method: SOP BAL-4200

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B200320-BS1	**Blank Spike, (1923027)**								
	MeSe(IV)		5.095	4.769	µg/L	94%	75-125		
	Se(IV)		5.000	4.892	µg/L	98%	75-125		
	Se(VI)		5.000	4.884	µg/L	98%	75-125		
	SeCN		5.015	4.878	µg/L	97%	75-125		
	SeMet		4.932	4.666	µg/L	95%	75-125		
B200320-DUP4	**Duplicate, (2005058-02)**								
	MeSe(IV)	ND		ND	µg/L			N/C	25
	Se(IV)	ND		ND	µg/L			N/C	25
	Se(VI)	31.34		31.44	µg/L			0.3%	25
	SeCN	0.240		0.287	µg/L			18%	25
	SeMet	ND		ND	µg/L			N/C	25
	SeSO3	ND		ND	µg/L			N/C	25
	Unk Se Sp	11.34		11.61	µg/L			2%	25
B200320-MS2	**Matrix Spike, (2005058-02)**								
	Se(IV)	ND	122.5	121.3	µg/L	99%	75-125		
	Se(VI)	31.34	127.5	152.1	µg/L	95%	75-125		
	SeCN	0.240	122.6	111.3	µg/L	91%	75-125		
	SeMet	ND	24.71	23.08	µg/L	93%	75-125		
B200320-MSD2	**Matrix Spike Duplicate, (2005058-02)**								
	Se(IV)	ND	122.5	121.5	µg/L	99%	75-125	0.1%	25
	Se(VI)	31.34	127.5	152.1	µg/L	95%	75-125	0.03%	25
	SeCN	0.240	122.6	111.9	µg/L	91%	75-125	0.6%	25
	SeMet	ND	24.71	22.97	µg/L	93%	75-125	0.5%	25

Accuracy & Precision Summary

Batch: B200340
Lab Matrix: Water
Method: EPA 1638 Mod

Sample	Analyte	Native	Spike	Result	Units	REC & Limits		RPD & Limits	
B200340-BS1	**Blank Spike, (2006037)**								
	Se		20.00	20.00	µg/L	100%	75-125		
B200340-BS2	**Blank Spike, (2006037)**								
	Se		20.00	20.20	µg/L	101%	75-125		
B200340-DUP2	**Duplicate, (2005012-01)**								
	Se	0.584		0.570	µg/L			2%	20
B200340-MS2	**Matrix Spike, (2005012-01)**								
	Se	0.584	10.20	11.29	µg/L	105%	75-125		
B200340-MSD2	**Matrix Spike Duplicate, (2005012-01)**								
	Se	0.584	10.20	10.63	µg/L	98%	75-125	6%	20

Method Blanks & Reporting Limits

Batch: B200320
Matrix: Water
Method: SOP BAL-4200
Analyte: MeSe(IV)

Sample	Result	Units
B200320-BLK1	0.00	µg/L
B200320-BLK2	0.00	µg/L
B200320-BLK3	0.00	µg/L
B200320-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.007
MRL: 0.025

Analyte: Se(IV)

Sample	Result	Units
B200320-BLK1	0.00	µg/L
B200320-BLK2	0.00	µg/L
B200320-BLK3	0.00	µg/L
B200320-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.007
MRL: 0.025

Analyte: Se(VI)

Sample	Result	Units
B200320-BLK1	0.00	µg/L
B200320-BLK2	0.00	µg/L
B200320-BLK3	0.00	µg/L
B200320-BLK4	0.00	µg/L

Average: 0.000
Limit: 0.025

MDL: 0.006
MRL: 0.025

Project ID: SIR-GU1901
PM: Jeremy Maute

Client PM: Steve Sande
Client Project: Si-3674

Method Blanks & Reporting Limits

Analyte: SeCN

Sample	Result	Units
B200320-BLK1	0.00	µg/L
B200320-BLK2	0.00	µg/L
B200320-BLK3	0.00	µg/L
B200320-BLK4	0.00	µg/L
	Average: 0.000	
	Limit: 0.025	

MDL: 0.005
MRL: 0.025

Analyte: SeMet

Sample	Result	Units
B200320-BLK1	0.00	µg/L
B200320-BLK2	0.00	µg/L
B200320-BLK3	0.00	µg/L
B200320-BLK4	0.00	µg/L
	Average: 0.000	
	Limit: 0.025	

MDL: 0.007
MRL: 0.025

Analyte: SeSO3

Sample	Result	Units
B200320-BLK1	0.00	µg/L
B200320-BLK2	0.00	µg/L
B200320-BLK3	0.00	µg/L
B200320-BLK4	0.00	µg/L
	Average: 0.000	
	Limit: 0.025	

MDL: 0.006
MRL: 0.025

Analyte: Unk Se Sp

Sample	Result	Units
B200320-BLK1	0.00	µg/L
B200320-BLK2	0.00	µg/L
B200320-BLK3	0.00	µg/L
B200320-BLK4	0.00	µg/L
	Average: 0.000	
	Limit: 0.025	

MDL: 0.007
MRL: 0.025

Method Blanks & Reporting Limits

Batch: B200340
Matrix: Water
Method: EPA 1638 Mod
Analyte: Se

Sample	Result	Units
B200340-BLK1	0.003	µg/L
B200340-BLK2	0.0005	µg/L
B200340-BLK3	0.003	µg/L
B200340-BLK4	0.001	µg/L
Average:	0.002	
Limit:	0.056	

MDL: 0.018
MRL: 0.056

Project ID: SIR-GU1901
PM: Jeremy Maute

Client PM: Steve Sande
Client Project: Si-3674

Sample Containers

Lab ID: 2005058-01
Sample: Si-3674-Effluent-1/16/20
Report Matrix: Groundwater
Sample Type: Sample
Collected: 01/16/2020
Received: 01/31/2020

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE Se-SP	15mL	na	none	na	na	Styrofoam Cooler - 2005058
B	EXTRA_VOL	30mL	na	none	na	na	Styrofoam Cooler - 2005058

Lab ID: 2005058-02
Sample: Si-3674-Effluent-1/28/20
Report Matrix: Groundwater
Sample Type: Sample
Collected: 01/28/2020
Received: 01/31/2020

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE Se-SP	15mL	na	none	na	na	Styrofoam Cooler - 2005058
B	EXTRA_VOL	30mL	na	none	na	na	Styrofoam Cooler - 2005058

Lab ID: 2005058-03
Sample: Si-3674-Effluent-1/16/20
Report Matrix: Groundwater
Sample Type: Sample
Collected: 01/16/2020
Received: 01/31/2020

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	na	Unk. HNO3 (client)	na	1	Styrofoam Cooler - 2005058

Lab ID: 2005058-04
Sample: Si-3674-Effluent-1/28/20
Report Matrix: Groundwater
Sample Type: Sample
Collected: 01/28/2020
Received: 01/31/2020

Des	Container	Size	Lot	Preservation	P-Lot	pH	Ship. Cont.
A	Bottle HDPE ICP-W	125mL	na	Unk. HNO3 (client)	na	1	Styrofoam Cooler - 2005058

Shipping Containers

Styrofoam Cooler - 2005058

Received: January 31, 2020 9:45
Tracking No: 7776 3388 4860 via FedEx
Coolant Type: Blue Ice
Temperature: 1.3 °C

Description: Styrofoam Cooler
Damaged in transit? No
Returned to client? No
Comments: IR-19

Custody seals present? No
Custody seals intact? No
COC present? Yes

<Signature removed>

BROOKS APPLIED LABS

Chain -of-Custody Form

Ship samples to:

<contact information removed>

Received by:	*Date:* 1/31/20
Work Order ID: 2005058	*Time:* 9:45
Project ID: SIR-GU1901	

only BAL Report 2005058

Client: SiREM
Contact: Steve Sande
Client Project ID: Si-3674
Samples Collected By: Steve Sande

Mailing Address:

Email Receipt Confirmation? Yes

BAL PM:

Requested TAT (business days)

- ☑ 20 (standard)
- ☐ 15*
- ☐ 10*
- ☐ 5*
- ☐ Other ____

*Surcharges may apply to expedited TATs

	Sample ID	Collection: Date	Collection: Time	Client Sample Info: Matrix Type	Number of Containers	Field Filtered?	Preservation Type	BAL Analyses Required: Total Hg, EPA 1631	Methyl Hg, EPA 1630	ICP-MS Metals (specify)	As Species (specify)	Se Species (specify)	Filtration	Other (Total Se)	Other (specify here)	Comments: Specify Here
1	Si-3674-Effluent-1/16/20	1/16/20		Groundwater	2	Yes	None					✓		✓		Speciation samples
2	Si-3674-Effluent-1/28/20	1/28/20		Groundwater	2	Yes	None					✓		✓		filt., unpreserved.
3																Total Se samples
4																unfilt. with HNO3.
5																
6																
7																
8																
9																
10																
	Trip Blank (specify)															

Relinquished By: Steve Sande	Date: 29Jan20	Time: 2:30	Relinquished By:	Date:	Time:
Received By:	Date:	Time:	Total Number of Packages:		

Page____of____ List Hazardous Contaminants: ____________

samples@brooksapplied.com | brooksapplied.com

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APPENDIX E:

GENE-TRAC® NGS
MICROBIAL COMMUNITY CHARACTERIZATION REPORT

130 Stone Rd W
Guelph, ON N1G 3Z2
(519) 822-2265

GENE-TRAC® NGS
MICROBIAL COMMUNITY CHARACTERIZATION REPORT

Client: Andrzej Przepiora, Geosyntec Consultants **SiREM Reference:** S-5502/S-5684

Project: GBR Column Study **Report Date:** 10-Mar-20

Introduction

Next generation sequencing (NGS) provides detailed characterization of microbial community structure, diversity, and taxonomic identification in environmental samples. This analysis targets both *Bacteria* and *Archaea,* thereby providing identity and community structure information for a wide range of prokaryotes.

This report summarizes the results of Gene-Trac® NGS performed on one sample from the GBR Column Treatability Study. This report includes:

- Taxonomic affiliation and abundance of generated sequences (Figure 1/ Table 1)
- Functional analysis (Figure 2)

Supporting Data:

- DNA extraction, microbial quantification and microbial diversity (Table A)
- Rarefaction curve (sequencing reads /microbial diversity) (Figure A)
- Case narrative
- Chain of custody records
- Detailed listing of taxonomic affiliation and sequences of operational taxonomic units (OTUs) (Attached OTU Table Excel spreadsheet)
- Detailed listing of functional analysis (Attached Functional Analysis Excel spreadsheet)

Microbial Community Composition

The taxonomic composition of the microbial communities in the samples is presented in the bubble plot (Figure 1). Table 1 provides an estimated enumeration of each operational taxonomic unit (OTU). Each OTU represents a microbial species based on a 97% similarity of 16S rRNA gene sequences. A complete listing of all OTUs detected in the analysis is provided in the Excel spreadsheet “OTU Table S-5502_5684” provided electronically with this report.

Figure E1: Bubble plot demonstrating relative abundance of key taxa. Number and relative size of bubble denotes the percentage of taxa as its proportion of total microbial community. Only OTUs comprising >1% of microbial community are shown.

Table E1: Estimated enumeration of major OTUs

Taxonomic Designation	OTU ID	Estimated Enumeration/L	
		GBRInf160919	Si3674Effluent101219
f__Comamonadaceae	14	6.E+08	1.E+08
f__Comamonadaceae	36	4.E+09	1.E+08
f__Comamonadaceae	4	2.E+10	7.E+08
g__Dechloromonas	7	3.E+10	1.E+07
g__Delftia	6	6.E+09	5.E+08
g__Desulfosporosinus; s__meridiei	1	5.E+09	3.E+09
g__Desulfosporosinus; s__meridiei	27	1.E+08	1.E+08
g__Desulfosporosinus; s__meridiei	9	2.E+10	4.E+08
g__Desulfovibrio; s__mexicanus	5	3.E+08	5.E+08
g__Janthinobacterium; s__lividum	11	1.E+09	2.E+08
g__Paracoccus; s__aminovorans	8	1.E+10	2.E+08
g__Pelosinus	0	1.E+11	1.E+08
g__Pseudomonas; s__veronii	12	1.E+10	4.E+07
g__Pseudomonas; s__pseudoalcaligenes	2	8.E+10	7.E+08
f__Shewanellaceae	10	3.E+09	3.E+08
g__Sulfurospirillum	3	0.E+00	8.E+08

Notes: k=kingdom, p=phylum, f-family, o=order, c=class, g=genus, s=species
-Estimated Enumeration/L was calculated by multiplying the % of microbial community value (Figure 1) by the *Bacteria Archaea* qPCR result for the sample (Table1)

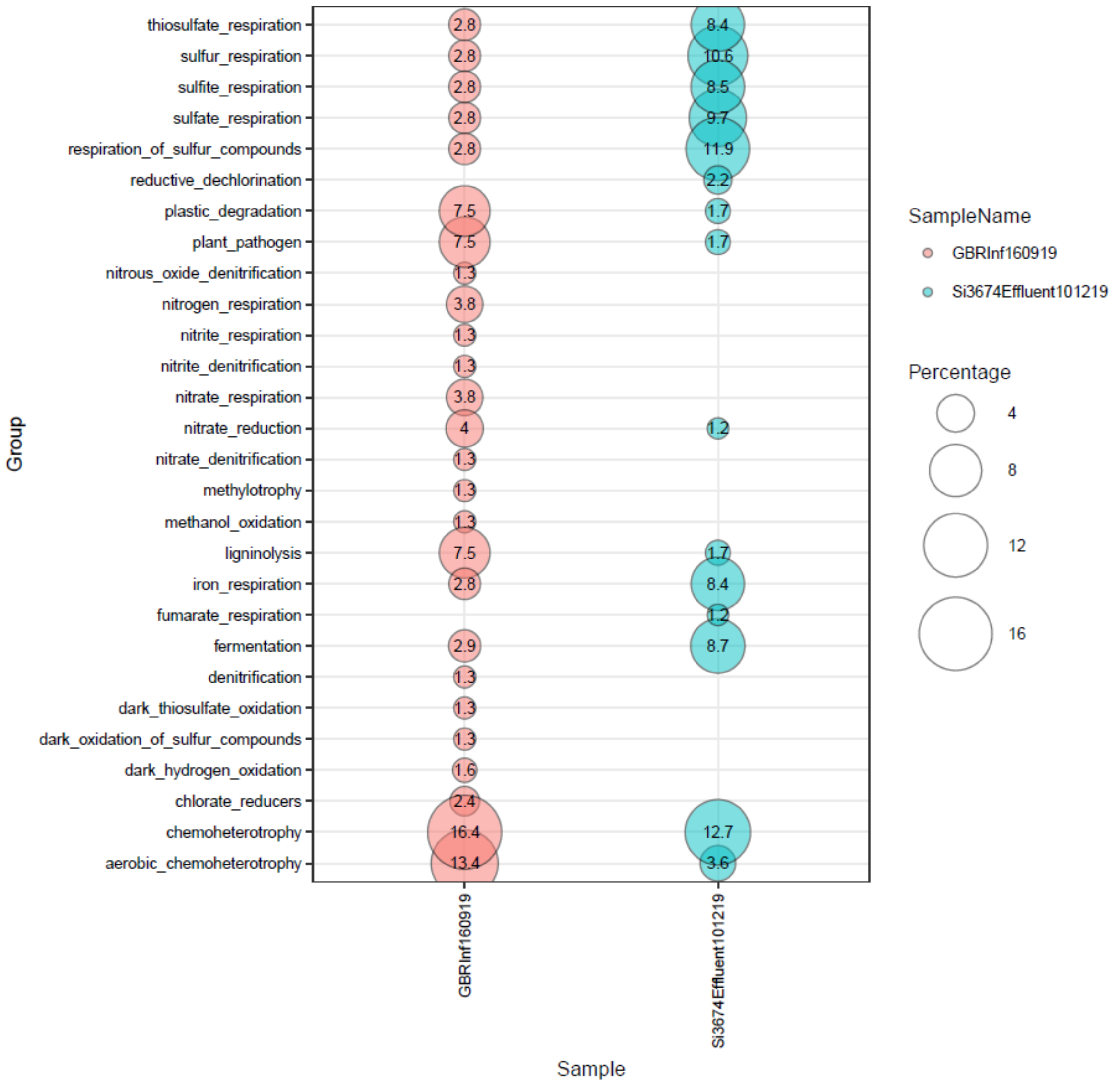

Figure E2: Functional analysis bubble plot demonstrating relative metabolic functions comprising >1% of functional annotatations

Functional Analysis

Taxonomic designations derived from NGS data can be used to infer microbial metabolic activities (i.e., functional analysis). This process provides information on the metabolic potential of microbial communities that otherwise would require more comprehensive sequencing protocols. FAPROTAX (Louca et al., 2016) is a functional analysis database that includes over 80 microbial functions such as nitrate respiration, methanogenesis, fermentation, aerobic chemoheterotrophy and hydrocarbon degradation, etc. The FAPROTAX database converts microbial taxa (i.e., microbial names) to functions (i.e., microbial metabolic activities). Figure 2 is a bubble plot summarizing functional annotations that comprise more than 1% of total designations. Detailed information on all functions including those comprising less than 1% of annotations and the microbial taxa used to derive functional designations are provided in an Excel spreadsheet "Functional Analysis S-5502 _5684" provided electronically with this report.

Supporting Data

Table A: Summary of DNA Extraction Results/Total *Bacteria*, *Archaea*/OTUs

Sample ID	DNA ID	Sample volume used for Extraction (mL)	Total DNA Extracted (ng)	*Bacteria* 16S rRNA gene copies/L	*Archaea* 16S rRNA gene copies/L	Microbial Diversity (OTUs)
GBR_Inf_160919	24125	15	1,643	3×10^{11}	1×10^{4}	95
Si-3674-Effluent-12/10/19	25203	25	2,345	8×10^{9}	ND	102

Notes:
mL – milliliters, ng – nanograms, µL – microliters, L- liter, ND – not detected

Microbial Diversity

The number of OTUs (i.e., groups of 16S rRNA sequences with 97% similarity or greater), can be interpreted as the number of microbial species in a sample, with a greater number of OTUs indicating proportionally higher microbial diversity. A total of 134 unique OTUs were identified in the sample in 52,613 sequencing reads.

Figure A is a rarefaction graph demonstrating the number of OTUs as a function of the number of sequencing reads. The rarefaction curve was asymptotic suggesting that the sequencing run characterized a significant proportion of the microbial diversity in the sample.

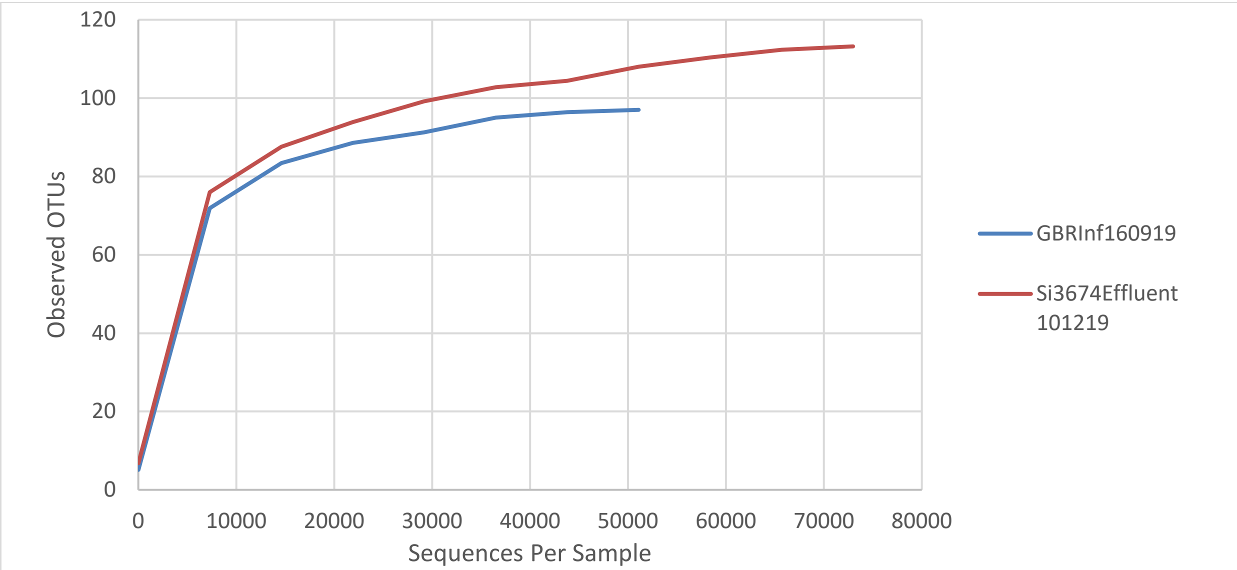

Figure A: Rarefaction curve indicating observed OTUs (i.e., microbial diversity) versus sequencing reads.

Case Narrative:

One influent liquid sample was collected from the GBR Column Study on 16-Sep-19 and logged in under SiREM reference S-5502. The sample was filtered and stabilized and DNA extraction was performed on 20-Sep-19. The DNA extract was submitted to Delta Genomics (Edmonton, AB) on 15-Oct-19 for sequencing using the Illumina® platform and data was returned on 5-Nov-19. Post-sequencing data processing was performed by SiREM. A sample of the column effluent was collected on 10-Dec-19 and logged in under SiREM reference S-5684. The sample was filtered and stabilized 12-Dec-19. DNA extraction was performed on 28-Jan-20 and the DNA extracts were submitted to Neogen Canada (Edmonton, AB) on 30-Jan-20 for sequencing using the Illumina® platform. Data was returned on 28-Feb-20 and post-sequencing data processing was performed by SiREM.

References

Louca, S., Parfrey, L.W., Doebeli, M. (2016) - Decoupling function and taxonomy in the global ocean microbiome. *Science* 353:1272-1277

Matsuki T, Watanabe K, Fujimoto J, Miyamoto Y, Takada T, Matsumoto K, Oyaizu H, Tanaka R. 2002. Development of 16S rRNA-gene-targeted group-specific primers for the detection and identification of predominant bacteria in human feces. *Appl. Environ. Microbiol.* 68: 5445–5451

SiREM

Attachment A: Chain of Custody

SiREM

Chain-of-Custody Form

sirernlab.com

130 Stone Rd. W
Guelph, ON N1G 3Z2
(519) 822-2265

Lab # S-5502

* Sample a part of GBR column study *

*Project Name	GBR Column	*Project #	Si-3674
*Project Manager	Jeff Roberts	*Company	SiREM
*Email Address	on behalf of Andrzej Przepiora		
Address (Street)			
City		State/Province	Country
*Phone #			
*Sampler's Signature		*Sampler's Printed Name	

Analysis

Client Sample ID	Sampling Date	Sampling Time	Matrix	# of Containers	Gene-Trac DHC	Gene-Trac VC	Gene-Trac DHB	Gene-Trac DHG	Gene-Trac tceA	Volatile Fatty Acids	Dissolved hydrocarbon gases	Treatability Study	NGS			Other Information
GBR_Inf_160919	16 Sep		GW	2									X			HOLD

Preservative Key

0. None
1. HCL
2. Other
3. Other
4. Other
5. Other
6. Other

Billing Information

P.O. #

*Bill To:

Turnaround Time Requested

Normal ☐

Rush ☐

For Lab Use Only

Cooler Condition:

Cooler Temperature:

Custody Seals: Yes ☐ No ☐

For Lab Use Only

HOLD FOR Analysis

Proposal #:

Relinquished By:	Received By:	Relinquished By:	Received By:	Relinquished By:	Received By:
Signature <Original signed by>	Signature <Original signed by>	Signature	Signature	Signature	Signature
Printed Name Steve Sande	Printed Name Steve Sande	Printed Name	Printed Name	Printed Name	Printed Name
Firm SiREM	Firm SiREM	Firm	Firm	Firm	Firm
Date/Time 16Sep19	Date/Time 16Sep19	Date/Time	Date/Time	Date/Time	Date/Time

Distribution: White - return to Originator; Yellow - Lab Copy; Pink - Retained by Client

** Mandatory Fields*

SiREM

Chain-of-Custody Form

sirem lab.com

130 Stone Rd. W
Guelph, ON N1G 3Z2
(519) 822-2265

Lab # S-5684

* Part of GBR Column Study (Riversdale 02/02) *

*Project Name	GBR Column	*Project #	Si-3674
*Project Manager	Jeff Roberts	*Company	SiREM
*Email Address			
Address (Street)			
City	State/Province	Country	
*Phone #			
*Sampler's Signature		*Sampler's Printed Name	Steve Sande

Analysis

Client Sample ID	Sampling Date	Sampling Time	Matrix	# of Containers	Gene-Trac DHC	Gene-Trac VC	Gene-Trac DHB	Gene-Trac DHG	Gene-Trac tceA	Volatile Fatty Acids	Dissolved hydrocarbon gases	Treatability Study	NGS			Other Information
													X			
Si-3674-091118	Dec 9		Gw	1									X			

Preservative Key
0. None
1. HCL
2. Other
3. Other
4. Other
5. Other
6. Other

Billing Information	
P.O. #	
*Bill To:	

Turnaround Time Requested
Normal ☐
Rush ☐

For Lab Use Only
Cooler Condition:
Cooler Temperature:
Custody Seals: Yes ☐ No ☐

For Lab Use Only
Proposal #:

Relinquished By:	Received By:	Relinquished By:	Received By:	Relinquished By:	Received By:
Signature <Original signed by>	Signature <Original signed by>	Signature	Signature	Signature	Signature
Printed Name Steve Sande	Printed Name Steve Sande	Printed Name	Printed Name	Printed Name	Printed Name
Firm SiREM	Firm SiREM	Firm	Firm	Firm	Firm
Date/Time 9Dec19	Date/Time 9Dec19	Date/Time	Date/Time	Date/Time	Date/Time

CPAWS 232

Distribution: White - return to Originator: Yellow - Lab Copy: Pink - Retained by Client

APPENDICES TO CPAWS SUBMISSION

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APPENDIX C

COPY: 2017-12-06 MEMS8468_Decision Matrix_v0.5_DRAFT 14-HCAA-00788

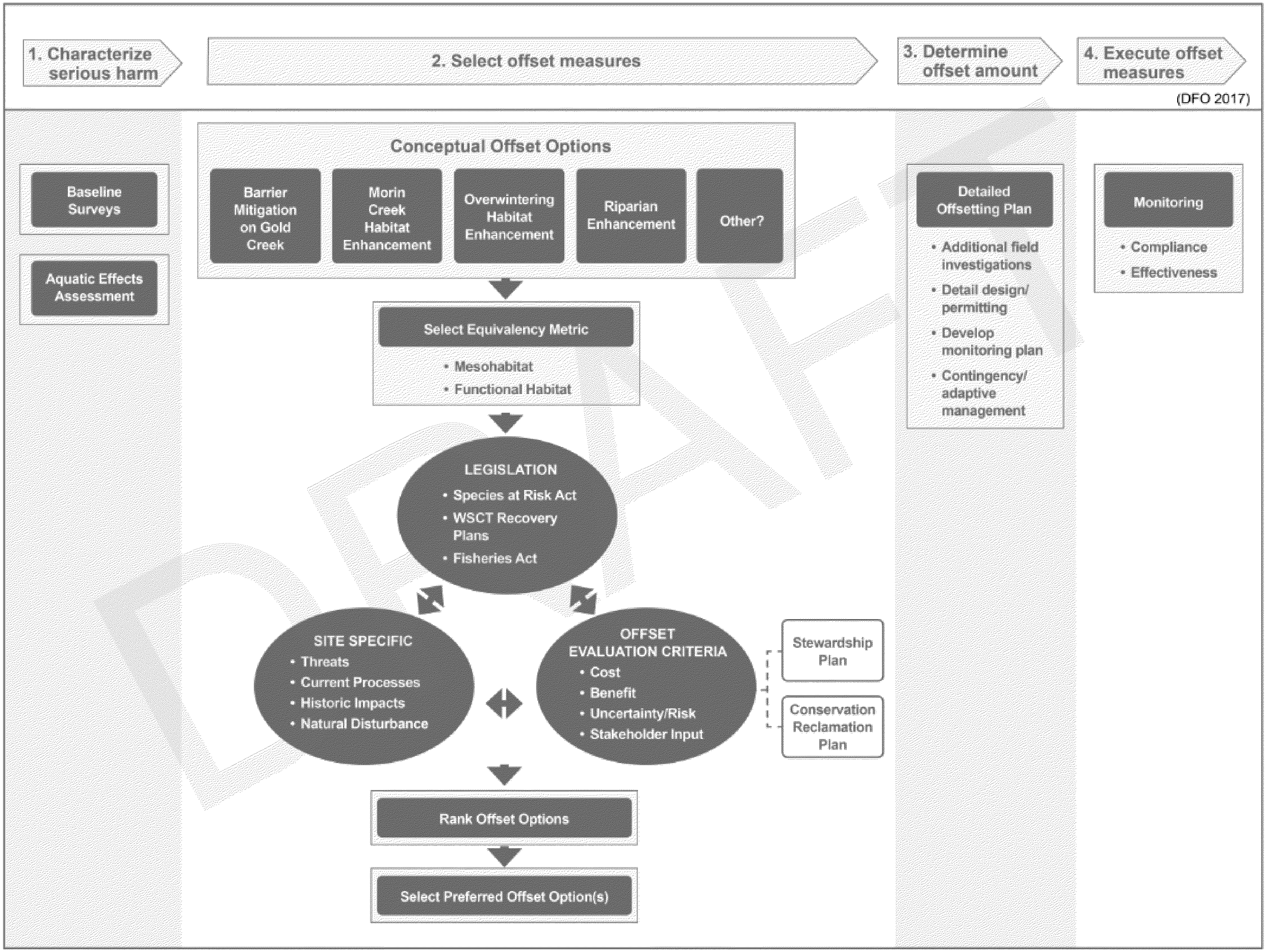
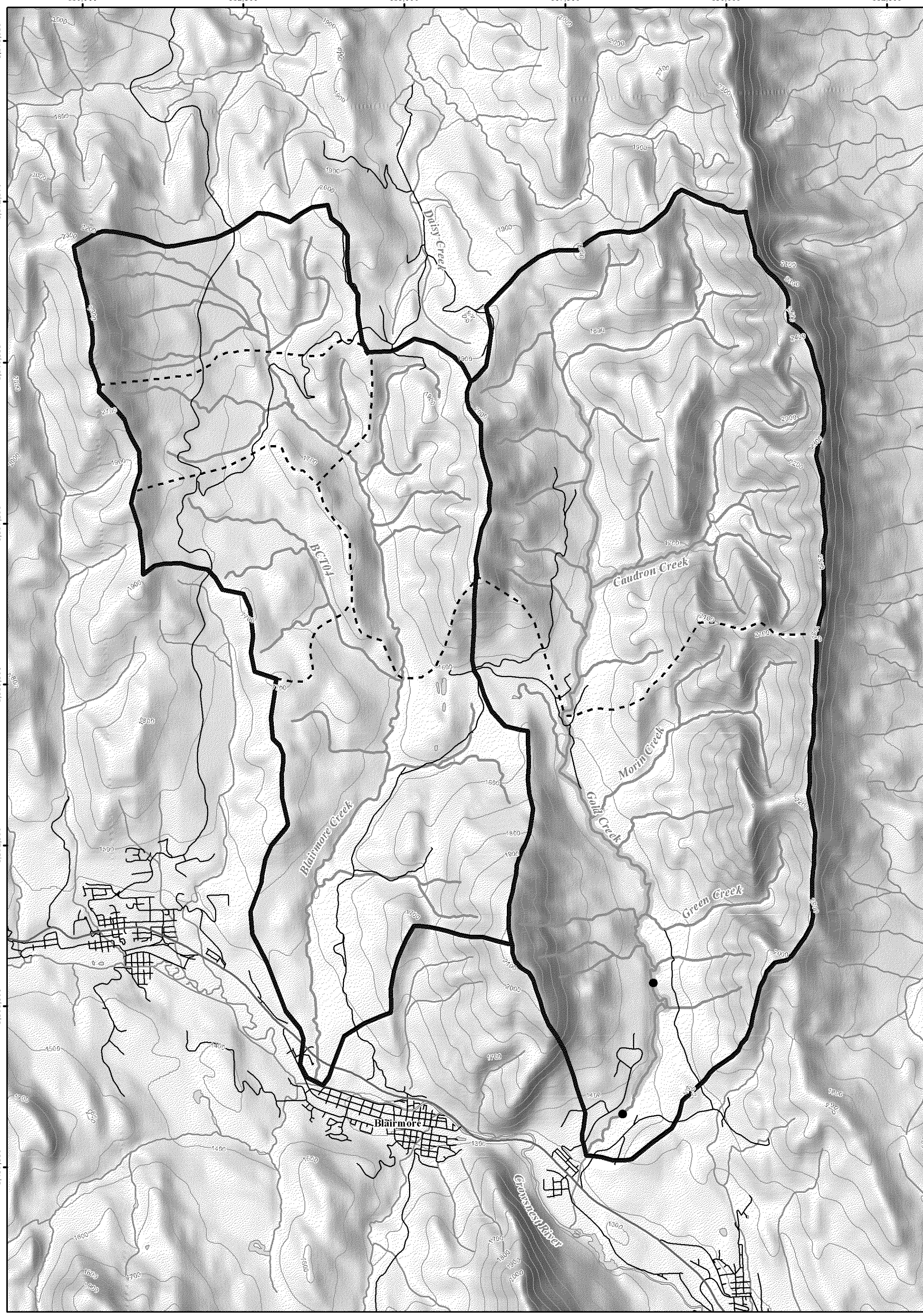
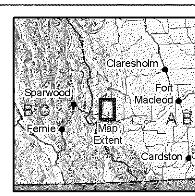


Figure 1 Major watersheds in the vicinity of the Grassy Mountain Coal Project.



Legend

- Primary Highway
- Road
- Watercourse
- Waterbody
- 100 m Contour
- Watershed Boundary
- Subcatchment Divide
- Identified Westslope Cutthroat Trout Critical Habitat (greater than 99% pure)
- Fish Barrier



0 0.5 1 2 km

Scale: 1:60,000

Projection: NAD 1983 UTM Zone 11N

Data Sources:
1. Hillshade, Esri Service Layer.
2. Vector base layers, Canvec 1:50,000.

Hatfield CONSULTANTS

K:\Data\Project\MEMS7779\A_MXD\Permitting\MEMS7779_SARA_Application_Map_20160331d_SB.mxd

000002

CPAWS 235

Fisheries and Oceans Canada | Pêches et Océans Canada

SARA Permit No.: 16-PCAA-00026

PERMIT ISSUED UNDER SECTION 73 OF THE *SPECIES AT RISK ACT*

Subject to the conditions described in this permit, the holder of this permit ("Permit Holder"), or any qualified person acting under the authority of the Permit Holder, is authorized under the authority of subsection 73(1) of the *Species at Risk Act*, S.C. 2002. c.29 (SARA) to engage in activities (as described in this permit) that kill, harm, harass, or capture individuals of the following threatened or endangered aquatic species listed on Schedule 1 of SARA:

Trout, Westslope Cutthroat (*Oncorhynchus clarkii lewisi*) Alberta population

Permit issued to:

Benga Mining Limited ("Permit Holder")
Attention to: [redacted]
12331 – 20th Avenue
P.O. Box 660
Blairmore, Alberta T0K 0E0

Location of Proposed Activity

This permit is only valid at the following locations:

Province: Alberta

Name of watercourses: Gold Creek, Blairmore Creek, Gold Creek tributaries (2 unnamed watercourses, Caudron Creek, Morin Creek, Green Creek), and Blairmore Creek tributaries (2 unnamed tributaries).

Valid Permit Period

This permit is valid from date of issue until 2016-09-15.

If the Permit Holder cannot complete the activity during this period, Fisheries and Oceans Canada (DFO) must be notified in advance of the expiration of the time period, as soon as the Permit Holder is aware.

The period during which other conditions of this permit must be complied with are provided in their respective sections below. DFO may, where appropriate, amend this permit. In cases where the Valid Permit Period is extended, written notice and/or an amended permit will be provided to the Permit Holder.

Canada

.../2

Description of the Activity

The objectives of the activities covered by this permit include:

1. To confirm fish presence and absence;
2. To describe fish distribution in terms of space and time;
3. To characterize fish population and/or community structure and understand fish species and life stages present;
4. To enumerate fish population abundance; and
5. To better understand fish life-history timing with particular emphasis on migration and seasonal/preferred habitat use.

The activities authorized by this permit consist of:

1. Sub-adult and adult population assessment: The capture of sub-adult and adult (fish greater than 150 mm fork length) from Gold Creek and Blairmore Creeks above known migration barriers using one-pass backpack electrofishing sample in targeted mesohabitats. Fish will be angled only where electrofishing is not feasible. Fish greater than 150mm fork length will be anaesthetized, measured for fork length and weight, and then marked using both Visible Implant Elastomer (VIE) and fin clip (the upper caudal lobe). Clipped fins will be stored and preserved in 95% ethanol. Only fork length and weight will be recorded for captured fish less than 150 mm fork length. All fish will be released within the mesohabitat unit in which they were captured. Approximately 5 days post-marking, the same sections of watercourse will be surveyed using snorkel surveys where surveyor(s) will record the number of fish marked and those fish with no marks. Ultra-violet lights will be used during the survey to assist in identifying VIE tags.
2. Recruitment and juvenile population assessment: At 10 locations on Gold Creek and Blairmore Creek, three (3) sites of approximately 100 m^2 each will be individually sampled for fish densities using a backpack electrofisher for three successive single-passes. The fork length and weight of each fish captured will be recorded. All fish will be released within the mesohabitat unit in which they were captured.
3. Tributary use and distribution survey: Fish will be sampling using either opportunistic or single-pass backpack electrofishing on Gold Creek tributaries (2 unnamed watercourses, Caudron Creek, Morin Creek, Green Creek) and Blairmore Creek tributaries (2 unnamed tributaries) to document fish presence, distribution, and habitat use (if fish are present). All fish will be released within the mesohabitat unit in which they were captured.

The effects that the activity may cause to the listed wildlife species, its critical habitat or the residences of its individuals and the effects of those changes authorized by this permit are as follows:

The incidental harm, harassment or death of Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*), a listed aquatic species at risk, resulting from capture, tagging, and measurement.

Terms and Conditions of Permit

The activity must be carried on in accordance with the following conditions:

1. General Conditions

1.1. A copy of this permit shall be kept on site at all times in the possession of the Permit Holder or a person acting under the Permit Holder's authority, and shall be made available to an enforcement officer upon request.

1.2. All persons undertaking the activity under the authority of the Permit Holder shall do so under the direction

.../3

and oversight of the Permit Holder and shall be made familiar with the conditions of this permit.

1.3. The activity must comply with the conditions identified within this permit. Activities that affect individuals of species at risk, their residences, or their critical habitat, other than those specifically identified within this permit are not authorized under this permit.

2. Conditions to avoid or minimize the impact of the activity on the species, its critical habitat and the residences of its individuals:

2.1. The capture of fish shall be undertaken by or under the direct supervision of an individual with experience and credentials in species at risk identification;

2.2. To the extent possible, activities shall be conducted in a manner whereby any individuals of the species shall be handled only in the circumstances authorized under this permit and with the least amount of harm;

2.3. The following measures shall be implemented to minimize the impact of the activity on the species, its critical habitat and the residences of its individuals:

2.3.1. Disturbance to aquatic habitat shall be minimized;

2.3.2. The Alberta Fisheries Management Division Electrofishing Policy Respecting Injuries to Fish (March 2004) shall be followed;

2.3.3. When possible, fieldwork is to be coordinated with other researchers working on similar species/locations to minimize the potential impact on all species at risk.

3. Conditions that relate to monitoring and reporting:

3.1. The Permit Holder shall monitor the effects of the activity and the avoidance and mitigation measures and standards referred to in this permit to determine whether they were conducted according to the conditions of this permit, and were successful at avoiding and mitigating the impacts of the permitted activities on the species listed above.

3.2. A report containing the following information shall be submitted to the Species at Risk Biologist identified in a form acceptable to DFO by November 1, 2016:

3.2.1. Digital vouchers, with distinguishing characteristics clearly photographed (see photographic instructions for aquatic Species at Risk in Portt et al. 2008), for each fish species (Species at Risk and non-Species at Risk collected);

3.2.2. Using the spreadsheet provided, identify all individuals caught (including number caught, date of capture, latitude, longitude).

3.2.3. The number and location of death of individuals of the affected species identified above, resulting from activities authorized by this permit.

3.3. The death of any individual of the affected species identified above, resulting from activities authorized by this permit, shall be reported immediately to the Species at Risk Biologist identified below.

Species at Risk Biologist:

Ernest Watson
Species at Risk Biologist
Fisheries and Oceans Canada
Freshwater Institute
<contact information removed>

.../4

<email address removed>
Email:

Authorization Limitations and Application Conditions

This permit cannot be transferred or assigned to another party. If the activity authorized under this permit is sold or transferred to another party, or if other circumstances arise that result in another party taking over the activity, the Permit Holder shall advise DFO in advance if the ownership or responsibility for the activity is expected to change.

The failure to comply with any condition of this permit is an offence under section 97 of SARA and might result in charges being laid under SARA.

This permit may be revoked or amended to ensure the survival or recovery of Westslope Cutthroat Trout, Alberta Population. Without limiting the generality of the foregoing, DFO may:

- suspend any permitted activities to avoid or mitigate additional adverse direct or indirect effects to the species listed above;
- amend or revoke this permit; and
- direct the Permit Holder to carry out at the Permit Holder's expense any modifications or actions deemed necessary by DFO to avoid or mitigate existing impacts or to avoid further adverse direct and indirect impacts to the species listed above.

This permit is valid only with activities and species listed herein and for no other purposes. It does not authorize the Permit Holder to buy, sell, trade, damage the residence of, destroy the residence of, or destroy part of the critical habitat of an individual of a wildlife species that is listed as Extirpated, Endangered or Threatened, or any part of derivative of such an individual. It does not purport to release the Permit Holder from any obligation to obtain permission from or to comply with the requirements of any other regulatory agencies

Date of Issue: 27 July 2016
<Original signed by>
Signature of authorizing officer:

Dale Nicholson
Regional Director / Directeur régional
Ecosystems Management / Gestion des écosystèmes
Fisheries and Oceans Canada / Pêches et Océans Canada
Central and Arctic Region / Région du Centre et de l'Arctique

Further information about this permit is available from Ernest Watson, Species At Risk Biologist at
<contact information removed>

PATH-SAPH

Text Report

Description:

Report Date: 2020/07/02

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR		
PATH File No.:	14-HCAA-00788	Habitat File No.: N/A	Receive Date: 2014/06/30

Action Date: 2016/01/11 Action ID No.: 26

Grassy Mountain Coal Project
Meeting between Fisheries and Oceans Canada, Benga Mining (and their consultants) and the Canadian Environmental Asessement Agency
January 11, 2016
Meeting Highlights

Subject: Westslope Cutthroat Trout (WSCT)

Time: 9:30 am - 11:00 am

Location Teleconference

Attendees: Tracy Utting (CEAA) Brett Maracle (CEAA) Cindy Parker (CEAA) Courtney Trevis (CEAA) Jason Shpeley (DFO) Ernest Watson (DFO) Serena Boutros (MPMO) [redacted] (Riversdale) [redacted] (MEMS) [redacted] (Hatfield) [redacted] (Hatfield)

Agenda Items

1.Introductions

2.Overview of Agenda and any additions

3.Critical Habitat Presentation Key Points: • Order to protect critical habitat needs to be issued within 180 days from listing under the *Species at Risk Act*. It is mandatory. • Destruction is defined as a loss of form, features, function • Westslope cutthroat trout is the first freshwater species listed in Canada. • Numerous other listings expected in the near future • Residence is normally protected both in and out of critical habitat, for WSCT however residences are only protected in critical habitat. • Residences are redds (structures to put eggs in) • Changes can be made to the recovery strategy to re-define or make additions to critical habitat for a species, i.e. if new data becomes available, new critical habitat can be identified • A Regulatory Impact Statement was presented at the time of listing presenting DFO's rationale • Recovery strategy is being revisited for WSCT (March 2016 or later) and may include: - Changes to description of riparian habitat - New critical habitat locations - Identification of areas required for recovery of the species • Proponent should work with province. • Permitting for this project would be one of the largest developments permitted under SARA to date. Q&A • Q: Critical habitat could include Blairmore Creek as well (which is less than 99% pure strain)? • A: DFO uncertain of provincial habitat % requirements for new critical habitat identification at this time. • Q: What is included in the destruction of critical habitat definition? • A: Changes in temperature and water flow are included. • Q: What about tributaries to Gold Creek? They have a function supporting water flow and nutrient flow. • A: If activities are impacting main stem they would likely be considered destruction and a permit would be required.

4\. Permitting Process Presentation: • For WSCT all residences are located within critical habitat • Project would be permitted under section (c): affecting the species is incidental to carrying out the activity. Clarification of incidental: the intent of the mine is not to destroy habitat/species, but that is incidental to construction and operation of the mine • Integrated approach will be taken. If permitted, a SARA-compliant Fisheries Act authorization will be issued, if pre-conditions in s.73 are followed. • Timelines: permit issued 90-days following receipt of a complete application • Letter of credit will be held once critical habitat destruction occurs and until offsetting measures are implemented. A partial credit may be released if an offset implementation schedule is established. • DFO needs detail to determine there will be no impacts to the recovery of the species Q&A • Q: At what point would a change be interpreted as destruction? A: Any change to feature, attributes, or function is considered destruction (note: form was corrected to attributes after the call). • Q: Are there specific parameters or points at which critical habitat is considered 'changed'? Who defines how much of a change in flow is considered destruction? A: DFO is looking to Benga to provide information and analysis to answer that question. Info submitted will undergo a scientific and critical information review. Changes to the functions, features or attributes of critical habitat in the "bankfull areas" of Gold Creek could be considered a destruction of that critical habitat. • Q: Is there integration with the province? Previously the province wouldn't permit baseline work. A: there is coordination between the federal and provincial recovery teams and the AER will assess aquatic information • Q: Is an additional permit required from DFO for baseline work and field studies? A: yes, a fish research license and SARA permit will be required for baseline research • Q: What about a permit for population work this winter? Survey results will support the recovery efforts for the species. A: Yes, that requires a permit and DFO will require proponent meet conditions imposed by the province as well. • Q: Is genetically pure still 99%? A:Yes, all protection only applies to 99% pure stock, and only in critical habitat • Q: Where did the 99% threshold come from? A:Uncertain of scientific source. Percentage may change after review of recovery plan. If approach change results in a change to the protection level, the status of the species may change. This would require re-assessment by an independent panel of experts. • Q:When is the 5-year re-assessment of the listing? A: *confirmed after call: The 5-year re-assessment is in 2017 • Q: When can Benga start discussion on watersheds and offsetting? A: DFO would like to be involved, likely province as well.

5. Benga update • Benga has upcoming programs to further delineate habitat and populations in both creeks • Benga plans to work with the province and federal government • Benga is in the process of developing studies, and study design to quantify the effects of the project on habitat in Gold and Blairmore creeks. • This includes temperature measurements and flow • Development of a habitat model for creeks and tributaries • There will (likely) be a grad student supported by Benga doing research on Gold and Blairmore watersheds.

6. EA Process • Initial conformity-scan IRs from the Agency will be submitted to the proponent shortly (submitted January 13, 2016) • These will be in relation to the EIS Guidelines • Federal review team will provide further, more specific, information requests in February which will also be sent to Benga and the

province.

Resources provided by DFO:

1. WSCT Critical Habitat biophysical Functions, Features and their Attributes can be found in the recovery plan for the species: <http://www.registrelep-sararegistry.gc.ca/default.asp?lang=En&n=DB347DE3-1>

2. Critical habitat "is identified as all areas of bankfull waterbodies currently occupied by naturally occurring, pure-strain populations within the original Westslope Cutthroat Trout distribution", the general description of functions, features and attributes of critical habitat for each life stage of the Westslope Cutthroat Trout can be found in table 1 in section 5.2 of the recovery plan.

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR		
PATH File No.:	14-HCAA-00788	Habitat File No.: N/A	Receive Date: 2014/06/30

Action Date:	2016/03/30	Action ID No.:	36

RE: Application for a Species at Risk Permit

Hi Ernie,

As we discussed earlier this month, we are looking to conduct some work in the Blairmore and Gold Creek watersheds. Please find our application for a SARA permit attached. We needed to submit our application today, however, will also have a map highlighting areas for the purposed activities submitted tomorrow.

Please confirm that you have received the application and let me know if I need to submit our application elsewhere within the Central and Arctic regional office.

If you require any additional information, please do not hesitate contact me, or [redacted] (CC'd). [redacted] is the named applicant, and Hatfield's [redacted] for the Grassy Mountain project in Blairmore, Alberta.

Thanks very much,

[redacted]

Hatfield Consultants | www.hatfieldgroup.com <http://www.hatfieldgroup.com/>
305, 1228 Kensington Road NW, Calgary, AB, Canada T2N 3P7
Tel: [redacted] | Fax: [redacted] | [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>

From: Watson, Ernest [<email address removed>
Sent: March-03-16 8:40 AM
To: [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>
Subject: RE: Application for a Species at Risk Permit

Hello [redacted]

From our conversation, it is my understanding that Hatfield is preparing an application for a Species at Risk Permit for field work on Gold Creek, Alberta. The field work is in support of an Environmental Impact Statement.

As you know, Gold Creek supports, and has been identified as critical habitat for, Westslope Cutthroat Trout (Alberta population), a species listed as Threatened under the Species at Risk Act (SARA)

I have attached the SARA permit application and instructions, which contains the information that is required by DFO for review.

Please note that a SARA permit can only be issued if (a) the activity is scientific research relating to the conservation of the species and conducted by qualified persons; (b) the activity benefits the species or is required to enhance its chance of survival in the wild; or (c) affecting the species is incidental to the carrying out of the activity. Furthermore, a permit will only be issued if the competent minister is of the opinion that: all reasonable alternatives to the activity that would reduce

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
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the impact on the species have been considered and the best solution has been adopted; all feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and the activity will not jeopardize the survival or recovery of the species.

Taking account the above, I urge you design a field program that is minimizes impacts to individuals, and supports the Recovery Approaches and Strategies outlined in the current Alberta Westslope Cutthroat Trout Recovery Plan (<http://esrd.alberta.ca/fish-wildlife/species-at-risk/species-at-risk-publications-web-resources/fish/documents/SAR-WestslopeCutthroatTrout-RecoveryPlan-A-Mar2013.pdf>). Specifically, any field work should be conducted in a manner that is consistent with and able to support population and habitat monitoring efforts currently undertaken by Alberta Environment and Parks (AEP). You should consult with Mike Bryski at Mike.Bryski@gov.ab.ca <mailto:Mike.Bryski@gov.ab.ca> to determine what current information is available for Gold Creek (you will have to provide a rationale as to why the field work on Gold Creek is necessary), and the methods employed in past monitoring efforts.

Please contact me if have any concerns or questions regarding the above.

Thanks, Ernie

Ernest Watson
Species at Risk Biologist, Species At Risk Program
Fisheries and Oceans Canada / Government of Canada
<contact information removed>

Biologistedes espèces en péril, Programme des espèces en péril
Pêches et Océans Canada / Gouvernement du Canada
<coordonnées professionnelles caviardées>

From: [redacted] [<mailto:[redacted]@hatfieldgroup.com>]
Sent: 2016-February-25 10:01 AM
To: XCA-FWI Species at Risk
Subject: Application for a Species at Risk Permit

Hi there,

I am submitting a request for a Species at Risk Permit application (Alberta). Any additional information regarding the application, if available would also be greatly appreciated.

Thanks very much,

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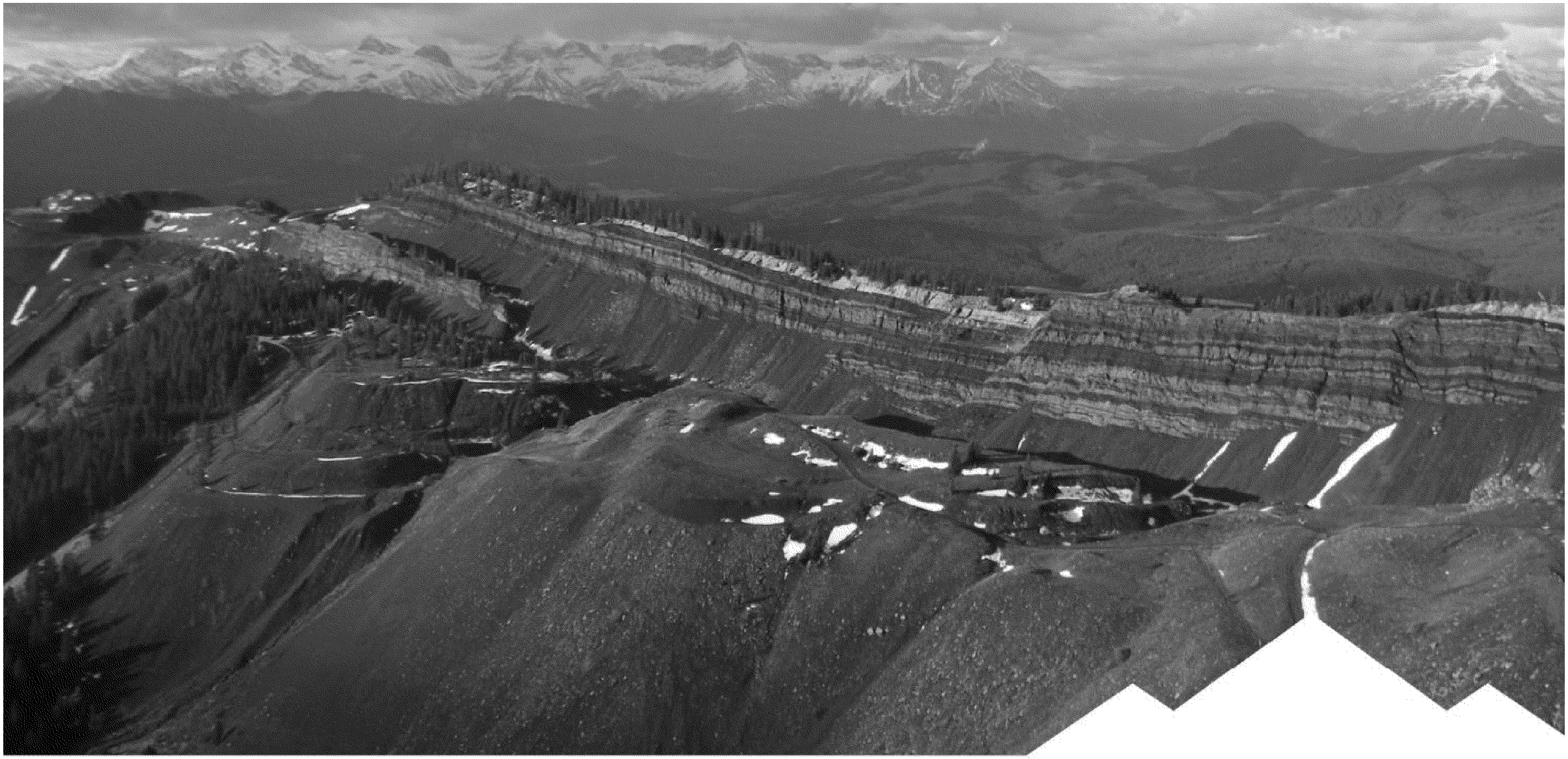
[redacted]

Hatfield Consultants | www.hatfieldgroup.com <http://www.hatfieldgroup.com/>
305, 1228 Kensington Road NW, Calgary, AB, Canada T2N 3P7
Tel: [redacted] | Fax: [redacted] | [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>



RIVERSDALE
RESOURCES

GRASSY MOUNTAIN PROJECT

April 2016

GRASSY MOUNTAIN COAL PROJECT

Draft Aquatic Resources 2016 Work Plan Discussion

RIVERSDALE RESOURCES

DISCUSSION OVERVIEW – AGENDA

- Introductions
- Habitat Protection Order
- Project Status
- Aquatic Resources Overview
- Proposed 2016 Work Plan
- Questions/Discussion

HABITAT PROTECTION ORDER - DFO

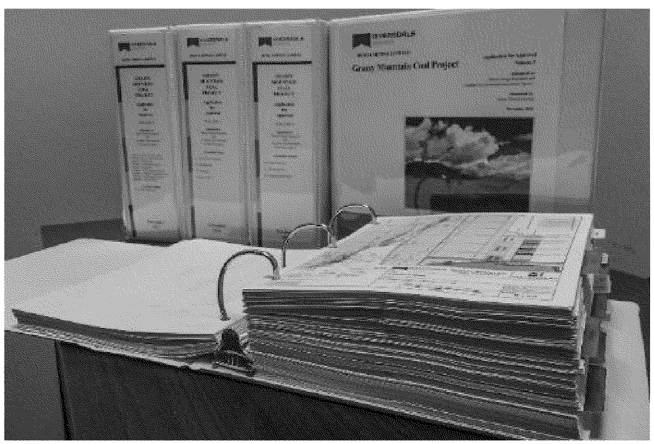
- Ernie Watson

GRASSY MOUNTAIN COAL PROJECT – CURRENT STATUS

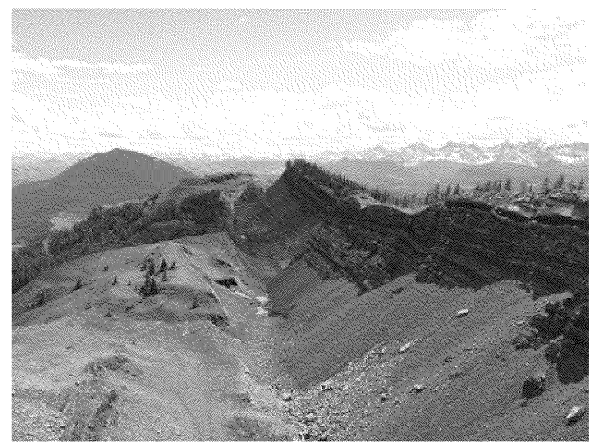
Exploration → Scoping Study → Feasibility → Application/EIA → **Regulatory** → Construction → Production

Regulatory	Construction	Production
+/- 20 months	+/- 18 months	Late 2019

- Filed CCA and CEAA Application and EIA November 10, 2015
- CEAA provided EIA Conformity Review SIRs Jan 13, 2016
- CEAA provided 1st round of technical Supplementary Information Requests (SIR) March 21, 2016
- AER provided a list of deficiencies addendum report on March 21, 2016 to clarify what information it is requesting be provided in an EIA Update
- Developing a work plan and schedule to present to AER with timeline for filing EIA Update and additional mine license applications July 2016



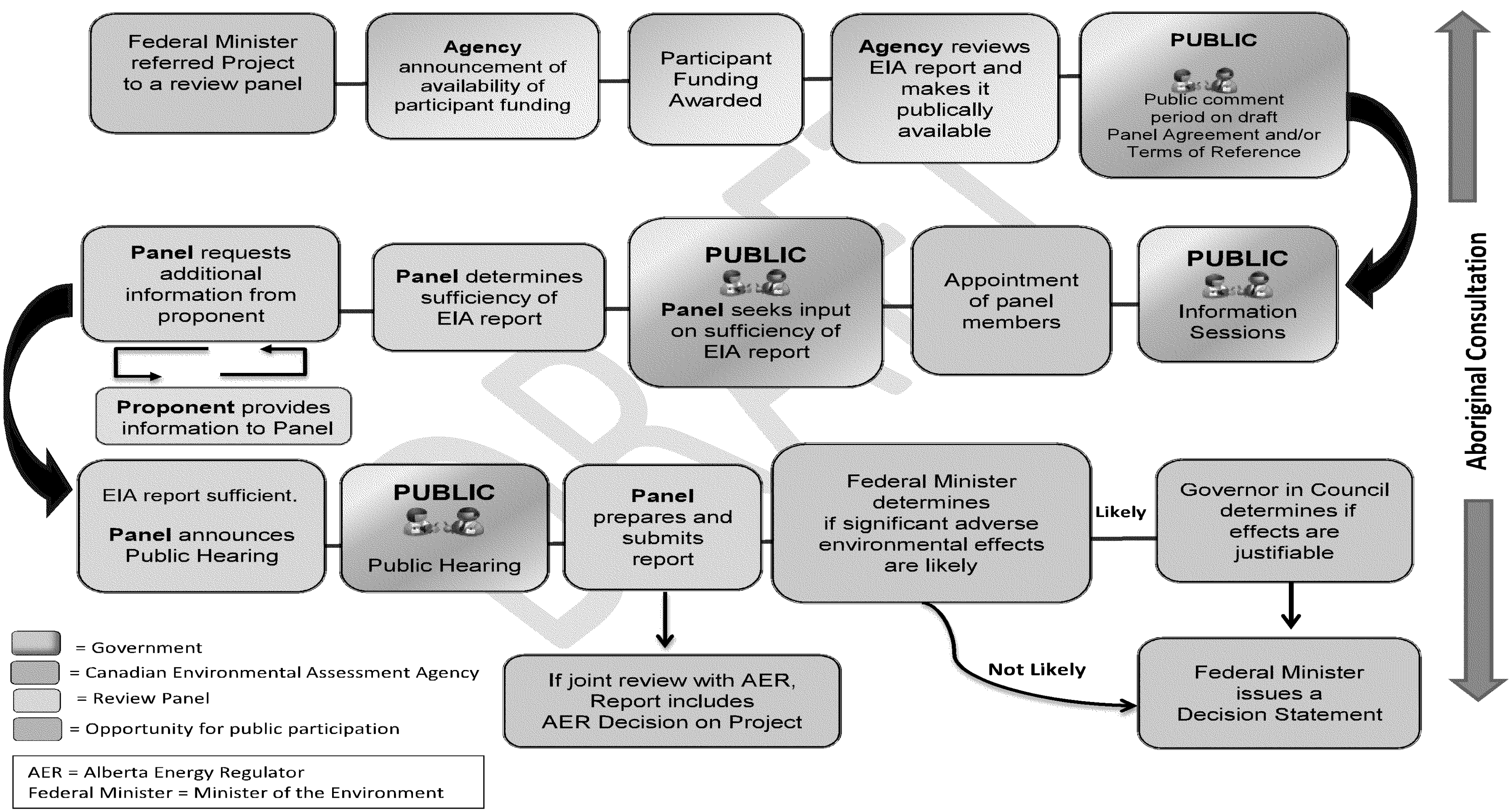
EIA



Grassy Mountain

WHERE IS THE GRASSY MOUNTAIN PROJECT IN THE REVIEW PANEL PROCESS?

Grassy Mountain Coal Project
Review Panel Process

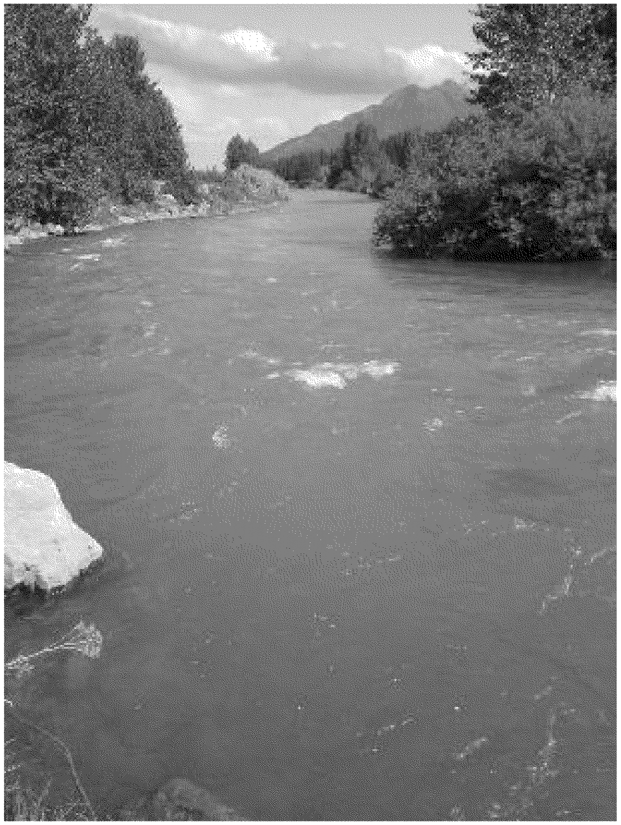


AQUATIC RESOURCES - OBJECTIVES

- Assess potential impacts to fish and fish habitat from changes in flow
- Assess potential impacts to fish and fish habitat from changes in water quality
- Assess potential impacts to fish populations based on proposed project activities
- Develop an appropriate offset plan to mitigate any residual effects.

AQUATIC RESOURCES - OVERVIEW

- Valued Components
- Study Area Descriptions
- Predicted Project Effects
- Mitigation/Offsetting of Effects

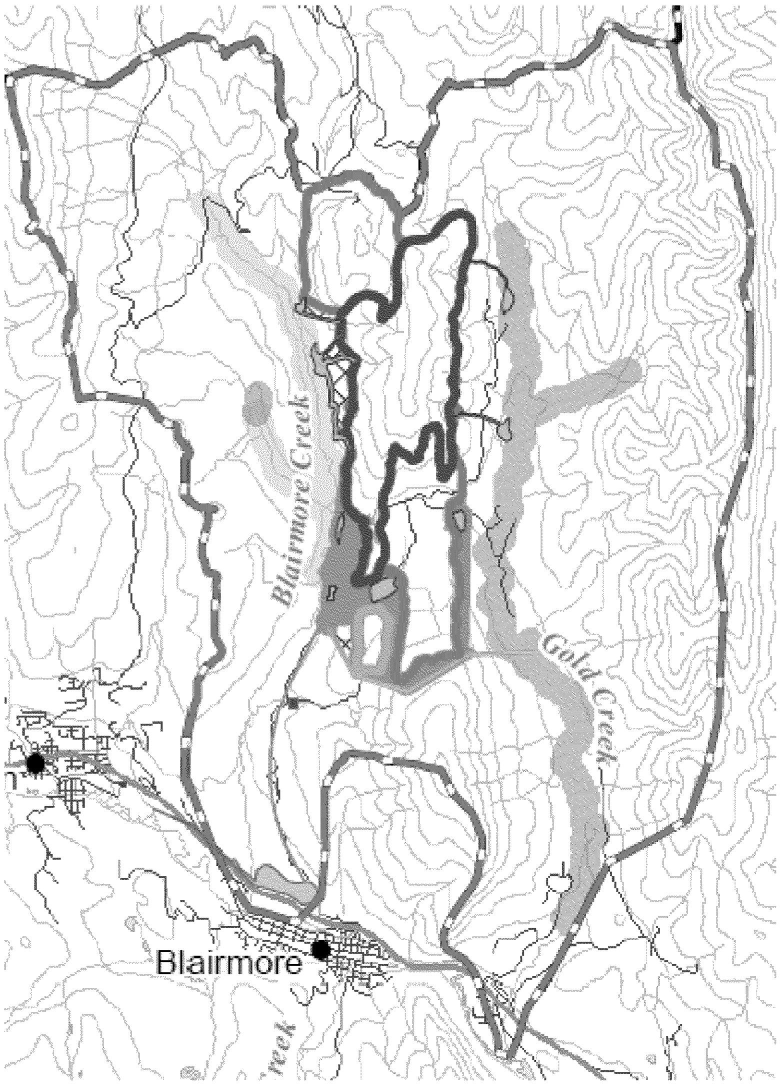


Crowsnest River

VALUED AQUATIC COMPONENTS

VCs	Rationale
Westslope Cutthroat Trout (WCT)	Resident in LSA and RSA; Threatened species in AB and Canada (AB pure-strain population listed under SARA); Recovery Plan identifies critical habitat within the study area; vulnerable to human disturbance.
Cutthroat Trout	Resident in LSA and RSA; provide recreation opportunities to the local community; vulnerable to human disturbance.
Bull Trout	Resident in RSA, Threatened species under Alberta *Wildlife Act*; Sensitive species under General Status of Wild Species; sensitive to human disturbance.
Rainbow Trout CTxRT Hybrids Mountain Whitefish **Lake Trout** **Brown trout*** **Brook Trout***	Resident in RSA; provide recreation opportunities to the local community. *(Exotic)

STUDY AREA



SARA Schedule 1 Listed Species:

- "Pure strain" (99% genetically pure) Westslope Cutthroat Trout

Local Study Area:

- Blairmore and Gold Creek watersheds
- Total Area: 114 km^2
- Portions of watersheds considered ***critical habitat*** for WCT:

  16.5 km (genetically pure, >99%)

  10 km (near-pure, 95-99%)

Regional Study Area:

- Entire Crowsnest River watershed
- Portions considered ***critical habitat*** for WCT:

  7.2 km (genetically pure, >99%)

  1 km (near-pure, 95-99%)

GOLD CREEK MAINSTEM – HABITAT CHARACTERISTICS

- **Morphology** of Gold Creek mainstem consists mainly of riffle or run with most reaches and parts of the creek containing pools;
- **Substrate** is exclusively cobble either associated with gravel or boulder, little embedded silts and fines except middle reaches that contain varying amounts of coal sediments and fines;
- Series of **barriers** to upstream fish migration in lower Gold Creek 1 km above its confluence with Crowsnest River, including old water supply dam, three waterfalls, and a smaller dam. The old water supply dam is impassable to fish and marks the downstream extent of WCT critical habitat;
- Additional waterfalls and chutes occur throughout the Gold Creek mainstem but do not appear to be permanent barriers to migration of fish;

GOLD CREEK TRIBUTARIES – HABITAT CHARACTERISTICS

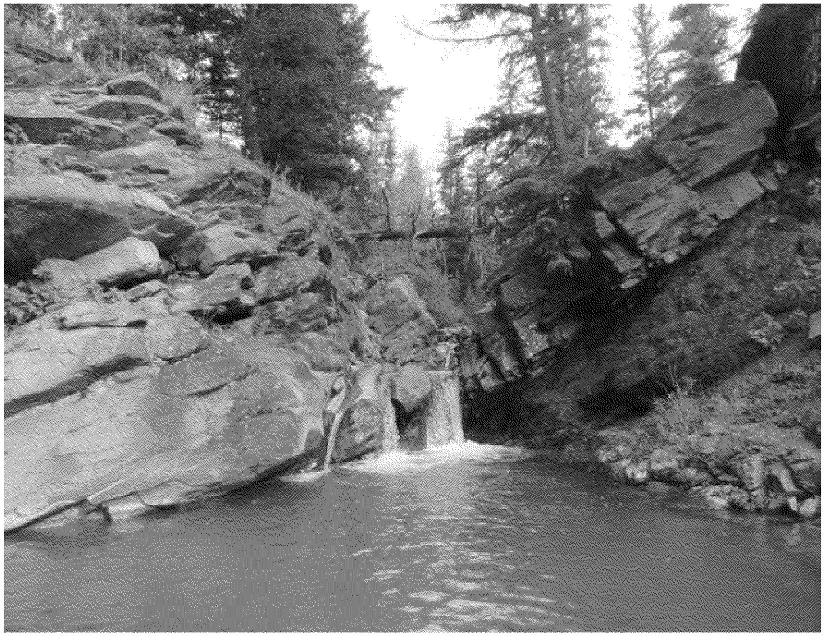
- **Groundwater** seeps along Gold Creek tributaries provide winter baseflows to the tributary and mainstem;
- Tributary **morphology** is riffle or run in lower sections, transitioning to run or cascade in upper sections (gradients >20%); few reaches with pools;
- Lower reaches of tributaries provide **optimal WCT habitat characteristics** (i.e., water depth, substrate, cover, water temperatures, dissolved oxygen)
- Waterfalls and chutes along most of the length of these tributaries; all Project-affected tributaries of Gold Creek have **barrier(s)** to upstream migration of fish (e.g., subsurface flow, impassable waterfall).

GOLD CREEK – HABITAT CHARACTERISTICS

- Evidence of anthropogenic disturbance throughout Gold Creek mainstem and tributaries, including dams, historical coal fines, stockpiles and sediments, cattle crossings, ATV and other vehicle crossings, bridges, and fence crossings.

BLAIRMORE CREEK MAINSTEM – HABITAT CHARACTERISTICS

- Mainstem primarily riffles/runs with cobble substrate;
- Bedrock substrates in some areas with plunge pools that could provide overwintering habitat;
- Waterfalls and chutes occur throughout Blairmore Creek mainstem but do not appear to be barriers to migration of fish along Blairmore Creek at all creek flows (e.g., hybrid CT found upstream of waterfall below)



Waterfall on Blairmore Creek mainstem immediately upstream of tributary BCT03

BLAIRMORE CREEK MAINSTEM – HABITAT CHARACTERISTICS

- Evidence of groundwater seeps along Blairmore Creek that supply shallow groundwater to the mainstem at various locations;
- Optimal water temperatures, dissolved oxygen for WCT
- Some anthropogenic disturbance in Blairmore Creek mainstem from oil and gas, forestry activities, ATV crossings, culverts.

BLAIRMORE CREEK TRIBUTARIES – HABITAT CHARACTERISTICS

- **Morphology** of these tributaries is riffle or run in the lower sections, transitioning to run or cascade in the upper sections;
- **Substrate** of these watercourses is cobble and large gravel, with limited suitable spawning habitat for trout species;
- All four Project-affected tributaries have **barriers** to upstream fish migration related to waterfalls (BCT02, BCT07) or steep slope (BCT05 and BCT06);
- All tributaries contain **waterfalls and chutes** along most of the lengths, with steep gradients in their upper reaches (>20%).

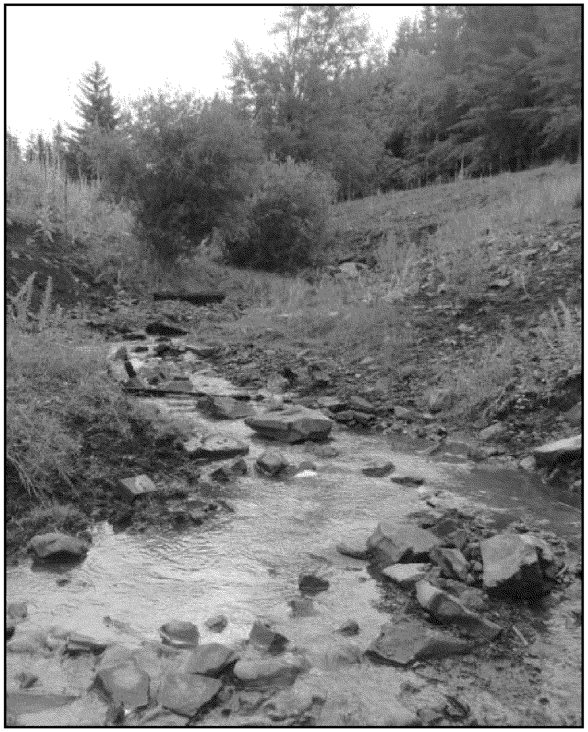
BLAIRMORE CREEK TRIBUTARIES – HABITAT CHARACTERISTICS

- BCT07 flows year-round; groundwater seeps along it create off-channel marshes;
- BCT05 and BCT06 have small flows with subsurface sections in summer (likely connected to Blairmore Creek only at high seasonal flows);
- Evidence of human disturbance in some areas, including ATV trails at BCT05 and BCT06, old mining activity at BCT07 and iron staining from the old mine portal at BCT02.

FISH RESOURCES OF GOLD CREEK

- AESRD (2013) reported the following species in Gold Creek: **cutthroat trout (WCT)**; **rainbow trout**; CT x RT **hybrids**; and **brook trout**;
- ***The majority of fish historically captured upstream of the lower mainstem barrier were brook trout, present through deliberate stocking;***
- Other fish species present in upper watershed include WCT (76% of non-brook-trout catch), followed by rainbow trout and CTxRT hybrids;
- Overall genetic purity of WCT sampled upstream of the barrier was >99%, meeting "pure" strain definition under the *WCT Recovery Plan*, although genetic testing of one site reported 6% hybridized trout.

FISH RESOURCES OF BLAIRMORE CREEK



- **Cutthroat trout**, **rainbow trout**, CTxRT **hybrids**, and **brook trout**;
- Cutthroat trout comprised 50% of the fish captured, followed by 23% CTxRT hybrids, with remaining 27% of fish equally distributed between rainbow trout and brook trout;
- WCT surveyed in Blairmore Creek considered **near-pure** strain.
- Additional 2015 genetic tests on Blairmore Creek WCT confirmed near-pure strains through most of watershed, with some additional **pure strain** fish found in upper tributaries upstream of proposed mine footprint.

FISH RESOURCES OF CROWSNEST RIVER

Blackburn (2011) reported for Crowsnest watershed:

- Crowsnest River mainstem: **rainbow trout** (66.5% of total catch), **mountain whitefish (**30.2%), **brown trout** (1.6%); **bull trout***, **cutthroat trout**, CTxRT **hybrids**, **lake trout** and **brook trout** (all <1%) (n=3,979);
- Tributaries: **cutthroat trout** (42.4%), **rainbow trout** (26.8%), **brook trout** (15%), CTxRT **hybrids** (14.3%), and **mountain whitefish** (1.5%) (n=1,085)

***Bull trout** are found in the Crowsnest River only downstream of Lundbreck Falls, an impassable barrier that has likely prevented bull trout from occupying the upper Crowsnest watershed.

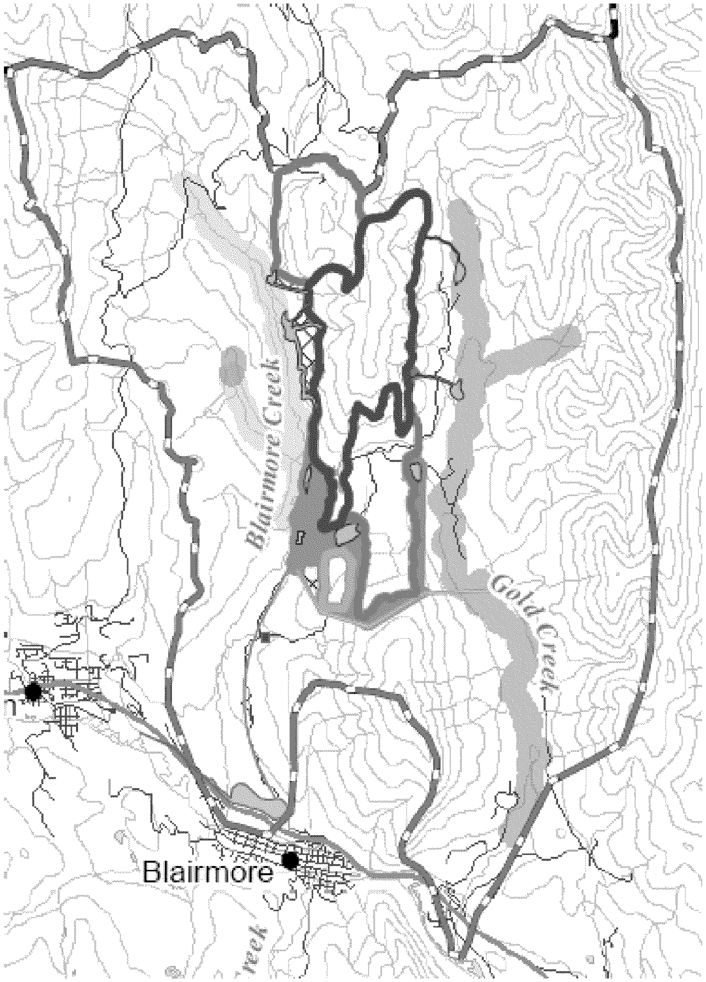
POTENTIAL PROJECT EFFECTS ON AQUATIC RESOURCES

1. Direct mine footprint (Design impacts) (most relevant in Blairmore Creek);
2. Effects of changes in stream flows caused by the Project (most relevant in Gold Creek);
3. Effects of changes in water quality (most relevant in Blairmore Creek);
4. Effects of watercourse crossings;
5. Effects from improved or altered access to fish-bearing waterbodies; and
6. Effects of blasting.

PREDICTED DIRECT EFFECTS ON AQUATIC HABITAT AREA

Habitat	Direct effects on aquatic habitats (loss of area)
Gold Creek mainstem	0 m^2
Gold Creek tributaries (GCT11)	197 m^2
Total Gold Creek	**197 m^2**
Blairmore Creek mainstem	0 m^2
Blairmore Creek tributaries (BCT05, BCT07)	341 m^2
Total Blairmore Creek	**341 m^2**
Total	538 m^2

All directly affected habitat is not WCT Critical Habitat.



EFFECTS OF FLOW CHANGES ON AQUATIC HABITAT

- Project effects on available creek habitat predicted for flows in March (overwintering), June (freshet), August (rearing), and low-flow (7Q10) events;
- **Flow-related change in Gold Creek mainstem habitat <1% through mine life until closure at Year 24, when -4.7 to -5.6% change in flow predicted, including in WCT critical habitats;**
- **Added flow in Blairmore Creek predicted to increase aquatic habitat, especially in winter (up to +18.9% increase in overwintering habitat);**
- Variable flow effects on habitat area in Project-affected tributaries throughout mine life: generally increase in early mine life; decrease in later mine life to closure;
- Minor influence on Crowsnest River flows predicted, except increased flows during low-flow (7Q10) events
- ***More detailed quantification of instream flow effects planned for 2016.***

MITIGATION OF EFFECTS ON FISH AND FISH HABITAT

Overall Mitigation/Offsetting Objective:

- **To achieve a net positive effect on WCT and WCT habitat,** the identification and implementation of habitat offsets are proposed, including:
  - **Habitat restoration and enhancement throughout Gold and Blairmore watersheds** to increase fish habitat and reduce existing anthropogenic impacts; and
  - **Support or implementation of WCT habitat enhancement projects identified through the *Alberta WCT Recovery Plan***, to improve knowledge and increase productive WCT critical habitats in Alberta.
- **Collaborate** with regulators, stakeholders, subject-area experts to develop offset plan that enhances WCT and their habitats and supports the Recovery Plan.
- ***Identification/quantification of offset opportunities planned for 2016.***

PROPOSED 2016 WORK PLAN

PROPOSED FISH & AQUATIC WORK PLAN (2016)

Overall Objectives:

- Augment and expand baseline aquatic information in the Local Study Area (especially fish populations in Gold Creek);
- More precisely define and quantify flow-related effects on fish and fish habitat;
- Identify and quantify fish-habitat offset opportunities to mitigate direct and indirect project effects on fish habitats;
- Provide additional information to guide project design.

2016 OVERALL APPROACH

- Comments from Jan/Mar 2016 AER/CEAA letters were considered and formed the basis of our approach.

- **Overall objectives fall into the following general categories:**
  1. Expand aquatics baseline;
  2. Refine effects assessment; and
  3. Identify and develop habitat offsetting opportunities.

- **Approach to 2016 work plan:**
  - Instream flow assessment;
  - Fish population and habitat-use studies; and
  - Conceptual offset plans.

INSTREAM FLOW ASSESSMENT

***Objective:* Precisely predict flow-related effects on fish and fish habitat, particularly WCT and their critical habitats**

Collection and analysis of multiple types of fish-related data for assessment of biological impacts of changes in creek flows:

- Hydrology;
- Fluvial geomorphology;
- Fish biology;
- Fish habitat (e.g., habitat classification/mapping, microhabitat characterization);
- Food resources (e.g., drift benthos); and
- Stream and riparian ecology.

Quantitative habitat simulation modeling (e.g., PHABSIM, RHABSIM, or SEFA), following accepted protocols, such as BC Instream Flow Incremental Methodology.

FISH POPULATION STUDIES

***Objective:* Document fish densities, population structure, community structure, life-histories and habitat use in LSA.**

Combination of passive and active sampling methods proposed:

- ***Passive:***
  - Snorkel surveys
  - Spring spawner survey (late May-early July)
  - Minnow trapping
- ***Active (possibilities):***
  - Electrofishing (single-pass or multiple-pass depletion)
  - Mark-recapture
  - Population genetics
  - Radio telemetry
- ***Design must balance value of data vs. impacts of sampling***

CONCEPTUAL OFFSETTING PLAN

***Objective:* Identify a suite of habitat-offsetting opportunities that are more than sufficient in scale and scope to mitigate predicted habitat losses/effects caused by the project.**

Possible offsetting opportunities will be identified from existing and additional baseline information, including:

- Geomorphology (channel stability and conditions);
- Stream and riparian ecology
- Habitats currently limiting fish production;
- Barriers to fish movement; and
- Historically degraded habitats.

Conceptual offsetting options will be presented to regulators for consideration, and refined upon completion of the IFS.

THANK YOU

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Grassy Mountain Coal Project

Meeting with the Alberta Energy Regulator, Canadian Environmental Assessment Agency, Riversdale Resources (Benga), Millennium EMS, Hatfield Consultants

2016 draft aquatic resources work plan

•Power point presentation on file.

DFO:

•Critical habitat linked to endangered species.
  - Linked, as necessary, to the recovery of the species.

•*Species at Risk Act* provides for the protection of functions, features and attributes.

•Critical Habitat Order prohibits the destruction of habitat.
  - A permit under the *Species at Risk Act* would be required to destroy habitat.
  - Definition of "destruction" aligns with the *Fisheries Act* definition of destruction.
  - This could include effects on thermal, chemical and or flow regimes, which could be considered destruction of habitat.

•The Critical Habitat Order is a function of the species at risk legislation, but does not change regulatory function.

Proponent group; i.e., Riversdale Resources (Benga), Millennium EMS, Hatfield Consultants:

•Working on a water balance model
  - When and where water is interacting
  - Base flow, etc.
  - Consider requesting that Natural Resources Canada or Environment and Climate Change Canada can look at the models being proposed.

•Objectives of the study Slide 7, all contribute to an appropriate offset plan based on residual impacts; i.e., flow, water quality, populations.

•Daisy Creek. Surface flow will not be directed to the Daisy Creek watershed.

DFO

•still need to understand potential groundwater surface water interactions as it relates to potential impacts to availabl fish habitats.

Proponent group; i.e., Riversdale Resources (Benga), Millennium EMS, Hatfield Consultants:

•Areas downstream of Caudron Creek; i.e., Gold Creek mainstem, seem to be sustained largely by Caudron Creek flows. Winter observation by Hatfield: 2016.

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•There will be a shift of water from Gold Creek watershed to Blairmore Creek watershed.

•Presentation identifies a 5-6% reduction in flow in Gold Creek at the end-of-mine life. The EIS says 10%. Slide 23.

AER

•Identified that Alberta Environment and Parks has quite a bit of information on fish in Gold Creek. Recommended tha the proponent use historical information as much as possible.

Proponent group; i.e., Riversdale Resources (Benga), Millennium EMS, Hatfield Consultants:

•Hatfield installed data loggers in Gold Creek and in portions of Blairmore Creek: March 2016.
  - Temperature

•Snorkel surveys in lower Gold Creek in March of 2016.

•Slide 28 identifies the respective disciplines and types of data that will be collected and input to models.

•The models that are being considered have been used extensively in British Columbia. It may be useful to seek inpu from B.C. DFO; i.e., pro's /con's.

AER

•Key: limiting the uncertainty Associated with project impacts.

•Population estimates need to be robust enough to allow a prediction of potential effects.

•Need to understand the population dynamic; eg., is there 50...100…1000 reproducing individuals. Is the population depressed or not? What is the chance that the population will be extirpated as a result of the project?

DFO

•Avoid impacts, and then consider the offsets required to mitigate the residual impacts of the project.

Proponent group; i.e., Riversdale Resources (Benga), Millennium EMS, Hatfield Consultants:

•Fisheries information will not be fully available until after the midJuly 2016 information request response projection. This leaves a gap in the environmental impact statement as supplemental information requests progress federally.
  - Issue for the AER because they require a new EIS submission.

PATH-SAPH

Text Report

Description:

Report Date: 2020/07/02

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PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date: 2016/06/23 Action ID No.: 46

On June 23, 2016, the federal review team, including: Fisheries and Oceans, Environment and Climate Change Canada, Transport Canada, Health Canada, Canadian Environmental Assessment Agency, Alberta Energy Regulator and various consultants attended the proposed Grassy Mountain coal site.

The visit was led by Riversdale Resources and was broken into discipline specific groups such as aquatics/water, wildlife etc.

Fisheries and Oceans staff, including Fisheries Protection Program and Species at Risk Program staff attended.

Fisheries and Oceans primary focus was attending the Gold and Blairmore Creek watersheds. This was done with Hatfield's fisheries consultant and the project manager from Millennium EMS.

Gold Creek is considered critical habitat for westslope cutthroat trout. Blairmore Creek has a non-pure population of cutthroat trout.

Gold and Blairmore Creeks and their tributaries are typical of mountain streams. Cold clear water with various habitat features including riffle/run/pool morphology, healthy overhanging vegetation, under-cut banks, robust visible in-water food supply and woody debris.

A potential offset site was visited in the event that an offset proposal is required. The project could involve the reconnection of Gold Creek with its natural channel. There are pro's and con's with this option. It appears that Gold Creek flows through an area that was likely channelized at one time. It has naturalized, but flows within 20 - 30 meters of a slack coal pile remnant of operations that ceased in the historic town of Lille, AB in the early 1900's.

Aquatics data is forth coming. The fisheries consultant has conducted some snorkel surveys as has observed westslope cutthroats throughout Gold Creek. Brook trout are present downstream of a historic barrier in lower Gold Creek close to the Blairmore Golf Course. Cutthroat and brook trout are present in Blairmore Creek. Some of the fish being observed are >30cm. Fish and fish habitat data is forth coming and a permit to conduct sampling of fish species at risk is currently being discussed.

Caudron Creek was reported on as providing spawning habitat; however, upon seeing the site and discussing that designation with the fisheries consultant, it seems unlikely. Caudron is essential a cascade system with the boulder substrate to validate this conclusion. Its primary function is likely to be water contribution to Gold Creek.

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		Action Date:	2016/06/29	Action ID No.:	47

RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hello all

Thanks again for your time today.

The following is a summary of the salient points/actions from the discussion. Please review and let me know if there are any errors or omissions.

- Introductions/Attendance: Tracy Utting (CEAA), Cindy Parker (CEAA), Ernie Watson (DFO), Mike Hunka (AER), Rushang Joshi (AER), Mike Bryski (AEP), [redacted] (Hatfield on behalf of Benga), [redacted] (MEMS on behalf of Benga). Regrets: [redacted] (DFO) and [redacted] (CEAA).
- [redacted] provided overview (context for Mike Bryski) of the Project's current status in the federal and provincial EIA review process.
- [redacted] provided overview of work completed in 2016 to date.
- [redacted] provided context around objectives and methodologies for fish population assessments on Gold Creek. Of note, the discussions were more focused on Gold Creek; however, works proposed to be completed will also include Blairmore Creek.
- Mike Bryski indicated that 300 m reaches were recognized as a standard size for sampling points/plots/reaches. Requested clarification on how many reaches to be included in the final work plan/FRL request. Confirmed that single pass electrofishing would be acceptable.
- Mark & Recapture methodologies discussed. Initial capture would be via electrofishing to target key habitats. Recapture could only involve snorkel surveys to minimize handling of fish. Mike Hunka asked how other habitats would be assessed (i.e., more shallow riffles vs deeper pools). [redacted] responded that target species would be 180 mm in fork length, that typically hold in pool or deeper run/glide habitats that are accessible via snorkeling. This was confirmed to be acceptable by Mike H. Tagging options discussed included Floy tags, a dye marker, or fin clip. Preference of which marker to use was not decided on in the meeting.
- Mike Bryski raised the discussion on Population Assessment vs Abundance. Mike H and Ernie confirmed that a Population Assessment would be more beneficial to better understand potential impacts of the Project and for future monitoring purposes (potential approval condition)
- Ernie Watson clarified for the purposes of the SARA permit request (1) options analysis for marking to be completed, with electrofishing to be considered for recapture technique, if needed. (2) once pros and cons on the options analysis has been conducted, present one option with rationale. (3) minimizing impact to individuals is SARA's primary objective.
- Mike Hunka clarified that the AER (and DFO) would like a final work plan that shows more detail on methodology so they can provide final confirmation that it'll meet AER MDRs and DFO/CEAA SIRs.
- Mike Bryski agreed with Ernie that once resolution on techniques is made, and both AER and DFO have reviewed and approved the work plan, a revised (or new) FRL can be issued to AEP.
- ACTION: [redacted] to update the current (high level) Work Plan provided on May 23 with more detail on non-passive techniques (for the overall program), the tagging options analysis, and details on the fish population methodology. This document to be submitted to the AER and DFO.
- ACTION/REQUEST: Coordinated response from the AER, DFO and AEP regarding questions or approval of the Work Plan to Benga (c/o [redacted]. A follow up phone call can be coordinated if deemed necessary. Once the Work Plan is

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approved formal submissions to DFO (for SARA permit) and AEP (for FRL) will be made (the entire Final Work Plan will be attached to both submissions).

Regards

[redacted]

Suite 325, 1925 - 18th Avenue NE

Calgary, AB T2E 7T8

[redacted] (D) [redacted] (C)

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-----Original Appointment-----

From: Utting,Tracy [CEAA] [<email address removed>

Sent: Monday, June 27, 2016 12:06 PM

To: Utting,Tracy [CEAA]; [redacted] <email address removed> <email address removed> <email address removed> Watson, Ernest: DFO; Shpeley, Jason D; [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>

Cc: Maracle,Brett [CEAA];<email address removed>

Subject: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

When: Wednesday, June 29, 2016 11:00 AM-12:00 PM (GMT-05.00) Eastern Time (US & Canada).

Where: Teleconference Dial-in Number: 1-877-413-4790, ID: [redacted]

PLEASE NOTE: AER has requested a start time of 9:00 am, otherwise we are looking at holding the meeting in the afternoon.

Teleconference Details:

Date: June 29, 2016

Conference ID: [redacted]

Dial-in number: 1-877-413-4790

It is critical that everyone on the required list attend (i.e. DFO, AER, and AEP) to facilitate a timely and consistent approach to the Fish Research Licenses. Please let me know if this meeting time does not work for you. Given holiday schedules, I would like to try and stick with Wednesday July 29 if possible. Thank-you in advance for finding time in your schedules for this meeting.

Background:

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date:	2016/06/29	Action ID No.:	47

During and following the Grassy Mountain Site Visit it became clear that the Fish Research License applications and Fisheries and Aquatics Work Plan outlining technical studies for baseline data collection on the Westslope Cutthroat Trout inhabiting Grassy Mountain area would benefit from an immediate and collaborative discussion between Fisheries and Ocean Canada (DFO), Alberta Environment and Parks (AEP), and the Alberta Energy Regulator (AER).

Hatfield group (on behalf of Riversdale) has indicated that they are looking to see the Fish Research Licenses (FRLs) in place so that they can be collecting baseline data on Westslope Cutthroat Trout the last week of July (or sooner).

This purpose of this meeting will be to discuss the proposed approaches to fish sampling and for DFO, AEP and AER to reach a level of consensus on what can and should be done for sampling of Westslope Cutthroat Trout in Gold and Blairmore creeks in order to facilitate issuance of the FRLs by Alberta Parks and Environment and by Fisheries and Oceans Canada under the *Species at Risk Act*.

Please feel free to call to discuss.

Tracy

Tracy Utting

Project Manager, Prairie and Northern Region
Canadian Environmental Assessment Agency / Government of Canada
<contact information removed>

Hatfield CONSULTANTS

CELEBRATING 40 YEARS

HCP Ref #: **MEMS7779**

July 5th, 2016

[redacted]
Benga Mining Limited
12331 – 20th Avenue
P.O. Box 660
Blairmore, Alberta T0K 0E0

Re: Proposed 2016 Fisheries and Aquatics Scope of Work for the Grassy Mountain Project

Dear [redacted]

The following fish and aquatic resources scope of work has been prepared in response to fisheries- and aquatic-specific supplemental information requests (SIRs) received from the Alberta Energy Regulator (AER), the Canadian Environmental Assessment Agency (CEAA), and Fisheries and Oceans Canada (DFO) based on their review of the November 2015 submission of Benga Mining Limited Grassy Mountain Project Environmental Impact Assessment (EIA) report (letters dated January 25 and March 21, 2016, respectively). Hatfield Consultants has developed this scope of work to address identified information requests and/or data gaps as well as provide sufficient detail to meet provincial and federal fish research license (FRL) application requirements for actively sampling a federally listed Species at Risk. This additional detail has been included based on the outcome of subsequent meetings with the same regulators as well as Alberta Environment and Parks (AEP).

1. INTRODUCTION

1.1. OBJECTIVES

The overall objectives of the study plan are three-fold: (1) to present and briefly describe additional field programs aimed to fill fish/aquatic/physical data gaps and enhance the current baseline data set as well as provide sufficient detail to support provincial and federal FRL applications; (2) provide additional information to guide project design; and (3) more precisely predict project-related effects on targeted valued components to appropriately inform the environmental permitting process especially (but not limited to) potential effects resulting from alterations to instream flows.

The goal is to generate sufficient data to:

- describe the abundance and distribution of fish habitats in the project area (local study area, LSA);
- evaluate the extent of influence of previous land and water uses on habitats;
- identify potential physical and biological bottlenecks to fish productivity and survival, and corroborate them with population data where possible (e.g., populations limited by available spawning habitat, factors affecting growth such as water temperature or trophic regimes);
- evaluate the sustainability of fish population(s) through an understanding of population dynamics, allow for assessment of how alterations to fish habitats and connectivity between habitats (required seasonally and/or by different life stages) may affect fish population productivity; and
- lay a foundation for ongoing baseline and subsequent monitoring programs that will measure project effects prior to and during mine construction, operation, and closure as well as define potential habitat offsetting (compensation) options and priorities.

1.2. STUDY AREA

The LSA for fish and aquatic resources, water quality, and hydrology are congruent and encompass areas where Project activities have the potential to impact aquatic habitat or fish populations and communities. The LSA is comprised of Blairmore and Gold creek watersheds, as the Project footprint is located entirely within these two watersheds (Error! Reference source not found.).

Both Blairmore Creek and Gold Creek watersheds are located in the eastern slopes of the southern Canadian Rockies. With an area of 52 km^2 and 62 km^2, respectively, Blairmore and Gold creek watersheds contain watercourses and parts of watercourses identified as critical habitat for Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*, WCT), a fish species first listed in 2013 as threatened under the *Species at Risk Act*. The Governments of Alberta (Alberta Westslope Cutthroat Trout Recovery Team 2013) and Canada (Fisheries and Oceans Canada 2014) have developed a recovery plan and strategy for WCT. The Recovery Plan identifies parts of four watercourses in the LSA, totaling approximately 16.5 km of watercourse, as critical habitat, each containing a population "that has no evidence of recent or contemporary introgression as determined by genetic testing (i.e., >0.99 pure on average)". Three of these are in the Gold Creek watershed, including almost 14 km of the Gold Creek mainstem, while one is located on a tributary to Blairmore Creek. Fish recovered in these designated critical habitats were determined to be 99% genetically-pure (Alberta Westslope Trout Recovery Team 2013, Fisheries and Oceans Canada 2014). Areas identified as critical habitat in these two watersheds are upstream of barriers that prevent immigration of other fish species and populations.

In addition, the Recovery Plan identifies parts of two watercourses, totaling approximately 10 km in length, in the Blairmore Creek watershed as containing near-pure WCT.

1.3. HISTORICAL INFORMATION

Publically available fisheries inventory and/or detailed habitat assessment information for either Gold Creek or Blairmore Creek watersheds is relatively limited. Sparse information is available through the Alberta Government Fish and Wildlife Management Information System (FWMIS) (i.e., fish presence/absence, species distribution) and peer reviewed publications or technical reports (i.e., interspecific hybridization, population estimates) for both mainstem and/or associated tributaries. To date, only limited anecdotal information has been found with respect to fish habitat assessments and no information uncovered with respect to seasonal fish movement or reproduction dynamics specific to either watershed.

Westslope Cutthroat Trout, non-native Rainbow Trout (*Oncorhynchus mykiss;* RBT); WCT x RBT hybrids; and non-native Brook Trout (*Salvelinus fontinalis*; BRT) have been reported in Gold Creek. The majority of fish reported as being captured (upstream of the known migration barrier) were apparently BRT. The source of these non-native fish has been traced to deliberate stocking and not a result of barriers on the Gold Creek mainstem being passable to upstream fish movement. Westslope Cutthroat Trout have been documented in two main tributaries to Gold Creek, both of which drain into Gold Creek from the east: Caudron Creek and Morin Creek. An assessment conducted in 2002 (Blackburn 2011) characterized Morin Creek as containing high fisheries potential with moderate spawning substrate, high value rearing habitat, and moderate overwintering habitat quality. The extent of Morin Creek surveyed is unknown. Caudron Creek was assessed in both 2002 and 2010 and was characterized as being primarily comprised of riffle habitat with sparse pools with substrate comprised of equal proportions of cobble and gravel, sub-dominated by boulder and fines. The precise extent of Caudron Creek surveyed is unknown. Blackburn (2011) estimated the WCT population abundance in upper Gold Creek and found that the population ranged between 65 and 271 individuals.

The federal Recovery Plan designates portions of Morin and Caudron creeks as critical habitat for WCT.

As with Gold Creek, WCT, RBT and BRT have been recovered in Blairmore Creek. Blackburn (2011) has compiled historical sampling records for Blairmore Creek and completed population estimates of WCT for both upper and lower Blairmore Creek. The population of upper Blairmore Creek WCT was estimated to be between 121 and 277 individuals, while lower Blairmore Creek was estimated between 201 and 310. No publically available information could be found regarding previously conducted fish habitat assessments or spawning surveys. Fish inventory sampling specific to the Grassy Mountain Project took place in August 2014 at two locations on Blairmore Creek mainstem. Genetic samples from 170 trout collected from five sites in Blairmore Creek identified 132 of those fish as pure (100%) WCT ranging in fork length from 62 mm to 250 mm. The remaining fish were identified as backcross hybrids. No new hybridization events (production of F_1 hybrids) between pure strain WCT and RBT were evident based on the data.

A recent study that focused on spatial and temporal variation of benthic macroinvertebrate communities in Blairmore Creek, Gold Creek, and Daisy Creek was recently obtained (Ree, 2014). The study's objective was to describe and determine factors affecting benthic invertebrate communities in three Rocky Mountain watercourses that inhabit pure strain WCT.

2. 2016 STUDY DESIGN

The 2016 scope of work will be comprised of a number of technical studies aimed to further characterize fisheries and aquatic baseline conditions and assess for potential effects as a result of the Project. These include:

Fisheries Resources

- Fish Habitat (to characterize the quality, distribution, quantity and limiting habitat in key watercourses potentially affected by the Project);

- Fish Biology (to determine/confirm fish presence, population/community composition, distribution and habitat use, population abundance/estimates, baseline fish health); and
- Instream Flow (in support of conducting an instream flow study to characterize potential positive and/or adverse effects of Project-related flow change and quantify potential alterations of flow change on critical fish/aquatic habitat).

Aquatics Resources

- Surface Water Quality;
- Aquatic Sediments; and
- Tissue Residues (fish and lower trophic levels).

A brief description of each program is provided, below.

2.1. FISHERIES RESOURCES

2.1.1. FISH HABITAT

Fish habitat assessments are required to describe the quality, abundance and distribution of fish habitats in the project area. Habitat surveys were completed in previous field seasons; the additional effort is to streamline the habitat surveys to ensure the data is characterized to the appropriate standard for estimating changes in physical habitat associated with proposed flow alterations (i.e., instream flow study) or mine construction.

Fish habitat collected in the field will use a modified version of British Columbia's *Fish Habitat Assessment Procedures* (Johnston and Slaney 1996) as described in Lewis et al. (2004) specifically aimed at water withdrawal/alteration projects. The data will be organized into different spatial scales to facilitate analysis. Three scales of analysis are identified: macrohabitat (reach scale), mesohabitat (hydraulic unit scale), and microhabitat (site-specific scale).

Habitat assessments will also be completed on identified key tributaries of both Gold (i.e., Caudron, Morin, Green creeks including other identified unnamed tributaries potentially to be affected by the mine) and Blairmore (i.e., BCT04) creeks. Additionally, identified obstructions/barriers to upstream fish movement from previous field surveys will be re-evaluated to confirm their barrier type and status.

The detailed fish habitat information will be compiled so that an assessment of existing conditions can be performed in addition to an assessment of the extent to which potential water alterations will affect fish habitat.

2.1.2. FISH BIOLOGY

The goal of the fish biology sampling program is to supplement existing historical baseline data with the collection of more up-to-date fish information in both Gold and Blairmore watersheds to:

- confirm fish presence and absence throughout the project area;
- describe fish distribution in terms of space and time;

- characterize fish population and/or community structure to understand fish species and life stages present;
- enumerate fish population abundance indicator(s) (CPUE, CPUA, density, population estimates etc.); and
- better understand life-history timing with particular emphasis on migration and seasonal/preferred habitat use.

Fish data will be generated using a suite of widely accepted standard collection methods over multiple seasons to facilitate key analyses. They currently include direct visual observation by way of snorkeling (overwintering & spawner surveys). Since March 2016, snorkel surveys have been utilized in both Gold and Blairmore creeks to gather fish information with respect to overwintering fish presence/absence, habitat use, abundance and distribution as well as spawn timing, spawning habitat use/preference and distribution. We will continue to leverage this passive method of data collection throughout the remainder of 2016 field programs where practical. However, to effectively address information requests issued by provincial and federal regulators and to generate a more robust baseline to assess for potential effects as a result of the proposed mine, active fish capture methods (e.g., electrofishing, angling) are necessary.

The proposed active fish sampling program will specifically target the following fish baseline studies:

i. WCT sub-adult and adult population assessment;

ii. WCT recruitment and juvenile population assessment;

iii. WCT tributary use and distribution survey; and

iv. Tissue Residue/Fish health (Section 2.2).

<u>WCT sub-adult and adult population assessment</u>

The objective of the WCT sub-adult and adult population assessment is to estimate the abundance of WCT (> 150 mm) in the mainstem of Gold and Blairmore creeks above known migration barriers utilizing a combined capture-recapture and snorkel survey approach. We have adopted this approach from Cope et al. (2013), where it has been applied to WCT population monitoring in the upper Fording River watershed. We believe this approach will reduce excessive stress to fish by reducing active sampling while still generating important baseline information. The survey would be conducted between July 26 and August 15, 2016. Briefly, capture of WCT would target fish >150 mm fork length using a combination of electrofishing and angling (where feasible). Angling will be attempted where possible but electrofishing will be the primary means of targeting sub-adult and adult WCT from targeted mesohabitats where we anticipate to find them actively rearing/holding, thus sampling area may vary. A one-pass electrofishing sample will be deployed at each targeted mesohabitat. The number of fish to be marked >150 mm will ultimately depend on the number of fish encountered above the targeted size threshold. We have selected the >150 mm fork length to account for smaller sized sub-adult/adult WCT that inhabit the upper reaches of both Gold and Blairmore creeks (C. Bettles, pers. obs., 2016). Fish will be anaesthetized in a 40 L bath of river water containing 2.0 ml clove oil yielding bath concentrations of 50 mg/l. Clove oil is a safe, inexpensive, and effective anaesthetic suitable for fish handling procedures in the field. The lowest effective dose of clove oil is recommended as time to recovery of equilibrium and fear response in salmonids has been shown to increase exponentially with exposure time (Keene et al. 1998). Because of its low solubility in water, the clove oil will first be dissolved in 10-ml of ethanol (95%) before being added to river water.

We propose to double mark fish using a combination of a Visible Implant Elastomer (VIE) and body mark (i.e., fin clip). Our analysis of marking/tagging options is summarized below. Given the increased turbidity in Blairmore Creek, tagging by fin clip, alone, would likely result in higher incidence of captured (recovered) fish being counted as 'unmarked'. The inclusion of the VIE tag will ensure that fish are more accurately assigned to 'marked' or 'unmarked' captures. An additional benefit for including the fin clip mark is to archive tissue samples for future genetic investigations of WCT including ongoing species integrity (i.e., hybridization) or more detailed population structure analyses. The clip also provides a physical mark indicating it has previously been sampled if encountered during future sampling programs and should typically last longer than the VIE. Fin clips will be collected from a portion of the upper caudal lobe from fish captured on each mark run and will be stored in 2-ml Nalgene® cryogenic vials (or similar) and preserved in 95% ethanol.

All marked fish will be released within the mesohabitat unit in which they were captured. Approximately 3-5 days post-marking, the same sections of watercourse will be surveyed using snorkel surveys where surveyor(s) will record the number of fish marked and those fish with no marks. Fish less than the 150 mm fork length cut-off will be recorded for completeness although they will not be included in the population estimate calculations.

Given suitable watershed conditions, snorkel counts have been proven to be a reliable and efficient means of obtaining indices or relative abundance for WCT throughout their range including the East Kootenay's (e.g., Baxter 2004, 2005, 2006a, 2006b, Baxter and Hagen 2003). However, it is possible that snorkel counts will be underestimates of true abundance as individuals are routinely missed due to impacts of visibility, fish behavior and stream channel complexity. To address possible observer challenges, fish are marked within the section (reach) of stream for which the estimate will be conducted and population estimate generated.

Several population index 'sections' will be established within delineated macro- and mesohabitat, which have been mapped.

The Maximum Likelihood Pooled-Peterson Estimate will be used to calculate the population abundance. It will be computed by pooling the captured-sample, the 'recovery' (of marked) sample, and the number of recaptures over all sections sampled in the 'designated' habitat within each watercourse. The term "recovered" or "recovery" is used for fish that are sighted through snorkel surveys and not physically handled. The key assumption of the pooled-Petersen method is that either; (a) the probability of marking is equal in all sections (b) the probability of recovery is equal in all sections (c) complete mixing of marked and unmarked fish across all sections. It is unlikely that fish from all sections mix completely across each watercourse (so condition (c) above may not be met), but the assumption of equal marking or equal recovery rates may be approximately satisfied because the effort and methods on all sections will generally be the same.

If the number of recovered fish is small over all sampled sections, an adjusted estimate (called the Chapman correction) will be used as the estimator. Equations can be provided upon request.

Marking/Tagging considerations: Analysis of options

A wide variety of tagging or marking methods can be can be used to create a known subset of fish populations. Marks are defined as anything recognizable that is external, internal, or incorporated into the integument of a fish, while a tag is usually defined as something attached externally or internally to a fish which contains specific identification information. Whereas no "perfect" tag exists, it is important to evaluate how each tag align with the study objectives.

A suite of tags/marks were considered and evaluated against the study objectives of the sub-adult and adult population assessment. These tags/marks included: body mark (i.e., fin clip), natural marks, anchor tags (e.g., floy tags), and visible implant elastomer (VIE). Table 1 provides a summary of each of the four tag/mark techniques.

Table 1 Options analysis of tag/mark techniques considered for the WCT sub-adult and adult population assessment

Tag/Mark Option	Strengths	Weaknesses
Body Mark (fin clip)	- Ability to collect non-lethal DNA samples. - Low cost. - Quick to sample in the field. - Requires minimal equipment.	- Difficult to recognize clips in the field depending on water visibility. - Regeneration of tissues can add uncertainty to longer-term studies. - Open wound can result thus increase risk to infection. - Limited study application.
Natural Mark	- Morphological or meristic marks are generally unique to fish.	- Attempted on WCT (e.g., Gifford and Mayhood 2014), but further testing is required to confirm effectiveness.
Anchor Tag (floy tag)	- Visible from shoreline and under UV light - Enable identification without recapture and without increasing mortality - Identifiable at night - High retention rates - May be applied to very small fish - Minimal impact on fish survival, growth, and behavior. - Low capital and material costs. - Fast to apply. - Well-established technique applied to various fish size classes. - Used extensively in WCT fish population assessment and monitoring programs.	- Limited coding capacity (can increase by using several colors, body locations, etc). - Can be difficult to detect in ambient light if growth is considerable and pigmented tissue is laid down over the tag. - May be hard to notice by casual observers. - Could potentially make fish more observable to predators.

VIE	- Tags are widely used b/c they have little effect on growth, survival, and behavior of fish (Phillips and Fries 2009). - Multiple tag locations and colors can create unique identifications. - tags visible under UV light even during daytime sampling. - Used effectively in cutthroat trout Mark-Recapture studies (Bonneau et al. 1995).	- Retention time varies by tag location, species, tag color as tag material degrades or covered over by new tissue growth (Bolland et al. 2009).

The tag/mark techniques listed above is not an exhaustive list of all available options. However, the above techniques were selected for consideration because of their application with Westslope Cutthroat Trout, other Cutthroat Trout sub-species or salmonids (e.g., Rainbow Trout).

Floy tags are one of the primary tagging techniques used for monitoring WCT populations in southeast British Columbia and have been applied for years on varying different drainages inhabiting the species. Based on discussions with regulators for this Project, the proposed use of floy tags at this time is not desirable, thus was dropped from further consideration.

VIE has been widely used as an effective mark in fish population studies, including WCT. Depending on how the VIE is marked on individual fish, it has been proven effective at identifying marked WCT through snorkel surveys (Bonneau et al. 1995) during daytime surveys. The use of a syringe requires increased handling of fish, but can be limited if the applicator is experienced and minimizes the number of VIE marks.

Using natural meristic marks was considered as it has the lowest invasive risk to fish of any of the considered tags/marks. However, its use specifically in identifying WCT is still in its infant stages, thus its accuracy in mark-recapture studies is still unproven. Further studies are required to refine the approach. Based on this, the use of natural meristic tags was excluded from further consideration.

The use of body marks (fin clips) is one of the simplest and oldest forms of marking fish. They are quick to execute thus minimizing the handling time/stress on fish. Fin clips have been used as marks in other WCT population studies (e.g., Alberta Conservation Association) and provide the added benefit of archiving tissue samples for future genetic analyses.

Based on the study objectives of the sub-adult and adult population assessment as well as consideration of the strengths and weaknesses of the select mark/tag options evaluated, we propose to apply a 'double mark' utilized VIE and fin clip. Our rationale for taking this approach is two-fold: (1) generate current and future data through fin clips. We feel that archiving tissue samples for future genetic analyses will be important in the ongoing monitoring of persistence and sustainability of WCT in both Blairmore and Gold creeks; and (2) given the potential for improperly assigning fin clipped individuals (e.g., relatively poor visibility in Blairmore Creek), the VIE acts as a double check to ensure more accurate identification thus more valid population abundance estimates. Furthermore, the use of UV light to identify VIE tags increases the accuracy rate of properly identifying marked fish.

WCT recruitment and juvenile population assessment

The objective of the WCT juvenile population assessment is to: (1) collect information on fry and juvenile presence/absence distribution in key mesohabitats (i.e. pool, glide, run, riffle) and (2) calculate density estimates of WCT fry (0+) and juvenile (1+ - one year old age class, 2+ - two year old age class).

The spatial scale of the assessment will include the mainstems of both Gold and Blairmore creeks within each watercourse's 'designated' habitat.

Sampling will predominantly utilize single-pass backpack electrofishing methods and will follow established sampling criteria described in *Standard for Sampling Small-Bodied Fish in Alberta* (2013a) and *Standard for Sampling of Small Streams in Alberta* (2013b) guidance documents. Sampling will occur at approximately 6-10 locations per watercourse.

Nested within each location will be three sites encompassing pool, riffle, glide, run and/or side-channel habitats; each site will be approximately 100 m^2 for a location total of approximately 300 m^2. Sampling of habitats will also take into consideration fish information needs (e.g., known spawning areas) for the Instream Flow Needs Study including refinement/validation of site-specific Habitat Suitability Curves. To minimize sample variance an experienced crew will be employed on each watercourse and the same crews will be utilized for all sampling.

Electrofishing is currently proposed to commence at the end of July/early August, 2016 based on data compiled with respect to this year's spawning window for Gold and Blairmore creeks as well as monitoring of the local hydrograph. We will initiate surveys in lower reaches where fry emergence has most likely concluded and to allow for any delayed emergence in upper reaches/headwaters. If no fry are observed at the onset of the program, sampling will be delayed until such time fry are visually active.

As mentioned above, at each location, three sites of approximately 100 m^2 each will be individually sampled for fish densities. A Smith-Root LR-24 DC Backpack electrofisher (or similar) will be used for three successive single-passes within each closed sample unit. Catch results will then be used to estimate the number of fry (0+ age class) and juveniles (1+ and 2+ age classes) within the enclosure area. Estimates and their 95% confidence interval will be reported as a standard numerical density (number fish/100 m^2) for each site. Capture, effort (area and electrofishing time for each single-pass) and life-history data (e.g., fork length, weight) will be recorded.

Estimates of juvenile fish density (number of fish/100 m^2) will be determined using closed, maximum-likelihood estimates (Kruse et al. 1998, Van Deventer and Platts 1990).

WCT tributary use and distribution survey

Tributary streams to both Blairmore and Gold creeks were evaluated and characterized in the 2015 EIA submission. Based on further evaluation of the previous data coupled with additional field information gathered during 2016 field surveys completed to date, a select number of tributaries require fish sampling to document fish presence, distribution, and habitat use (if fish are present). These tributaries include: Gold Creek tributaries (GCT13, GCT10, Caudron Creek, Morin Creek, Green Creek); Blairmore Creek tributaries (BCT04, BCT02) (Figure 1). Fish sampling in each target tributary will use either opportunistic or single-pass electrofishing technique (Bateman et al. 2005). Opportunistic sampling will occur in those tributaries that are not directly affected by the proposed mine to better understand how they contribute to the sustainability of WCT in each watershed. A combination of opportunistic and single-pass sampling will be deployed in those tributaries likely to be directly affected by the proposed mine (e.g., GCT10, BCT02). The objective for these two tributaries is to: (1) understand their fish bearing status; (2) if fish are present characterize their distribution (Bateman et al. 2005); and (3) estimate fish density as per described above.

2.1.3. INSTREAM FLOW

The primary objectives of the instream flow needs (IFN) study are to characterize potential effects of flow change, and quantify potential effects of flow change on fish/aquatic habitat and how it relates to "Serious Harm" in the context of fisheries productivity. The study has been designed to provide a quantitative analysis of anticipated effects by predicting hydraulic conditions important for fish (i.e., stream depth, width, and water velocity) during different phases of the Project and by comparing the subsequent changes in habitat quality to baseline conditions. The instream flow study is multidisciplinary in nature; it will incorporate data from the fish biology and fish habitat programs (described above) as well as other baseline field programs related to hydrology, water quality, fluvial geomorphology, lower trophic organisms, and riparian/stream ecology.

We propose to use a combination of the BC Instream Flow Methodology (BCIFM; Lewis et al. 2004) with habitat simulation modeling (e.g., PHABSIM, RHABSIM, SEFA or alternative). These methods are similar to, and supported by, the habitat component of the Instream Flow Incremental Methodology (IFIM). Both methods assume that habitat for fish (and other aquatic species) changes as a function of flow and that predictive models can be developed to describe this relationship for a given stream. The BCIFM is a stratified-random approach to fish habitat measurement. The selection of transect sites is critical; transects will be established with primary focus on WCT critical habitat (i.e., spawning, incubation, rearing, overwintering etc.) and associated life stage(s).

Generally, the key steps involved will include the following:

i. Quantify the habitat unit composition of each Macrohabitat reach by delineating the reach into pool (slow), riffle (fast, turbulent), and glide/run (fast, non-turbulent) mesohabitats, expressed in linear distance (m) of channel occupied by the mesohabitat within the reach. This is completed the methods applied through Johnston and Slaney's (1996) Level 1 assessment (as described above).

ii. Identify an adequate number of transect sites per reach. The number required will depend on heterogeneity of habitats within the reach. A minimum of five transects will be established per mesohabitat unit type. The number and location of transects sites will be guided by professional judgement.

iii. For each transect, microhabitat characteristics (depth, velocity, substrate, and cover) will be measured at a minimum of three flow levels spanning the (ideal) range of 5% to 40% naturalized mean annual discharge (NMAD); however, a greater number of flow levels may be collected in each system.

Additional physical and biological data are typically required to execute a defensible IFN. These include:

- Hydrology;

- Hydrogeology;
- Fluvial geomorphology;
- Surface water temperature; and
- Drift benthic invertebrates.

Baseline data specific to these technical areas will be collected in support of executing the IFN. Of note, water chemistry data collected for the project will be considered as part of the IFN studies.

Hydrometric stations have been re- and newly-established in both Blairmore (re-established, N=2) and Gold (re-established, N=1; newly established, N=2) creeks where the baseline will be refined using continuous local hydrology data (~1 year). The baseline characterization of surface hydrology for the LSA and RSA will conform to MOE (2012) and Lewis et al. (2004) for the purposes of the IFS. Newly established hydrometric station installed in Gold Creek have been specifically established upstream towards the headwaters of Gold Creek and just downstream of Gold Creek's main tributary, Caudron Creek aimed to characterize the water inputs along the west banks of Gold Creek that are potentially to be altered by the proposed mine. Hydrometric station data will be supplemented with microhabitat discharge measurements at transects positioned in key mesohabitats in the area of Gold Creek where surface and groundwater inputs will potentially be altered by the proposed mine. Furthermore, groundwater findings generated from the groundwater numerical model developed for the mine will be evaluated.

A fluvial geomorphology assessment will be conducted with the objective to describe natural channel conditions, whether previous land and water uses have altered channel conditions, and to what extent the proposed water alterations (i.e., proposed decrease flow in Gold Creek and proposed increase flows in Blairmore Creek) will alter baseline channel conditions. The geomorphology assessment will describe the watershed physical characteristics, physical channel condition, influences of water and land use on channel processes, and the potential effects of the proposed flow alterations on present and future conditions.

Understanding annual stream temperature fluctuations in Blairmore Creek and Gold Creek watersheds is paramount for characterizing critical habitat and potential limiting factor(s), as well as predicting effects of the Project, on fish production. For the temperature assessment, continuous (automated) recording thermographs were installed in March 2016 at multiple sites on both Gold Creek and Blairmore Creek mainstems and set to collect water temperature every 30 minutes. Calibration and installation of thermographs followed standard operating procedures outlined by Washington State Department of Ecology (Ward 2011). Additionally, established hydrometric stations also collected water temperature data.

Macroinvertebrates and their habitats are often considered in instream flow assessments in an effort to preserve food sources for fish, because many fish species, in particular all stream-rearing salmonids, depend on drift of invertebrates from upstream areas. Abundance and distribution of macroinvertebrates in the drift will be characterized through the use of drift samplers, which are vertically fixed nets that collect invertebrates suspended in the water column. Samplers are held in place with vertical stakes pounded into the substrate (e.g., quarter-inch diameter steel rod for removable sets, rebar, T-bar, or angle iron for permanent stakes that are left in the stream). Three sample locations will be targeted on each of Blairmore and Gold creeks; upper-, mid- and lower- reaches. Five replicates per site will be sampled. Sites will be sampled twice during the main growing season once in July and once in September, at low to moderate flows.

2.2. AQUATIC RESOURCES

2.2.1. SURFACE WATER QUALITY

Supplemental water quality sampling in 2016 will target sites established in previous field seasons to further enhance the current baseline. The short-term target was winter (March) 2016 to enhance the winter surface water quality baseline dataset. The same field protocols and QA/QC applied during the preceding field seasons were used to ensure consistency and minimize sampling bias. An additional target was to establish an appropriate reference site. Caudron Creek was selected as a reference surface water quality site given its water quantity importance to Gold Creek as well as being uninfluenced by the proposed mine given its location (east side of Gold Creek) in the LSA.

2.2.2. AQUATIC SEDIMENTS

The objective of the sediment sampling program is to characterize baseline sediment chemistry at key locations in the vicinity of the proposed mine site, with emphasis in those areas targeted for mine effluent discharge or run-off water over the course of the mine life.

Sampling locations for aquatic sediments will be coordinated with existing established locations for water quality, tissue residue, benthic invertebrates, and fish habitat to provide opportunity to examine relationships between these components of the aquatic environment. However, fine bottom sediments may not be widespread, particularly in steeper-gradient areas. Therefore, while integration of these components is preferred, sampling locations for sediments will be located where fine sediments are identified.

Variables for laboratory analyses of aquatic sediments (reported as dry weight) will include the following:

i. Particle size distribution;

ii. Total organic carbon (TOC);

iii. Polycyclic aromatic hydrocarbons (PAH);

iv. Nutrients (if warranted);

v. Moisture content; and

vi. Total Metals.

2.2.3. TISSUE RESIDUE

Similar to sediments, tissues can absorb metal or organic contaminants discharged by operational or post-closure mines. Contaminants may be taken up directly from the water column via facilitated diffusion (e.g., inorganic metals) or, in the case of organic selenium and methyl-mercury, may be taken up via dietary sources, stored in fat and proteins, and biomagnified up the food chain.

Regardless of the mode of uptake, the quantification of tissue contaminant levels is a necessary part of any baseline program, providing reference for future contaminant accumulation in aquatic organisms.

Significant change from baseline concentrations may trigger additional impact assessment and/or the implementation of contingency mitigation measures that should have been developed as part of the mine review process.

Given the sensitivities around WCT and the limited fish species diversity in both Blairmore and Gold creeks, we are proposing to utilize non-native Brook Trout in lower Blairmore Creek as the sentinel fish species. With the exception of reproductive timing (WCT, spring; Brook Trout, fall), both species exhibit similar life-history strategies, particularly where Brook Trout have been introduced into native WCT range (Shepard 2010). We will also include benthic invertebrate samples (from previously collected Hess/Surber samples or proposed drift samples) for characterization as part of the tissue residue program.

We propose to collect tissue specimens during the summer as part of the fish biology sampling program. Periphyton samples will be collected from select locations in both Blairmore and Gold creeks following the methodology described in MOE (2012). Sampling of periphyton will be collected in June 2016 at select established locations in both Blairmore and Gold Creek mainstems. Benthic invertebrate samples collected from previous field programs and/or those collected during the proposed 2016 drift sampling program (part of the instream flow study) will be included for tissue analysis.

Fish tissue samples will be targeted at locations downstream from the mine's proposed effluent discharge location. Given Brook Trout have not, historically, been documented and non-native Rainbow Trout (*Oncorhynchus mykiss*) appear to be extremely limited in upper Blairmore Creek, another watercourse with known non-native Brook Trout in the vicinity of the LSA, but uninfluenced by the Project, will be targeted. Additionally, every effort will be made to associate sampling effort in the vicinity of aquatic sediment and surface water quality stations, where feasible.

Tissue residue samples for both fish and periphyton will follow sampling protocols outlined in the Water and Air Baseline Monitoring Guidance Document for Mining Proponents and Operators (BC MOE 2012).

3. SCHEDULE

The following table is the tentative schedule for executing the necessary 2016 field programs. Some field programs/activities have already been executed. Note that exact dates of when field work will occur is subject to seasonal sensitivities, site-specific (i.e., discharge) conditions, and timely issuance of scientific fish collection permit approvals.

Table 2 Proposed 2016 field timing for executing fish and aquatic resource field programs.

Program	Activity	Timeline (2016)
Fish Resources	Fish Baseline Field Surveys	March, May/June, July/August, October
	Fish Habitat Field Surveys (includes IFS needs), including temperature data logger install	March, June, September, October/November
Fish Resources	Fluvial Geomorphology Assessment	May, June, July
Fish Resources	Drift Benthic Surveys	July, September
Fish Resources	Hydrometric Station Establishment	March, May

Aquatic Resources	Water: Physical & Chemical Characterization	March, May, August, October
Aquatic Resources	Aquatic Sediments	June
Aquatic Resources	Tissue Residue	July, August (fish, aquatics)
Habitat Offsetting	Reconnaissance Survey	June-August

4. REPORTING FOR JULY 15 EIA RE-SUBMISSION

As noted in the proposed field schedule (Section 3), fish and aquatic resource baseline field programs are not expected to be completed until Q4 2016. Thus, the proposed instream flow assessment (study) to evaluate potential physical effects to fish and fish habitat as a result of anticipated flow alterations in both Gold and Blairmore creeks is not expected to be complete until Q1 2017.

For the Environmental Impact Assessment (EIA) re-submission targeted for early Q3 2016, the main focus for the fisheries and aquatic resource program will be to provide a revised assessment of potential predicted water quality effects to fish/aquatic resources based on the outputs from the water quality predicted model.

If there are any specific questions or comments regarding the content provided in this high-level plan, they can be directed to the undersigned.

Sincerely,

[redacted]
Hatfield Consultants

[redacted]
Hatfield Consultants

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From: Watson, Ernest
Sent: Wednesday, July 13, 2016 2:51 PM
To: [redacted]
Cc:
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Thanks [redacted]!

Appreciate the response [redacted] I will pass the information on to the other Mikes as well.

Cheers and enjoy!

Ernie.

From: [redacted] [mailto:[redacted]@hatfieldgroup.com]
Sent: July-13-16 1:21 PM
To: Watson, Ernest
Cc: [redacted]
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hi Ernie,

Thanks is for your follow up. My responses to your inquiries are as follow:

(1) use of fin clips only will potentially affect our recapture/recovery estimates, particularly in Blairmore Cr where turbidity is higher and visibility is limited to only a few feet at best. If we remove the recovery snorkel approach and replace with an additional e-fishing (recapture) event will likely work in upper reaches but likely not very well in lower reaches where pool habitats are deeper and e-fishing won't be effective. We are targeting habitats where the sub-adult and adult fish will be likely congregating, which will be pool habitat...the larger/deeper the better. I would prefer to maintain the snorkel recapture approach as we already have reasonable handle on what to expect given the amount of snorkeling performed to date in each system.

(2) we would deploy the use of a UV light as part of the recapture snorkel surveys, which will allow for improved identification of VIE marked fish whether in Gold or Blairmore Creek.

I anticipate these responses meet your expectations/requirements. If you have any follow up questions please let me know. I cell service is limited but I will try to respond promptly.

Regards
[redacted]

[redacted]
Hatfield Consultants |www.hatfieldgroup.com
200-850 Harbourside Drive, North Vancouver, BC V7P 0A3, Canada
Tel: [redacted] | Dir/Cell: [redacted] | Fax: 604.926.5389

On Jul 13, 2016 12:35 PM, "Watson, Ernest" <<email address removed> wrote:

>

> >

> Hello [redacted]
>
>
>
> Just a couple of questions in terms of methodology for fish population estimates:
>
>
>
> (1) How would using finclips only with a second pass round of e-fishing affect your population estimates? (i.e. keep fin clip, and replace VIE and follow-up snorkel with another single pass of e-fishing)
>
> (2) Would the underwater visibility differences between Gold and Blairmore Creeks affect the ability to compare the estimates from the two waterbodies using VIE with snorkel survey?
>
>
>
> Thanks! Ernie.
>
> **Ernest Watson**
>
> Species at Risk Biologist, Species At Risk Program
> Fisheries and Oceans Canada / Government of Canada
<contact information removed>

> Biologistedes espèces en péril, Programme des espèces en péril
> Pêches et Océans Canada / Gouvernement du Canada
<coordonnées professionnelles caviardées>

>
>
> **From:** [redacted] [mailto:[redacted]@mems.ca]
> **Sent:** July-05-16 3:43 PM
> **To:** <email address removed> ; '<email address removed> Watson, Ernest; '<email address removed> 'Scott,Janet [CEAA]'
> **Cc:** 'Maracle,Brett [CEAA]'; Shpeley, Jason D; '[redacted]@hatfieldgroup.com'; 'Parker,Cindy [CEAA]'; 'Utting,Tracy [CEAA]'
> **Subject:** RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout
>
>
>
> Hello all
>
>
>
> On behalf of Benga please find attached, as per the Action identified in our discussion last week, the

Grassy Mountain EIA Fish and Aquatics Work Plan.
>
>
>
> I will plan to individually touch base with Mike Hunka, Ernie Watson, as well as Mike Bryski on Monday, July 11th. If deemed necessary from that correspondence, I can arrange a group follow up meeting to answer any questions or provide further clarification.
>
>
>
> Kind regards
>
> [redacted]
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> [redacted]
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> [redacted]
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> [redacted]
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> Suite 325, 1925 – 18th Avenue NE
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> Calgary, AB T2E 7T8
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> [redacted] (D) [redacted] (C)
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> [redacted]@mems.ca www.mems.ca
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> ________________________________
> **From:** [redacted]
> **Sent:** Wednesday, June 29, 2016 12:54 PM
> **To:** 'Utting,Tracy [CEAA]'; <email address removed> <email address removed> Watson, Ernest: DFO; [redacted]@hatfieldgroup.com; Parker,Cindy [CEAA]; <email address removed>
> **Cc:** Maracle,Brett [CEAA]; Shpeley, Jason D; [redacted]
> **Subject:** RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout
>

>
>
>
>
> Hello all
>
>
>
> Thanks again for your time today.
>
>
>
> The following is a summary of the salient points/actions from the discussion. Please review and let me know if there are any errors or omissions.
>
>
>
> · Introductions/Attendance: Tracy Utting (CEAA), Cindy Parker (CEAA), Ernie Watson (DFO), Mike Hunka (AER), Rushang Joshi (AER), Mike Bryski (AEP), [redacted] (Hatfield on behalf of Benga), [redacted] (MEMS on behalf of Benga). Regrets: Jason Shpeley (DFO) and Brett Maracle (CEAA).
>
> · [redacted] provided overview (context for Mike Bryski) of the Project's current status in the federal and provincial EIA review process.
>
> · [redacted] provided overview of work completed in 2016 to date.
>
> · [redacted] provided context around objectives and methodologies for fish population assessments on Gold Creek. Of note, the discussions were more focused on Gold Creek; however, works proposed to be completed will also include Blairmore Creek.
>
> · Mike Bryski indicated that 300 m reaches were recognized as a standard size for sampling points/plots/reaches. Requested clarification on how many reaches to be included in the final work plan/FRL request. Confirmed that single pass electrofishing would be acceptable.
>
> · Mark & Recapture methodologies discussed. Initial capture would be via electrofishing to target key habitats. Recapture could only involve snorkel surveys to minimize handling of fish. Mike Hunka asked how other habitats would be assessed (i.e., more shallow riffles vs deeper pools). [redacted] responded that target species would be 180 mm in fork length, that typically hold in pool or deeper run/glide habitats that are accessible via snorkeling. This was confirmed to be acceptable by Mike H. Tagging options discussed included Floy tags, a dye marker, or fin clip. Preference of which marker to use was not decided on in the meeting.
>
> · Mike Bryski raised the discussion on Population Assessment vs Abundance. Mike H and Ernie confirmed that a Population Assessment would be more beneficial to better understand potential impacts of the Project and for future monitoring purposes (potential approval condition)
>
> · Ernie Watson clarified for the purposes of the SARA permit request (1) options analysis for marking to be completed, with electrofishing to be considered for recapture technique, if needed. (2) once pros and cons on the options analysis has been conducted, present one option with rationale. (3) minimizing impact to individuals is SARA's primary objective.

>
> · Mike Hunka clarified that the AER (and DFO) would like a final work plan that shows more detail on methodology so they can provide final confirmation that it'll meet AER MDRs and DFO/CEAA SIRs.
>
> · [redacted] agreed with Ernie that once resolution on techniques is made, and both AER and DFO have reviewed and approved the work plan, a revised (or new) FRL can be issued to AEP.
>
> · ACTION: [redacted] to update the current (high level) Work Plan provided on May 23 with more detail on non-passive techniques (for the overall program), the tagging options analysis, and details on the fish population methodology. This document to be submitted to the AER and DFO.
>
> · ACTION/REQUEST: Coordinated response from the AER, DFO and AEP regarding questions or approval of the Work Plan to Benga (c/o [redacted]. A follow up phone call can be coordinated if deemed necessary. Once the Work Plan is approved formal submissions to DFO (for SARA permit) and AEP (for FRL) will be made (the entire Final Work Plan will be attached to both submissions).
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> Regards
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> [redacted]
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> Suite 325, 1925 – 18th Avenue NE
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> Calgary, AB T2E 7T8
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> [redacted] (D) [redacted] (C)
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s.16(2)(c)
s.19(1)

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> -----Original Appointment-----
> **From:** Utting,Tracy [CEAA] [mailto: <email address removed>]
> **Sent:** Monday, June 27, 2016 12:06 PM
> **To:** Utting,Tracy [CEAA]; [redacted] <email address removed>; <email address removed> [redacted] Vatson, Ernest: DFO; Shpeley, Jason D; [redacted]@hatfieldgroup.com
> **Cc:** Maracle,Brett [CEAA]; <email address removed>
> **Subject:** UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout
> **When:** Wednesday, June 29, 2016 11:00 AM-12:00 PM (GMT-05.00) Eastern Time (US & Canada).
> **Where:** Teleconference Dial-in Number: 1-877-413-4790, ID: [redacted]
>
>
>
>
>
> PLEASE NOTE: AER has requested a start time of 9:00 am, otherwise we are looking at holding the meeting in the afternoon.
>
> Teleconference Details:
>
>
>
> Date: June 29, 2016
>
> Conference ID: [redacted]
>
> Dial-in number: 1-877-413-4790
>
> It is critical that everyone on the required list attend (i.e. DFO, AER, and AEP) to facilitate a timely and consistent approach to the Fish Research Licenses. Please let me know if this meeting time does not work for you. Given holiday schedules, I would like to try and stick with Wednesday July 29 if possible. Thank-you in advance for finding time in your schedules for this meeting.
>
> Background:
>
>
>
> During and following the Grassy Mountain Site Visit it became clear that the Fish Research License applications and Fisheries and Aquatics Work Plan outlining technical studies for baseline data collection on the Westslope Cutthroat Trout inhabiting Grassy Mountain area would benefit from an immediate and collaborative discussion between Fisheries and Ocean Canada (DFO), Alberta Environment and Parks (AEP), and the Alberta Energy Regulator (AER).
>
> Hatfield group (on behalf of Riversdale) has indicated that they are looking to see the Fish Research Licenses (FRLs) in place so that they can be collecting baseline data on Westslope Cutthroat Trout the last week of July (or sooner).
>
> This purpose of this meeting will be to discuss the proposed approaches to fish sampling and for DFO, AEP and AER to reach a level of consensus on what can and should be done for sampling of Westslope Cutthroat Trout in Gold and Blairmore creeks in order to facilitate issuance of the FRLs by Alberta

Parks and Environment and by Fisheries and Oceans Canada under the *Species at Risk Act*.
>
> Please feel free to call to discuss.
>
> Tracy
>
> Tracy Utting
>
>
>
> Project Manager, Prairie and Northern Region
>
> Canadian Environmental Assessment Agency / Government of Canada
>
<contact information removed>
>
> CONFIDENTIALITY CAUTION:
> This message is intended only for the use of the individual or entity to which it has been addressed and may contain information that is privileged and confidential. If you are not the intended recipient, or the employee or agent responsible for delivering the message to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If this communication has been received in error, respond immediately via telephone or return e-mail, and delete all copies of this material.

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date:	2016/07/15	Action ID No.:	49

RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Thanks [redacted] I can also confirm that I received an e-mail from Ernie Watson to indicate that Jason Shpeley and he reviewed the plan and are supportive.

I've reviewed the plan for consistency with AEP standards, but not for the suitability to address needs for the EIA. Our review of the previous version of the study plan was more comprehensive and comments were provided.

I know Ernie has spoken to [redacted] about Floy-tagging fish, and I'll just reiterate that AEP is not supportive of using Floy-tags. My understanding is that [redacted] has agreed and that fin-clipping and VIE marking will be used. I'll just note that if visibility is an issue for sighting marked fish during the snorkelling recapture run for population estimation, I am also supportive of using electrofising to recapture fish.

Note that electrofishing sites should be 300m in length, as a minimum. This is a standard that AEP uses as a minimum reach length for estimation of abundance.

Also, for the sake of consistency, please use 153mm fork length as the dividing length between juvenile WSCT (<153mmFL) and adult WSCT (>or=153mmFL).

I note that the description of the critical habitat does not include Gold Creek. From the federal recovery plan, the WSCT critical habitat in Gold Creek is listed as:

> Gold Creek and Tributaries
> Critical habitat for Westslope Cutthroat Trout in Alberta is found within Gold Creek from 49°36'27.797"N -114°23'34.32"W, to an upstream location on Gold Creek, 49°42'27.914"N, -114°23'49.456"W. The downstream extent of critical habitat is a water supply dam and the upstream extent of critical habitat is generally the upstream extent of sampling reaches on the mainstem and tributaries where Westslope Cutthroat Trout were caught. On one tributary critical habitat ended at the start point of a sampling reach where Westslope Cutthroat Trout were caught (no end points were provided in the electrofishing survey). The following tributaries to Gold Creek are also included as critical habitat (see Appendix 2 for coordinates of the upstream extent of critical habitat on these tributaries): Morin Creek and Cauldron Creek.

I look forward to receiving the FRL application. Please include a copy of the study plan with your application and copies of the e-mails from DFO and AER indicating support for the proposed work.

Thanks!

Michael S. Bryski P.Biol.
Senior Fisheries Biologist
Alberta Environment and Parks
Crowsnest District, South Saskatchewan River Basin

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date:	2016/07/15	Action ID No.:	49

2nd Floor, YPM Place
530 - 8th Street South
Lethbridge, AB T1J 2J8
<contact information removed>

From: Mike Hunka [<mailto:<email address removed>
Sent: July-14-16 3:49 PM
To: [redacted]
Cc: Shpeley, Jason: DFO; Mike Bryski
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hi [redacted]

At this point the AER is supportive of the proposed plan, and once the clarification from Hatfield is available, please send it along. I will be away from the office, but I have cc Mike to confirm the AER's support for the proposal.

Cheers

Michael Hunka, P. Biol
Fisheries Biologist, Environmental Assessment

Alberta Energy Regulator
<contact information removed>
Suite 402, 4999 - 98 Avenue, Twin Atria Building, Edmonton AB T6B 2X3
inquiries 1-855-297-8311 24-hour emergency 1-800-222-6514 www.aer.ca <http://www.aer.ca/>

From: [redacted] [<mailto:[redacted]@mems.ca>]
Sent: Thursday, July 14, 2016 3:10 PM
To: Mike Hunka
Cc: Shpeley, Jason: DFO; Rushang Joshi; Karen Roberts; Rod Drummond
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hi Mike

Thanks for the feedback. I'll direct these technical points to Hatfield to confirm and clarify.

It shouldn't be a problem to clarify these items, and glad to hear we're in better alignment with the AER's expectations regarding aquatics.

FYI - I spoke with Ernie Watson regarding the plan on Tuesday & Wednesday, and he'd indicated he was satisfied with the revised work plan. My understanding from Ernie is that Mike Bryski is aiming to provide feedback by the end of this week.

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date:	2016/07/15	Action ID No.:	49

Ernie indicated he'll keep in touch with Mike Bryski to clarify any permitting clarifications. Does Mike Bryski need anything from yourself or Rod?

Regarding final work plan. Yes, my intention once everyone is in agreement, is to rescind the previous version(s) via a letter to Rushang, with the final attached to the letter, to avoid any confusion in future review proceedings.

Thanks

[redacted]

[redacted]

Suite 325, 1925 - 18th Avenue NE

Calgary, AB T2E 7T8

[redacted] (D) [redacted] (C)

[redacted]@mems.ca <mailto:[redacted]@mems.ca> www.mems.ca <http://www.mems.ca/>

From: Mike Hunka [<mailto: <email address removed>

Sent: Thursday, July 14, 2016 2:19 PM

To: [redacted]

Cc: Shpeley, Jason: DFO; Rushang Joshi; Karen Roberts; Rod Drummond

Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hi [redacted]

I have gone over the proposal and it looks good from the fish perspective, I just had a couple of questions as relating to the Benthic sampling, water quality and sediment sections:

1. Confirm that the benthic surveys will follow previously established procedures, to allow for comparisons with previously collected data.
2. Confirm that benthic surveys will classify organisms to the lowest possible taxonomic level
3. For sampling of sediments, a nutrient suite needs to be included in the assessment, to allow for assessment of changes in sediment quality over time. Provide the proposed nutrient
4. Clarify what parameters will be sampled in the water quality assessments, as baseline water quality needs to be established prior to the mine releasing mine affected waters to both Blairmore and Gold Creeks.

Other than these points of clarification, the proposed study plan should result in the collection of the information that was required in the EIA and should address the major deficiencies identified in the January 25, 2016 letter to Benga. If you have any questions, please feel free to follow up with me. In regards to moving forward, please provide the updated plan with the above information in a final proposal, which will be included in the file.

I will be away next week, however if you need to speak to someone regarding the project, please feel free to contact Rod in my absence.

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

	Action Date:	2016/07/15	Action ID No.:	49

Michael Hunka, P. Biol
Fisheries Biologist, Environmental Assessment

Alberta Energy Regulator
<contact information removed>
Suite 402, 4999 - 98 Avenue, Twin Atria Building, Edmonton AB T6B 2X3
inquiries 1-855-297-8311 24-hour emergency 1-800-222-6514 www.aer.ca <http://www.aer.ca/>

From: [redacted] [<mailto:[redacted]@mems.ca>]
Sent: Tuesday, July 05, 2016 2:43 PM
To: '<email address removed> Mike Hunka; 'Watson, Ernest: DFO'; Rushang Joshi; 'Scott,Janet [CEAA]'
Cc: 'Maracle,Brett [CEAA]'; 'Shpeley, Jason D'; [redacted] [redacted]@hatfieldgroup.com'; 'Parker,Cindy [CEAA]'; 'Utting,Tracy [CEAA]'
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hello all

On behalf of Benga please find attached, as per the Action identified in our discussion last week, the Grassy Mountain EIA Fish and Aquatics Work Plan.

I will plan to individually touch base with Mike Hunka, Ernie Watson, as well as Mike Bryski on Monday, July 11th. If deemed necessary from that correspondence, I can arrange a group follow up meeting to answer any questions or provide further clarification.

Kind regards
[redacted]

[redacted]

Suite 325, 1925 - 18th Avenue NE
Calgary, AB T2E 7T8
[redacted] (D) [redacted] (C)
[redacted]@mems.ca <mailto:[redacted]@mems.ca> www.mems.ca <http://www.mems.ca/>

From: [redacted]
Sent: Wednesday, June 29, 2016 12:54 PM
To: 'Utting,Tracy [CEAA]'; <email address removed> mailto:<email address removed> <email address removed>] <mailto:<email address removed> ; Watson, Ernest: DFO; [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>; Parker,Cindy

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date: 2016/07/15 Action ID No.: 49

[CEAA]; <email address removed>
Cc: Maracle,Brett [CEAA]; Shpeley, Jason D; [redacted]
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hello all

Thanks again for your time today.

The following is a summary of the salient points/actions from the discussion. Please review and let me know if there are any errors or omissions.

- Introductions/Attendance: Tracy Utting (CEAA), Cindy Parker (CEAA), Ernie Watson (DFO), Mike Hunka (AER), Rushang Joshi (AER), Mike Bryski (AEP), [redacted] (Hatfield on behalf of Benga), [redacted] (MEMS on behalf of Benga). Regrets: Jason Shpeley (DFO) and Brett Maracle (CEAA).
- [redacted] provided overview (context for Mike Bryski) of the Project's current status in the federal and provincial EIA review process.
- [redacted] provided overview of work completed in 2016 to date.
- [redacted] provided context around objectives and methodologies for fish population assessments on Gold Creek. Of note, the discussions were more focused on Gold Creek; however, works proposed to be completed will also include Blairmore Creek.
- Mike Bryski indicated that 300 m reaches were recognized as a standard size for sampling points/plots/reaches. Requested clarification on how many reaches to be included in the final work plan/FRL request. Confirmed that single pass electrofishing would be acceptable.
- Mark & Recapture methodologies discussed. Initial capture would be via electrofishing to target key habitats. Recapture could only involve snorkel surveys to minimize handling of fish. Mike Hunka asked how other habitats would be assessed (i.e., more shallow riffles vs deeper pools). [redacted] responded that target species would be 180 mm in fork length, that typically hold in pool or deeper run/glide habitats that are accessible via snorkeling. This was confirmed to be acceptable by Mike H. Tagging options discussed included Floy tags, a dye marker, or fin clip. Preference of which marker to use was not decided on in the meeting.
- Mike Bryski raised the discussion on Population Assessment vs Abundance. Mike H and Ernie confirmed that a Population Assessment would be more beneficial to better understand potential impacts of the Project and for future monitoring purposes (potential approval condition)
- Ernie Watson clarified for the purposes of the SARA permit request (1) options analysis for marking to be completed, with electrofishing to be considered for recapture technique, if needed. (2) once pros and cons on the options analysis has been conducted, present one option with rationale. (3) minimizing impact to individuals is SARA's primary objective.
- Mike Hunka clarified that the AER (and DFO) would like a final work plan that shows more detail on methodology so they can provide final confirmation that it'll meet AER MDRs and DFO/CEAA SIRs.
- Mike Bryski agreed with Ernie that once resolution on techniques is made, and both AER and DFO have reviewed and approved the work plan, a revised (or new) FRL can be issued to AEP.
- ACTION: [redacted] to update the current (high level) Work Plan provided on May 23 with more detail on

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date:	2016/07/15	Action ID No.:	49

non-passive techniques (for the overall program), the tagging options analysis, and details on the fish population methodology. This document to be submitted to the AER and DFO.

- ACTION/REQUEST: Coordinated response from the AER, DFO and AEP regarding questions or approval of the Wor

s.19(1)

From: Watson, Ernest
Sent: July-20-16 4:23 PM
To: [redacted]@rivresources.com)
Cc: [redacted]@mems.ca); Shpeley, Jason D
Subject: Receipt of application for a permit under the Species at Risk Act (SARA) - DFO FILE 16-PCAA-00026: Westslope Cuthroat Trout (Alberta Populations), Gold Creek, Population Survey

Dear [redacted]

The Species at Risk Program (the Program) of Fisheries and Oceans Canada would like to acknowledge your request for a permit under the *Species at Risk Act* for the activity affecting a listed aquatic species, as outlined in correspondence entitled "Proposed 2016 Fisheries and Aquatics Scope of Work for the Grassy Mountain Project", submitted by Hatfield Consultants and received on July 5th, 2016.

Your request will be reviewed and a response informing you of the decision to issue or decline to issue a permit will be provided within 90 days of the date of this letter, in accordance with the Permits Authorizing an Activity Affecting Listed Wildlife Species Regulations, unless one of the following conditions apply:

- additional consultations are necessary, including Aboriginal consultations;
- a decision first needs to be made under another federal law (e.g. the Canadian Environmental Assessment Act) before a permit can be legally issued;
- the terms and conditions of a SARA permit that was previously issued to you have not been met;
- you request or agree that the time limit not apply; or
- the activity described in the permit application is modified before DFO provides a response to you.

You will be notified within 90 days if one of these conditions applies to your application.

If any changes are made to your application during this time, please contact us with the updated information.

If you have any questions regarding the above, please contact me. Please refer to the file number referenced above when corresponding with DFO.

Yours sincerely,

Ernest Watson

Species at Risk Biologist, Species At Risk Program
Fisheries and Oceans Canada / Government of Canada
<contact information removed>

Biologistedes espèces en péril, Programme des espèces en péril
Pêches et Océans Canada / Gouvernement du Canada
<coordonnées professionnelles caviardées>

s.19(1)

From: [redacted]@mems.ca>
Sent: Wednesday, July 20, 2016 4:37 PM
To: 'Mike Hunka'; Rod Drummond
Cc: Shpeley, Jason D; Rushang Joshi; Karen Roberts; [redacted]@hatfieldgroup.com; Watson, Ernest
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hi Mike

Please find attached our confirmation of your four clarification requests.

1. Confirm that the benthic surveys will follow previously established procedures, to allow for comparisons with previously collected data.

   1.benthic surveys most recently collected were done using a drift sampling protocol, which is standard for completing IFN assessments. Drift benthics are the primary food source for WCT; consequently, the sampling results are most applicable for evaluating food productivity and assessing for potential impacts to WCT. Hatfield have recently collected and analyzed periphyton samples from both Gold and Blairmore creeks. Hatfield will evaluate periphyton lab results.

2. Confirm that benthic surveys will classify organisms to the lowest possible taxonomic level

   2. benthic classification of samples will be conducted to the lowest practical/acceptable level necessary to predictively assess for project-specific impacts. Typically the taxonomic level is performed to genus or family level.

3. For sampling of sediments, a nutrient suite needs to be included in the assessment, to allow for assessment of changes in sediment quality over time. Provide the proposed nutrient

   3.Was this sentence cut off? Nutrients will be included in the analysis of aquatic sediments. We have been measuring TOC in sediments, which is a key nutrient and relevant from an Se-cycling perspective.

4. Clarify what parameters will be sampled in the water quality assessments, as baseline water quality needs to be established prior to the mine releasing mine affected waters to both Blairmore and Gold Creeks.

   4. The additional water quality sampling will include the analysis of those variables established early on in the project. The variables list has not changed from the previous Surface WQ sampling program so it has been readily available for review and comment for some time.

Please let us know if you have any questions or concerns.

Regards

[redacted]

MILLENNIUM
EMS Solutions Ltd.
Suite 325, 1925 – 18th Avenue NE
Calgary, AB T2E 7T8
403-270-5008 (D) 403-804-3636 (C)
[redacted]@mems.ca www.mems.ca

From: Mike Hunka [mailto:<email address removed>
Sent: Thursday, July 14, 2016 2:19 PM
To: [redacted]
Cc: Shpeley, Jason: DFO; Rushang Joshi; Karen Roberts; Rod Drummond
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hi [redacted]

I have gone over the proposal and it looks good from the fish perspective, I just had a couple of questions as relating to the Benthic sampling, water quality and sediment sections:

1. Confirm that the benthic surveys will follow previously established procedures, to allow for comparisons with previously collected data.
2. Confirm that benthic surveys will classify organisms to the lowest possible taxonomic level
3. For sampling of sediments, a nutrient suite needs to be included in the assessment, to allow for assessment of changes in sediment quality over time. Provide the proposed nutrient
4. Clarify what parameters will be sampled in the water quality assessments, as baseline water quality needs to be established prior to the mine releasing mine affected waters to both Blairmore and Gold Creeks.

Other than these points of clarification, the proposed study plan should result in the collection of the information that was required in the EIA and should address the major deficiencies identified in the January 25, 2016 letter to Benga. If you have any questions, please feel free to follow up with me. In regards to moving forward, please provide the updated plan with the above information in a final proposal, which will be included in the file.

[redacted]

Michael Hunka, P. Biol
Fisheries Biologist, Environmental Assessment

Alberta Energy Regulator
<contact information removed>
Suite 402, 4999 - 98 Avenue, Twin Atria Building, Edmonton AB T6B 2X3
inquiries 1-855-297-8311 24-hour emergency 1-800-222-6514 www.aer.ca

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From: [redacted] [mailto:[redacted]@mems.ca]
Sent: Tuesday, July 05, 2016 2:43 PM
To: '<email address removed> ; Mike Hunka; 'Watson, Ernest: DFO'; Rushang Joshi; 'Scott,Janet [CEAA]'
Cc: 'Maracle,Brett [CEAA]'; 'Shpeley, Jason D'; [redacted] '[redacted]@hatfieldgroup.com'; 'Parker,Cindy [CEAA]'; 'Utting,Tracy [CEAA]'
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hello all

On behalf of Benga please find attached, as per the Action identified in our discussion last week, the Grassy Mountain EIA Fish and Aquatics Work Plan.

I will plan to individually touch base with Mike Hunka, Ernie Watson, as well as Mike Bryski on Monday, July 11th. If deemed necessary from that correspondence, I can arrange a group follow up meeting to answer any questions or provide further clarification.

Kind regards
[redacted]

[redacted]

MILLENNIUM
EMS Solutions Ltd.
Suite 325, 1925 – 18th Avenue NE
Calgary, AB T2E 7T8
[redacted] (D) [redacted] (C)
[redacted]@mems.ca www.mems.ca

From: [redacted]
Sent: Wednesday, June 29, 2016 12:54 PM
To: 'Utting,Tracy [CEAA]'; <email address removed> ; <email address removed> Watson, Ernest: DFO; [redacted]@hatfieldgroup.com; Parker,Cindy [CEAA]; <email address removed>
Cc: Maracle,Brett [CEAA]; Shpeley, Jason D; [redacted]
Subject: RE: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout

Hello all

Thanks again for your time today.

The following is a summary of the salient points/actions from the discussion. Please review and let me know if there are any errors or omissions.

- Introductions/Attendance: Tracy Utting (CEAA), Cindy Parker (CEAA), Ernie Watson (DFO), Mike Hunka (AER), Rushang Joshi (AER), Mike Bryski (AEP), [redacted] (Hatfield on behalf of Benga), [redacted] (MEMS on behalf of Benga). Regrets: Jason Shpeley (DFO) and Brett Maracle (CEAA).
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- Mike Bryski agreed with Ernie that once resolution on techniques is made, and both AER and DFO have reviewed and approved the work plan, a revised (or new) FRL can be issued to AEP.
- ACTION: [redacted] to update the current (high level) Work Plan provided on May 23 with more detail on non-passive techniques (for the overall program), the tagging options analysis, and details on the fish population methodology. This document to be submitted to the AER and DFO.
- ACTION/REQUEST: Coordinated response from the AER, DFO and AEP regarding questions or approval of the Work Plan to Benga (c/o [redacted] A follow up phone call can be coordinated if deemed necessary. Once the Work Plan is approved formal submissions to DFO (for SARA permit) and AEP (for FRL) will be made (the entire Final Work Plan will be attached to both submissions).

Regards

[redacted]

<< OLE Object: Picture (Device Independent Bitmap) >>

Suite 325, 1925 – 18th Avenue NE
Calgary, AB T2E 7T8
[redacted] (D) [redacted] (C)
[redacted]@mems.ca www.mems.ca

s.16(2)(c)
s.19(1)

-----Original Appointment-----
From: Utting,Tracy [CEAA] [mailto: <email address removed>]
Sent: Monday, June 27, 2016 12:06 PM
To: Utting,Tracy [CEAA]; [redacted] <email address removed> <email address removed> Watson, Ernest: DFO; Shpeley, Jason D; [redacted]@hatfieldgroup.com
Cc: Maracle,Brett [CEAA]; <email address removed>
Subject: UPDATED TIME: Meeting to discuss Fish Research Licenses - Westslope Cutthroat Trout
When: Wednesday, June 29, 2016 11:00 AM-12:00 PM (GMT-05.00) Eastern Time (US & Canada).
Where: Teleconference Dial-in Number: 1-877-413-4790, ID: [redacted]

PLEASE NOTE: AER has requested a start time of 9:00 am, otherwise we are looking at holding the meeting in the afternoon.

Teleconference Details:

Date: June 29, 2016

Conference ID: [redacted]

Dial-in number: 1-877-413-4790

It is critical that everyone on the required list attend (i.e. DFO, AER, and AEP) to facilitate a timely and consistent approach to the Fish Research Licenses. Please let me know if this meeting time does not work for you. Given holiday schedules, I would like to try and stick with Wednesday July 29 if possible. Thank-you in advance for finding time in your schedules for this meeting.

Background:

During and following the Grassy Mountain Site Visit it became clear that the Fish Research License applications and Fisheries and Aquatics Work Plan outlining technical studies for baseline data collection on the Westslope Cutthroat Trout inhabiting Grassy Mountain area would benefit from an immediate and collaborative discussion between Fisheries and Ocean Canada (DFO), Alberta Environment and Parks (AEP), and the Alberta Energy Regulator (AER).

Hatfield group (on behalf of Riversdale) has indicated that they are looking to see the Fish Research Licenses (FRLs) in place so that they can be collecting baseline data on Westslope Cutthroat Trout the last week of July (or sooner).

This purpose of this meeting will be to discuss the proposed approaches to fish sampling and for DFO, AEP and AER to reach a level of consensus on what can and should be done for sampling of Westslope Cutthroat Trout in Gold and Blairmore creeks in order to facilitate issuance of the FRLs by Alberta Parks and Environment and by Fisheries and Oceans Canada under the *Species at Risk Act*.

Please feel free to call to discuss.

Tracy

Tracy Utting

Project Manager, Prairie and Northern Region

Canadian Environmental Assessment Agency / Government of Canada

<contact information removed>

MILLENNIUM
EMS Solutions Ltd.

No information has been removed or severed from this page

PATH-SAPH

Text Report

Description:

Report Date: 2020/06/30

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date: 2016/07/20 Action ID No.: 50

RE: Receipt of application for a permit under the Species at Risk Act (SARA) - DFO FILE 16-PCAA-00026: Westslope Cuthroat Trout (Alberta Populations), Gold Creek, Population Survey

Thanks Ernie. Much appreciated and thanks to you and your team in expediting things.

Regards

[redacted]

12331 - 20th Avenue
P.O. Box 660
Blairmore, Alberta T0K 0E0
Tel: [redacted]
Cell: [redacted]

From: Watson, Ernest [<mailto:<email address removed>
Sent: July-20-16 3:23 PM
To: [redacted]@rivresources.com <mailto:[redacted]@rivresources.com>>
Cc: [redacted] ([redacted]@mems.ca <mailto:[redacted]@mems.ca>) <[redacted]@mems.ca <mailto:[redacted]@mems.ca>>; Shpeley, Jason D <<email address removed> <mailto:<email address removed>
Subject: Receipt of application for a permit under the Species at Risk Act (SARA) - DFO FILE 16-PCAA-00026: Westslope Cuthroat Trout (Alberta Populations), Gold Creek, Population Survey

Dear [redacted]

The Species at Risk Program (the Program) of Fisheries and Oceans Canada would like to acknowledge your request for a permit under the *Species at Risk Act* for the activity affecting a listed aquatic species, as outlined in correspondence entitled "Proposed 2016 Fisheries and Aquatics Scope of Work for the Grassy Mountain Project", submitted by Hatfield Consultants and received on July 5th, 2016.

Your request will be reviewed and a response informing you of the decision to issue or decline to issue a permit will be provided within 90 days of the date of this letter, in accordance with the Permits Authorizing an Activity Affecting Listed Wildlife Species Regulations, unless one of the following conditions apply:

- additional consultations are necessary, including Aboriginal consultations;
- a decision first needs to be made under another federal law (e.g. the Canadian Environmental Assessment Act) before a permit can be legally issued;
- the terms and conditions of a SARA permit that was previously issued to you have not been met;
- you request or agree that the time limit not apply; or

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date:	2016/07/20	Action ID No.:	50

- the activity described in the permit application is modified before DFO provides a response to you.

You will be notified within 90 days if one of these conditions applies to your application.

If any changes are made to your application during this time, please contact us with the updated information.

If you have any questions regarding the above, please contact me. Please refer to the file number referenced above when corresponding with DFO.

Yours sincerely,

Ernest Watson
Species at Risk Biologist, Species At Risk Program
Fisheries and Oceans Canada / Government of Canada
<contact information removed>

Biologistedes espèces en péril, Programme des espèces en péril
Pêches et Océans Canada / Gouvernement du Canada
<coordonnées professionnelles caviardées>

Referral Title: Westslope Cutthroat Trout, Gold Creek, Alberta, Population Assessment (16-PCAA-00026)

Record of Consideration of the Conditions set out in the *Species at Risk Act, Section 73* for SARA permits or other authorizations that act as SARA permits

---

Context

The Minister of Fisheries and Oceans must consider the conditions set out in subsections 73(2) to (6.1) of the *Species at Risk Act* (SARA) prior to issuing a permit or entering into an agreement, authorizing a person to engage in an activity affecting a listed wildlife species, its critical habitat or the residences of its individuals. This includes other authorizations, licences, or similar documents that have the same effect as a SARA permit according to s. 74 of SARA.

Purpose

The purpose of this document is to provide a record that demonstrates the consideration of the conditions set out in Section 73 of SARA prior to the issuance or refusal of a:

☒ SARA Permit

☐ an authorization or licence issued in accordance with s. 74 of SARA

for the following activity:

Activity Title: Westslope Cutthroat Trout, Gold Creek, Alberta, Population Assessment (16-PCAA-00026)

The activity is being undertaken to provide baseline data in support of the Environmental Impact Assessment for the proposed Grassy Mountain Project. The objective of the proposed activity is to evaluate the status of fish populations in the Gold Creek and Blairmore Creek watersheds, specifically:

1. To confirm fish presence and absence throughout the project area;
2. To describe fish distribution in terms of space and time;
3. To characterize fish population and/or community structure to understand fish species and life stages present;
4. To enumerate fish population abundance; and
5. To better understand fish life-history timing with particular emphasis on migration and seasonal/preferred habitat use.

To achieve the objectives, the proposed activities consist of:

1. Sub-adult and adult population assessment: The Westslope Cutthroat Trout sub-adult and adult (fish greater than 150 mm fork length) population assessment will occur in the mainstem of Gold and Blairmore creeks above known migration barriers utilizing a combined capture-recapture and snorkel survey. Fish will be captured using one-pass backpack electrofishing sample in targeted mesohabitats. Fish will be angled where electrofishing is not feasible. The number of fish marked will depend on the number of fish captured. Fish greater than 150mm fork length will

be anaesthetized, measured for fork length and weight, and then marked using both Visible Implant Elastomer (VIE) and fin clip. Clipped fins (the upper caudal lobe) will be stored and preserved in 95% ethanol. Only fork length and weight will be recorded for captured fish less than 150 mm fork length. All fish will be released within the mesohabitat unit in which they were captured. Approximately 3-5 days post-marking, the same sections of watercourse will be surveyed using snorkel surveys where surveyor(s) will record the number of fish marked and those fish with no marks. Ultra-violet lights will be used during the survey to assist in identifying VIE tags.

2. Recruitment and juvenile population assessment: A Westslope Cutthroat Trout juvenile population assessment will be conducted on Gold and Blairmore Creeks in key mesohabitats at 10 locations in each watercourse. At each location, three sites of approximately 100 m2 each will be individually sampled for fish densities using a backpack electrofisher for three successive single-passes. The fork length and weight of each fish captured will be recorded. All fish will be released within the mesohabitat unit in which they were captured.
3. Tributary use and distribution survey: Gold Creek tributaries (2 unnamed watercourses, Caudron Creek, Morin Creek, Green Creek) and Blairmore Creek tributaries (2 unnamed tributaries) will be sampled to document fish presence, distribution, and habitat use (if fish are present). Fish sampling in each tributary will use either opportunistic or single-pass backpack electrofishing. All fish will be released within the mesohabitat unit in which they were captured.

Proposed by:

[redacted]
Benga Mining Limited
12331 – 20th Avenue
P.O. Box 660
Blairmore, Alberta T0K 0E0

Note that the following documents are included in the file:

☐ Application[1]

☒ Permit/SARA compliant Authorization or Licence

☒ Supporting documentation: Correspondence entitled "Proposed 2016 Fisheries and Aquatics Scope of Work for the Grassy Mountain Project", prepared by Hatfield consultants, dated July 5th, 2016.

---

[1] Information requirements for applications are set out in the *Permits Authorizing an Activity Affecting Listed Wildlife Species Regulations*.

Referral Title: Westslope Cutthroat Trout, Gold Creek, Alberta, Population Assessment (16-PCAA-00026)

1. Section 73(2) - the purpose of the activity

This information has been used to determine whether the activity qualifies for a SARA Permit.

1a Based on the purpose or intention of the activity, which category does the activity fit into? [Check one]

- ☐ scientific research
- ☐ activity benefits the species or is required to enhance the species' chance of survival in the wild
- ☒ affecting the species is incidental to the carrying out of the activity
- ☐ none of the above (activity does not qualify for a SARA Permit)

If "none of the above", the activity does not qualify for a permit or authorization under SARA

1b If the activity is scientific research:

Does the research relate to the conservation of the species?

☐ Yes ☐ No

Is the research being conducted by qualified persons?

☐ Yes ☐ No

If "No" to either question, the activity does not qualify for a permit or authorization under SARA

2. Section 73(3)(a) - reasonable alternatives to the activity that would reduce the impact on the species

This information will help determine whether the activity is the best of all reasonable alternatives that would reduce the impact on the species

2a Did the applicant consider alternatives to the activity that would reduce the impact on the species?

☒ Yes ☐ No

The proposed sampling methodology (electrofishing) is non-lethal, and will be conducted by qualified Fisheries staff and in adherence to provincial standards. The sampling methods were selected based on the survey objectives and logistics, habitat to be sampled, capture efficiency of target species and minimal impact to fish. A wide variety of tagging or marking methods were considered and evaluated against the study objectives of the sub-adult and adult population assessment. The double tagging approach was taken in order to: (1) generate current and future data through fin clips, including archiving tissue samples for future genetic analyses; and (2) the VIE ensures a more accurate identification thus more valid population abundance estimates in low visibility environment. Little or no mortality is expected using either method. Tagging with VIE will allow follow-up snorkel survey, which is less intrusive than follow-up sampling by electofishing.

2b Are there additional alternatives that could be considered?

☐ Yes ☒ No

If no, has an adequate rationale been provided?

☒ Yes ☐ No

2c Has the best solution has been adopted?

☒ Yes ☐ No

If "No" to 2a or 2c, do not issue permit or authorization

3. Section 73(3)(a) - feasible measures to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals

This information confirms that all feasible measures to minimize the impact of the activity on the species are part of the activity plan

3a Did the applicant propose measures that will to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals?

☒ Yes ☐ No

The proposed sampling methodology (electrofishing) is non-lethal, and will be conducted by qualified individuals in adherence to provincial standards. These sampling methods were selected based on the research objectives and logistics, habitat to be sampled, capture efficiency of target species and minimal impact to fish. All fish will be released alive within the mesohabitat unit in which they were captured.

3b Are there additional measures that could be implemented and should be included as conditions of the permit, authorization or licence?

☐ Yes ☒ No

3c If no, has an acceptable rationale been provided?

☒ Yes ☐ No

Although this activity is being undertaken to provide baseline fish population data in support of the Environmental Impact Assessment for the proposed Grassy Mountain Project, the species-specific fish data generated will also produce information that will support specific research and monitoring goals/objectives as outlined in the Recovery Strategy for the Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*), Alberta Populations in Canada (DFO 2014). This includes:

Research

- Elucidate life-history requirements and characteristics;
- Elucidate habitat requirements;
- Improve knowledge of population genetics;
- Develop population models; and
- Understand limiting factors.

Monitoring

- Population Monitoring; and
- Habitat Monitoring

4. Section 73(3)(c) - jeopardy to the survival or recovery of the species

Determining whether or not the activity would jeopardize survival and recovery of the species is based on the information provided by the applicant on the effects of the activity in combination with species information in the possession of DFO.

4a Have all the effects of the activity on the species, its residences, and its critical habitat been considered?

☒ Yes ☐ No

4b Has the level of risk to the survival and recovery of the species been assessed?

☒ Yes ☐ No

The intent is for the live capture and release of the individuals after measurement and tagging. Careful considerations of potential impacts were considered in the study design and methodologies proposed, and the application of mitigation measures will be applied to minimize any impacts on Westslope Cutthroat Trout, Alberta populations. The data collected from the proposed activities have a direct linkage to strategies and actions recommended in the SARA recovery plan for this species.

Provided the mitigation contained in the description of activities and the permit issued under section 73 of the Species at Risk Act, the project will pose a low risk to the survival and recovery of the species. The Recovery Strategy for Westslope Cutthroat Trout has assessed the threat of accidental mortality to the survival and recovery of the species as low (Fisheries and Oceans Canada 2014).

Citation: Fisheries and Oceans Canada 2014. Recovery Strategy for the Alberta populations of Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in Canada Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. iv + 28 pp + Appendices.

4c If offsetting is proposed, has the level of benefit of the offset to the affected listed species been assessed?

☐ Yes ☐ No ☒ N\A

4d Has the level of uncertainty associated with the effects, the mitigation, and any offset been taken into account?

☒ Yes ☐ No

4e Taking into account the above, can it be reasonably concluded that the activity will not jeopardize the survival and recovery of the species?

☒ Yes ☐ No

The activities will not jeopardize the recovery of the species. Careful considerations of potential impacts were considered in the study design and methodologies proposed, and the application of mitigation measures will be applied to minimize any project impacts on Westslope Cutthroat Trout populations. Furthermore, the data collected from the proposed activities have a direct linkage to strategies and actions recommended in the SARA recovery plan for this species.

5. Section 73 (4) – Consultations with relevant wildlife management boards

5a Is the species found in an area in respect of which a wildlife management board is authorized by a land claims agreement to perform functions in respect of wildlife species?

☐ Yes ☒ No

5b Could the activity affect individuals, residences or critical habitat of that species on such lands?

☐ Yes ☒ No

5c If yes to both of the above questions:

Has the wildlife management board been consulted about the activities affecting listed species in the area under their administration?

☐ Yes ☐ No

If no, do not proceed until a consultation has taken place

6. Section 73 (5) Consultations with relevant Indian Bands

6a Is the species found in a reserve or any other lands that are set apart for the use and benefit of a band under the Indian Act?

☐ Yes ☒ No

6b Could the activity affect individuals, residences or critical habitat of the species in such an area?

☐ Yes ☒ No

6c If yes to both of the above questions:

Has the band, or an Aboriginal organizations mandated to conduct consultations on behalf of the band, been consulted about the activities affecting listed species on their lands?

☐ Yes ☐ No

If no, do not proceed until a consultation has taken place

7. Section 73 (6) - terms and conditions necessary for protecting the species, minimizing the impact of the authorized activity on the species, or providing for its recovery

7a Have qualifications of personnel conducting the activities been specified in the permit, authorization or license?

☒ Yes ☐ No

7b Are timelines or other conditions specified to avoid periods when the species is sensitive to disturbance?

☒ Yes ☐ No

7c Have all appropriate mitigation measures, existing standards or best practices been specified?

☒ Yes ☐ No

7d Have contingency measures been specified to be undertaken in the event that the mitigation measures fail?

☒ Yes ☐ No

7e Are monitoring and reporting requirements included?

☒ Yes ☐ No

7f If offsetting has been proposed, have the offsetting measures been specified, including completion time, monitoring, reporting and financial security?

☐ Yes ☐ No

8. Section 73 (6.1) Date of expiry

8a Does the agreement or permit set out the date of its expiry?

☒ Yes ☐ No

8b Is the date of expiry reasonable and appropriate?

☒ Yes ☐ No

Final Decision:

SARA conditions ☒ have been met ☐ have not been met

Additional Comments:

Prepared by:

Name: Ernest Watson

Title: Species at Risk Biologist

Date: July 23, 2016

Recommendation:

Name: Melanie Toyne

Title: Team Leader, Species at Risk

Date: _July 27, 2016_____________________________

Recommended: ☒

Approval:

Name: Debbie Ming

Title: A/Regional Manager, Species at Risk

Date: July 27, 2016_______________________________

Approved: ☒

From: Watson, Ernest
Sent: Thursday, July 28, 2016 12:38 PM
To: [redacted]
Cc: [redacted]
Subject: Re: 16-PCAA-00026 SARA Section 73 Permit for Incidental Harm

Understood and thanks!

Ernest Watson
Species at Risk Biologist | Biologistedes espèces en péril

From: [redacted]
Sent: Thursday, July 28, 2016 9:39 AM
To: [redacted]
Cc: [redacted] Watson, Ernest
Subject: Re: 16-PCAA-00026 SARA Section 73 Permit for Incidental Harm

We will be aiming to avoid using any anaesthetic, but if the need arises we will use an alternative to close oil (e.g. alka seltzer). MS222 is carcinogenic to humans thus is a product I would prefer not to have staff work with unless absolutely necessary.

[redacted]

[redacted]
Hatfield Consultants |www.hatfieldgroup.com
200-850 Harbourside Drive, North Vancouver, BC V7P 0A3, Canada
Tel: [redacted] | Dir/Cell: [redacted] | Fax: 604.926.5389

On Jul 28, 2016 7:17 AM, [redacted]@rivresources.com> wrote:

> [redacted]
>
> [redacted]
>
> Sent from my iPhone
>
> On Jul 28, 2016, at 7:32 AM, Watson, Ernest < <email address removed> wrote:
>
> > I forgot to mention: during our review, it was noted that clove oil has not been approved as a fish anesthetic for use in Canada. DFO recommends using MS222 instead.
> >
> > Thanks, Ernie.
> >
> > Ernest Watson
> > Species at Risk Biologist | Biologistedes espèces en péril
> >
> > ---
> > This email has been scanned by the Symantec Email Security.cloud service.
> > For more information please visit http://www.symanteccloud.com
> > ---

s.19(1)

Hatfield CONSULTANTS

MEMO

Date: December 8, 2016 HCP Ref No.: MEMS7779

From: [redacted]

To: [redacted] (Benga Mining)

Subject: Candidate List and Selection of Westslope Cutthroat Trout Habitat Suitability Criteria (HSC) Curves

[redacted]

This memo has been prepared in response to commentary received from the Alberta Energy Regulator (AER) and Fisheries and Oceans Canada (DFO) requesting the rationale applied in the selection of Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) habitat suitability criteria (HSC) curves for use in the Grassy Mountain Coal Project Instream Flow Needs (IFN) Assessment. Below is a brief summary of the steps exercised in the evaluation and selection of the preferred HSC curves:

- Westslope Cutthroat Trout (WSCT) were confirmed as the target fish species for the IFN given their presence and distribution throughout both Gold Creek and Blairmore Creek in the aquatic local study area (LSA) as well as their federal at-risk and provincial conservation designations.
- HSC literature sources specific to WSCT were identified and HSC curves for key life stages/life-history function (e.g., spawning/incubation, fry rearing, juvenile rearing, adult rearing/holding, overwintering) were compiled for comparison.
- The literature HSC curves were evaluated based on how they were generated by the authors (e.g., use of data from multiple cutthroat trout sub-species, use of only WSCT data, the geographic location of watercourses used in the development/refinement of HSC curves, the amount of data used to build the HSC curves, size and physical habitat characteristics of watercourse(s) used in developing/refining HSCs, professional peer review).
- Coarse validation of HSCs using field data collected from the target watercourses (e.g., snorkel data during spawning/overwintering/rearing surveys, evaluation of local hydrometric data during the WSCT spawning window etc.).

Attachment 1 provides a compilation of all the literature HSCs (for depth, velocity, substrate) generated for WSCT. A detailed reference list is provided, below. HSC curves were assembled from Washington Department of Fish and Wildlife (WDFW), British Columbia Ministry of Environment (BC MoE), Teck Coal Limited's Fording River Operations Swift Project Environmental Assessment (Golder 2012), and Teck Coal Limited's Line Creek Operations Phase II (Golder 2011).

While the curves from WDFW are shown, they include data from other sub-species of cutthroat trout (e.g., Coastal Cutthroat Trout), thus, are not considered as appropriate for this Project. Focus was placed on the HSC curves developed by BC MoE (2014) and Golder (2011, 2012) for key life stages/life-history functions.

Golder (2012) developed proposed (blue; presented in the attached) and final (green; presented HSC curves that underwent multiple peer reviews and were refined in a system relatively close geographically to the proposed Grassy Mountain Coal Project. Golder (2012) proposed HSC curves (blue curves) were initially vetted through the BC MoE Instream Flow Specialist (Ron Ptolemy) and further re-evaluated through a fish sub-committee (created as part of the Fording River Operations EA), which was comprised of individuals from provincial and federal governments, First Nations, and fisheries consultants. Through the sub-committee, the HSCs were refined to develop final (green curves) specific to the Fording River system. Finally, each blue and green curve was evaluated crudely using local data (e.g., hydrological, fish) collected for the Grassy Mountain Project.

Golder (2011) also developed HSC curves specific for overwintering. They were considered given the close geographic extent to this project. No other curves were considered as suitable.

The resultant HSCs were the following:

1. **Spawning/Incubation**

   - Depth HSC: Golder (2012) 'Final' (Green Curve) was selected.
   - Velocity HSC: Golder (2012) 'Proposed' (Blue Curve) was selected.
   - Substrate HSC: Golder (2012) 'Final' (Green Bars) was selected.

   Rationale: The proposed depth (blue curve) HSC remained unchanged post-evaluation from the Fording River fish sub-committee (green curve). We believe the selected HSC provides a conservative range of depth preference based on observations made during this project's WSCT spawning surveys and is relatively aligned with literature for Alberta populations of WSCT (e.g., DFO 2014). The proposed (blue curve) and final (green curve) velocity HSC were evaluated against local hydrology data from Gold Creek, fish spawning data collected during the WSCT spawning window (May, June 2016) for both Gold and Blairmore creeks, and spawning velocity preferences for Alberta WSCT (e.g., DFO 2014). Local hydrology information from Gold Creek was used as a surrogate for Blairmore Creek. We evaluated hydrometric data from locations within Gold Creek and found that velocities between May and August 2016 ranged between 0.08 m/s and 0.3 m/s in upper Gold Creek (above the Caudron Creek confluence, an important tributary to the Gold Creek watershed) and 0.1 m/s and 0.5 m/s in lower-/mid Gold Creek (below the Caudron Creek confluence). Further, we observed spawning throughout several reaches in both Gold and Blairmore creeks. Given the line of evidence, the proposed (blue curve) HSC is more appropriate for WSCT spawning in both Gold Creek and Blairmore Creek systems. The spawning substrate HSC from Golder (2012) matches that proposed by WDFW (2016), thus we have adopted this suitability criteria.

2. **Fry Rearing**

   - Depth HSC: Golder (2012) 'Final' (Green Curve) was selected.
   - Velocity HSC: Golder (2012) 'Final' (Green Curve) was selected.
   - Substrate HSC: Golder (2012) 'Final' (Green Curve) was selected.

Rationale: The final depth (green) HSC (Golder (2012) better reflects the local conditions of both Gold and Blairmore creeks compared to the proposed (blue) HSC and the HSC from BC MoE. Similar to the depth HSC, the final velocity HSC from Golder (2012) is conservative and appears to reasonably associate with observed field conditions. The Golder (2012) final (green) substrate HSC was selected given its suitability appears to better reflect the species life-stage requirements.

3. Juvenile Rearing

- Depth HSC: Golder (2012) 'Final' (Green Curve) was selected.
- Velocity HSC: Golder (2012) 'Final' (Green Curve) was selected.
- Substrate HSC: Golder (2012) 'Final' (Green Curve) was selected.

Rationale: The final depth (green) HSC (Golder (2012) better reflects the local conditions of both Gold and Blairmore creeks compared to the proposed (blue) HSC as well as the HSC from BC MoE (Ptolemy 2014). Similar to the depth HSC, the final velocity HSC from Golder (2012) is conservative and associates with observed field conditions. The Golder (2012) final (green) substrate HSC is aligned with other literature sources and is consistent with the WSCT life-stage requirements.

4. Adult Rearing/Holding

- Depth HSC: Golder (2012) 'Final' (Green Curve) was selected.
- Velocity HSC: Golder (2012) 'Final' (Green Curve) was selected.
- Substrate HSC: Golder (2012) 'Final' (Green Curve) was selected.

Rationale: The final depth (green) HSC (Golder 2012) is conservative and tends to associate with observations of habitat use in Gold and Blairmore creeks compared to the proposed (blue) HSC curve. Similar to the depth HSC, the final velocity HSC from Golder (2012) is conservative thus was selected to account for any habitat/flow variabilities between Gold and Blairmore creeks. The Golder (2012) final (green) substrate HSC was selected given its suitability appears to better reflect the species life-stage requirements.

5. Overwintering

- Depth HSC: Golder (2011) Curve was selected.
- Velocity HSC: Golder (2011) Curve was selected.
- Substrate HSC: Golder (2012) 'Final' (Green Curve) was selected.

Rationale: The Golder (2011) depth HSC curve was selected given the multiple data sources that were used to generate the suitability prior to use with Teck's Line Creek Operations Phase II project. The Golder (2011) velocity HSC curve appears to reflect local conditions of both Gold and Blairmore creeks. The Golder (2012) final (green) substrate HSC was selected given the range of suitability appears to reflect the species life-stage requirements.

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Of note, I have not included discussion around the selection of the drift invertebrate HSC curves as, to my knowledge, only one set of depth and velocity curves exist (Ptolemy 2001) and will be presented in the Instream Flow Needs Assessment.

If there are any questions or concerns with respect to the selection of HSC curves for application in the Grassy Mountain Instream Flow Needs Assessment, they can be directed to myself for consideration and/or response.

Regards,

[redacted]

Encl. **Attachment 1**

References Cited

Fisheries and Oceans Canada. 2014. Recovery Strategy for the Alberta populations of Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*) in Canada [Final]. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. iv + 28 pp + Appendices.

Golder Associates. 2012. Modification to Westslope Cutthroat Trout Habitat Suitability Index Model Memo in Fording River Operations Swift Project Environmental Assessment: Preliminary Fisheries Offsetting Plan (2014). Report prepared on behalf of Teck Coal Limited (Fording River Operations). 44pp + Appendices.

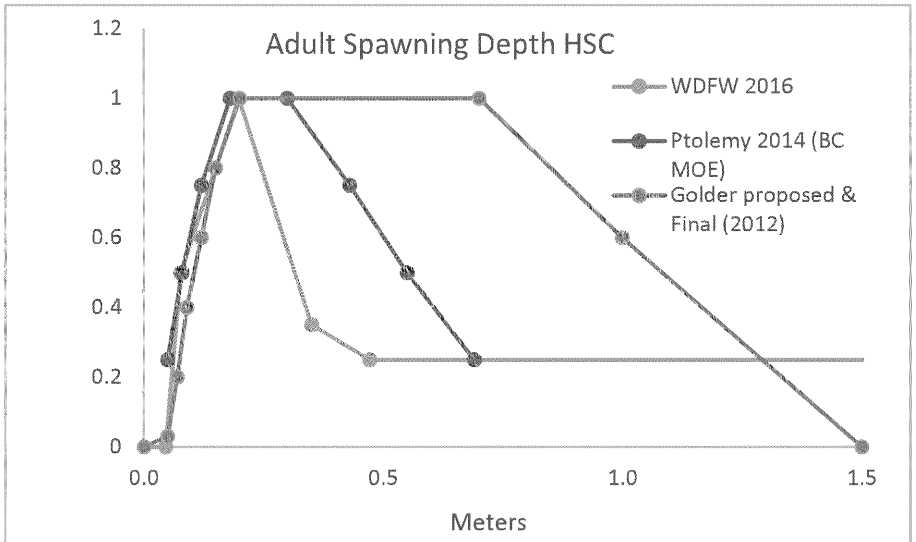
Golder Associates. 2011. Teck Coal Limited Line Creek Operations Phase II: Fish Habitat Compensation Plan. 55pp + Appendices.

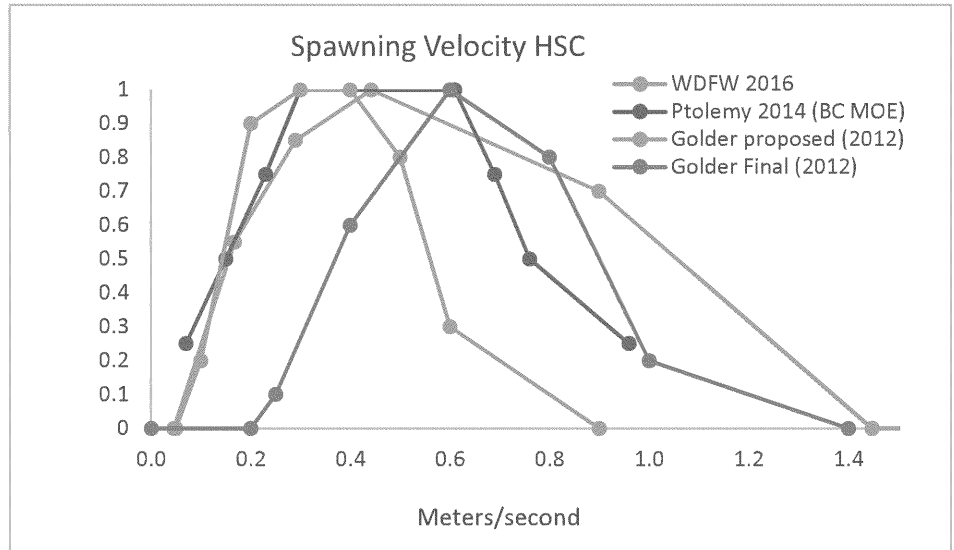
Ptolemy, R. 2014. WUP HSI curves for Westslope Cutthroat Trout fry and parr life stages. BC Ministry of Environment.

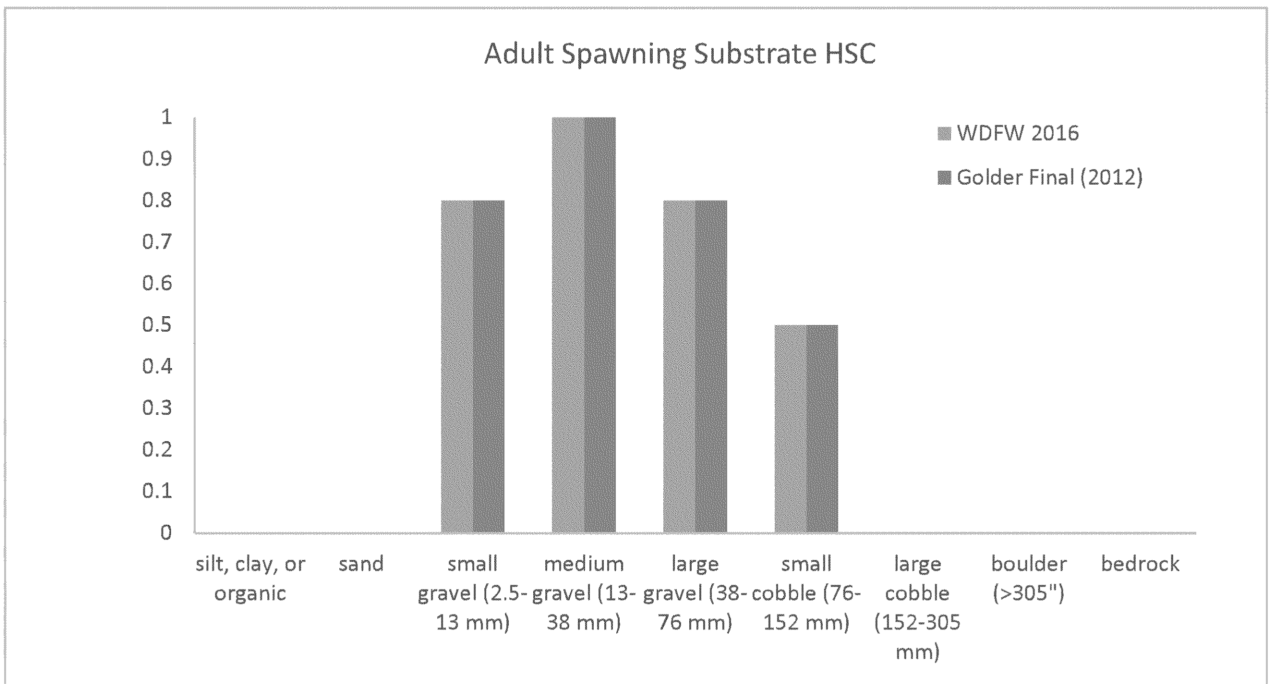
Ptolemy, R. 2001. HSI curves for benthic invertebrates. BC Ministry of Environment.

WDFW. 2004. Instream Flow Study Guidelines: Technical and habitat suitability issues including fish preference curves. Included updated versions 2008, 2013, 2016.

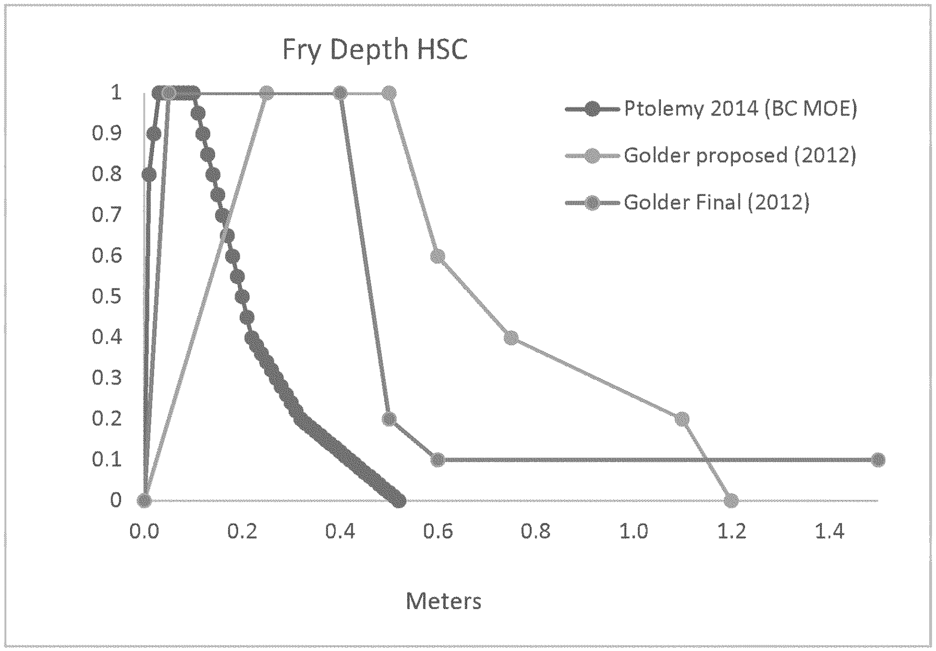
WSCT Spawning Habitat Suitability Criteria Curves

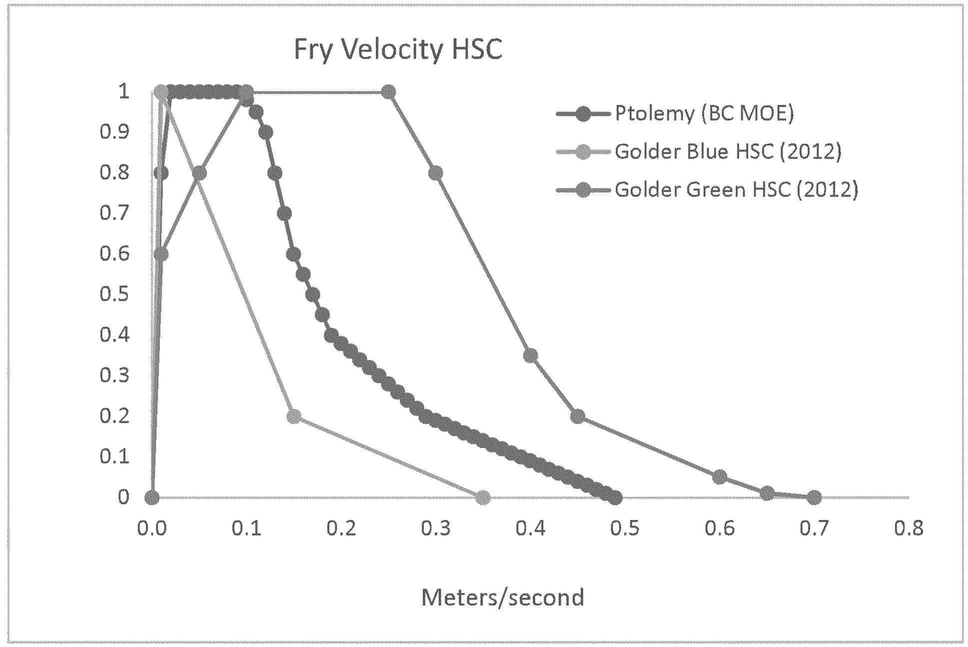


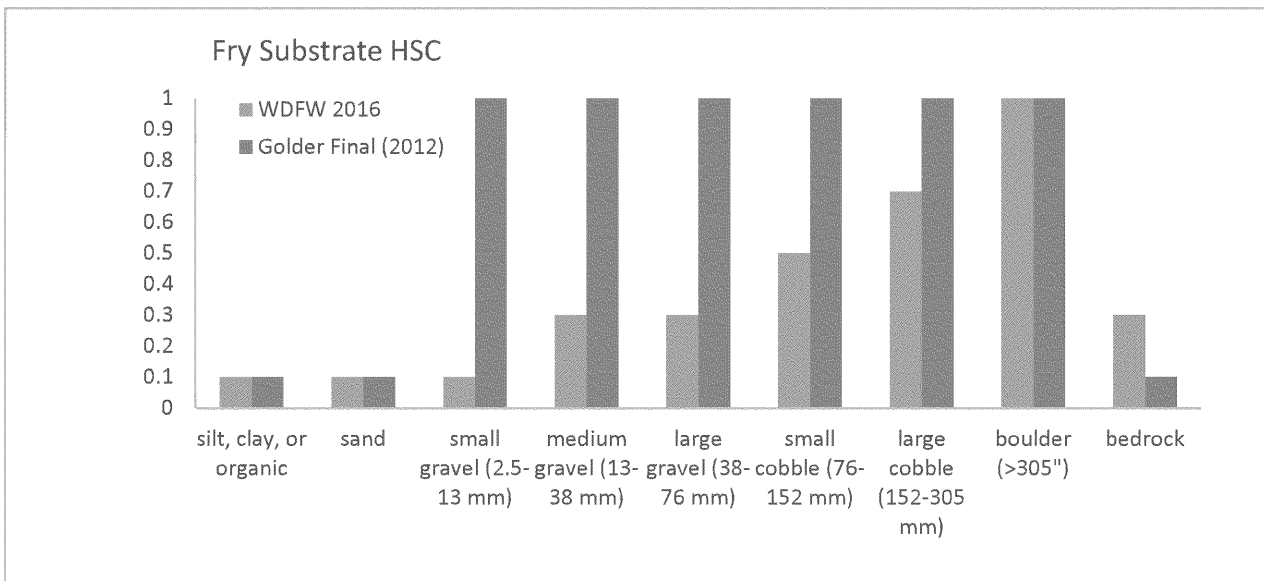




WSCT Fry (Rearing) Habitat Suitability Criteria Curves







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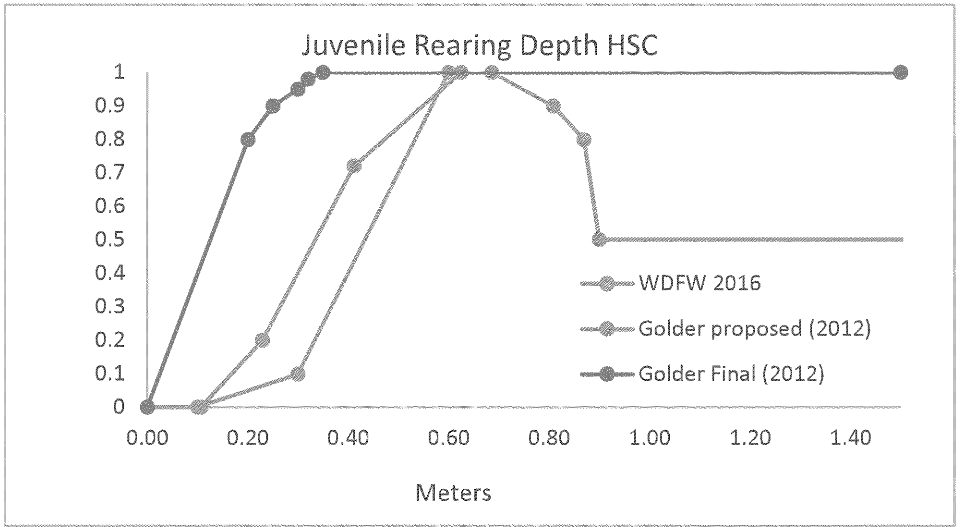
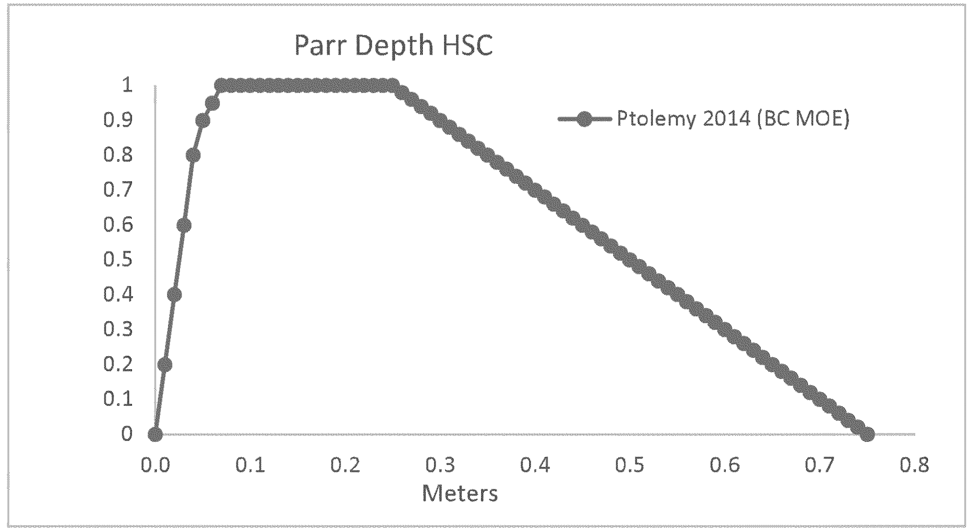
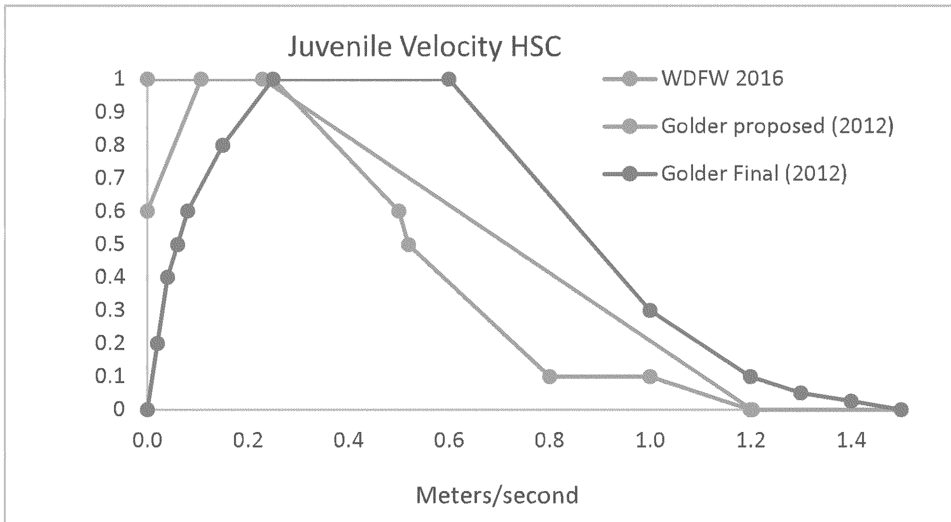
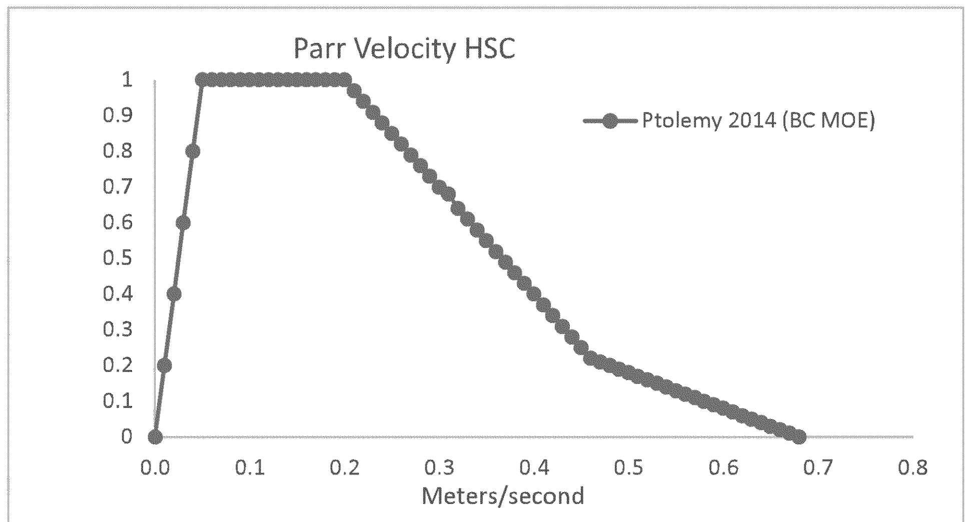
WSCT Juvenile (Rearing) Habitat Suitability Criteria Curves

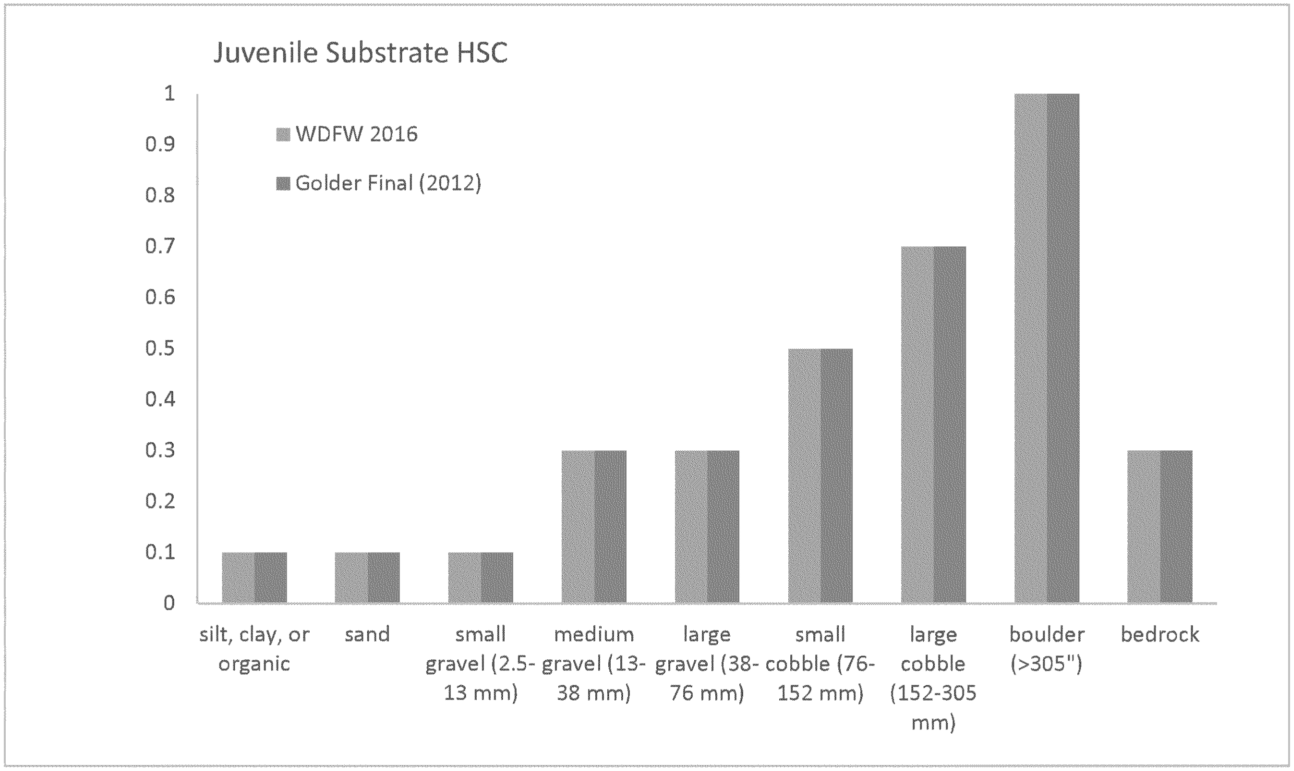




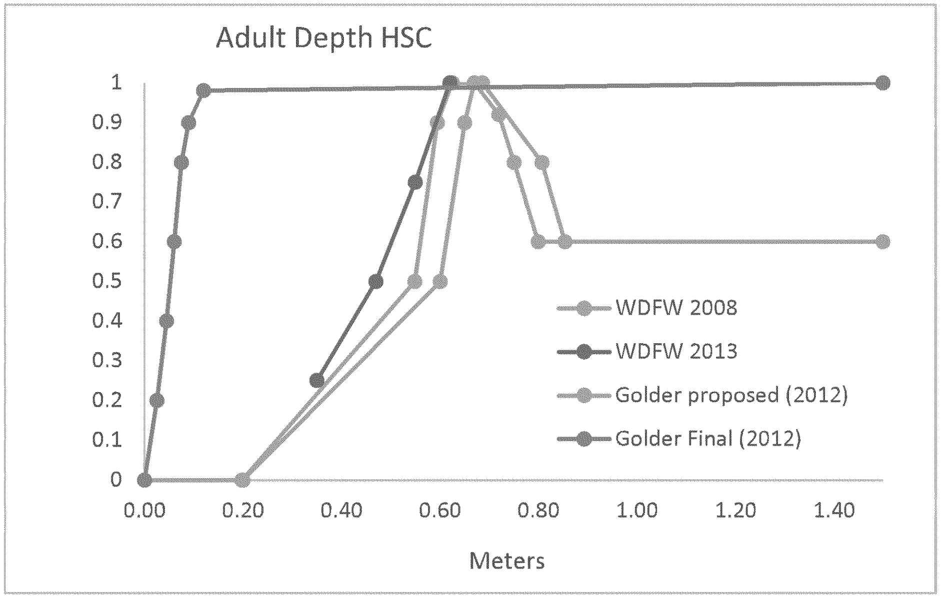


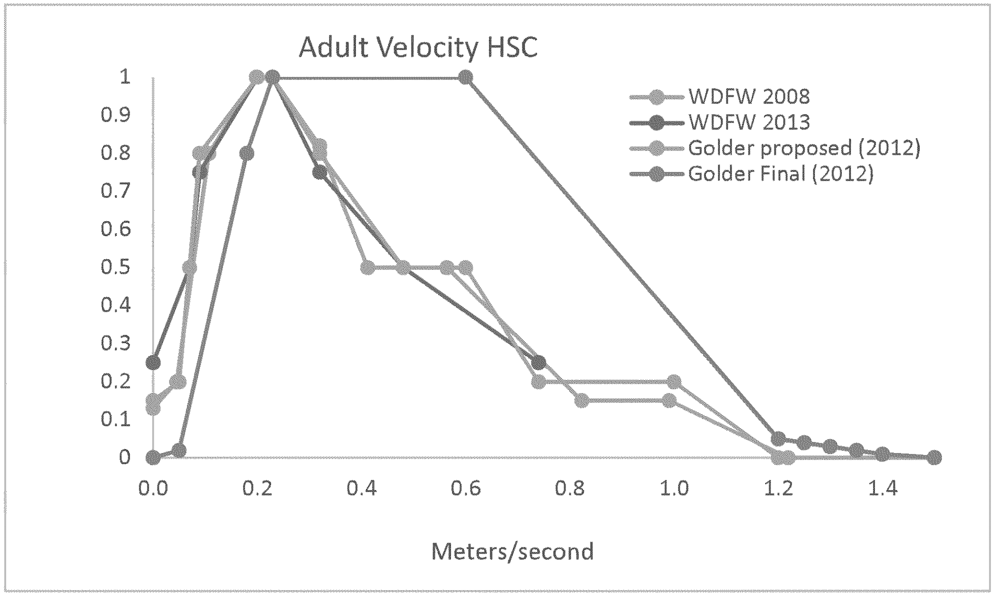


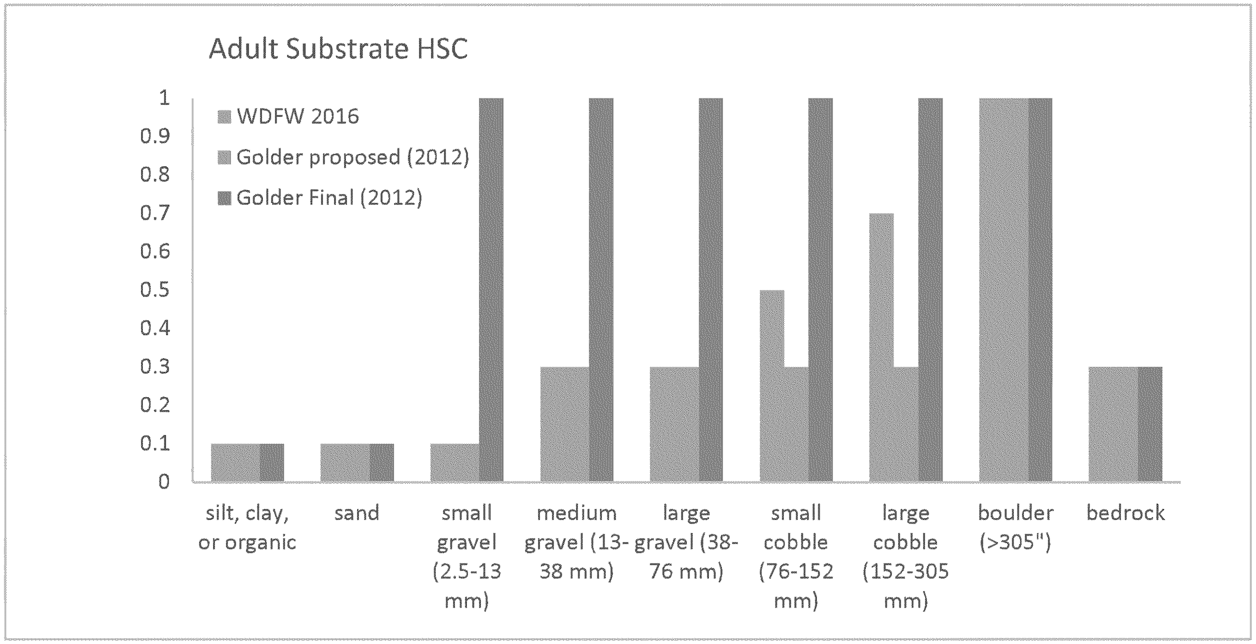
WSCT Juvenile (substrate) Habitat Suitability Criteria Curves



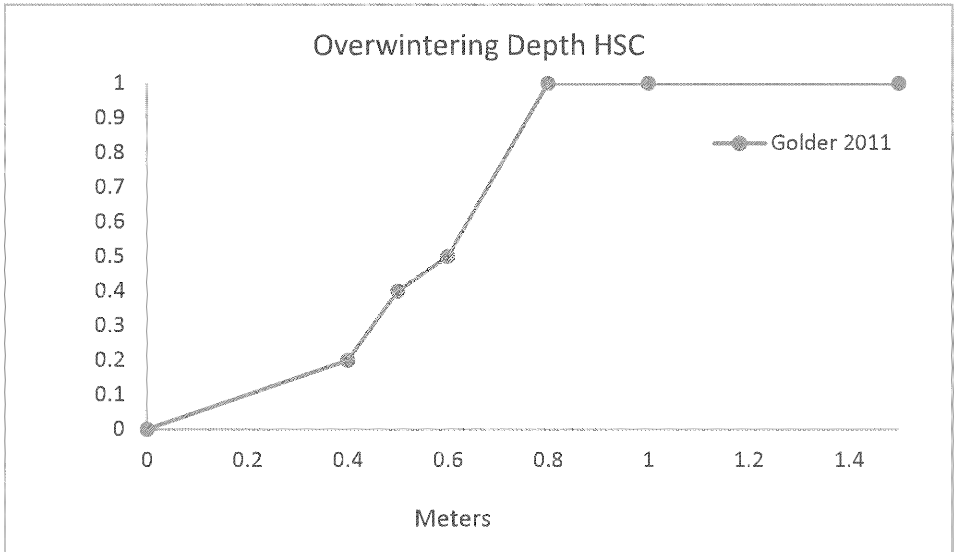
WSCT Adult (Rearing/Holding) Habitat Suitability Criteria Curves

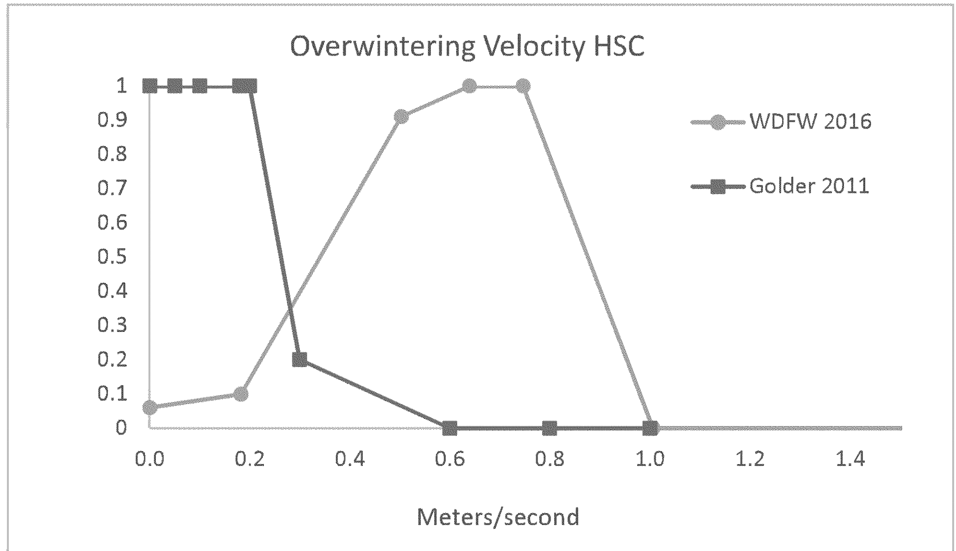


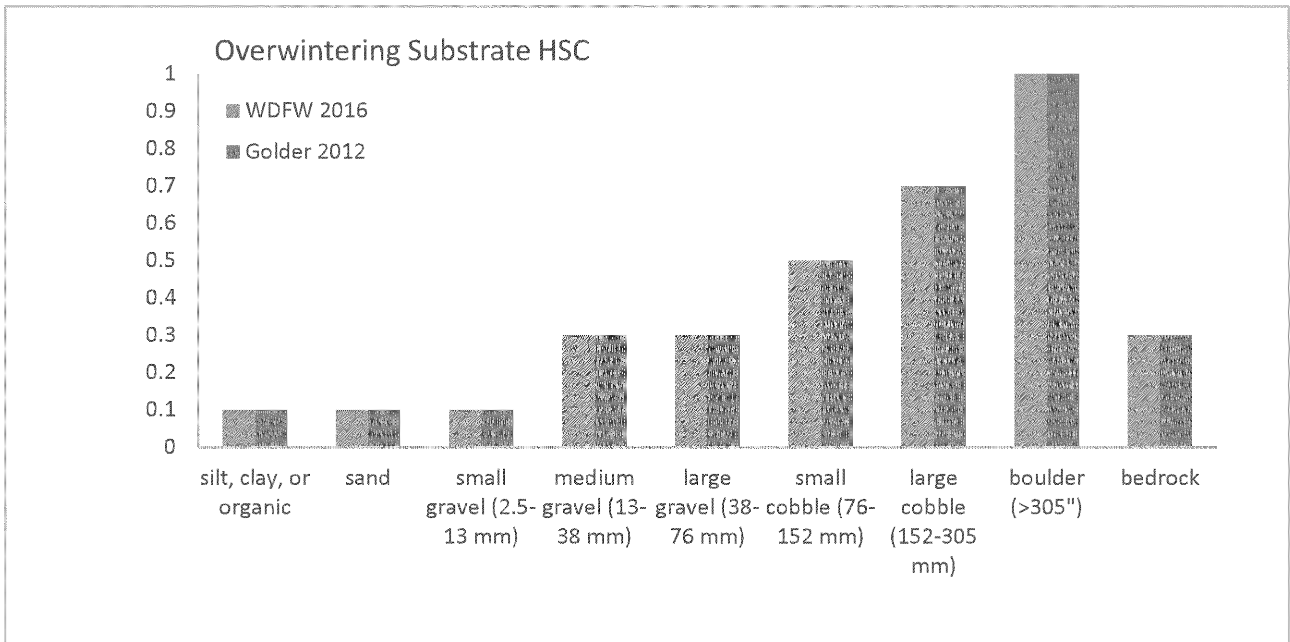




WSCT Overwintering Habitat Suitability Criteria Curves







Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30
		Action Date:	2016/12/08	Action ID No.:	61

RE: Grassy Fish HSC Discussion

Hello Mike and Ernie

As requested, please find attached a memo providing rationale for the applied HSC curves used in the IFN study.

Regards

[redacted]

Suite 325, 1925 - 18th Avenue NE
Calgary, AB T2E 7T8
[redacted] (D) [redacted] (C)
[redacted]@mems.ca <mailto[redacted]@mems.ca> www.mems.ca <http://www.mems.ca/>

-----Original Appointment-----
From: [redacted]
Sent: Friday, November 25, 2016 12:50 PM
To: [redacted] Mike Hunka; Shpeley, Jason: DFO; Watson, Ernest; 'Utting,Tracy [CEAA]'; Rushang Joshi; [redacted] Africa Geremew; [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>
Subject: Grassy Fish HSC Discussion
When: Thursday, December 01, 2016 2:00 PM-3:00 PM (UTC-07:00) Mountain Time (US & Canada).
Where: Conferencecall#3

Hello all

Please find attached an agenda for the requested meeting. The agenda provides some additional context for the intent of the meeting.

Also attached is some supporting information on available HSC curves for WSCT (see attachments below).

In short, we're proposing to use the most robust and reviewed HSC curves; however, would like to take the opportunity to inform both the AER and DFO of the approach.

Regards

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date: 2016/12/08 Action ID No.: 61

[redacted]

<< File: Benga_HSI Data.pdf >> << File: HSC Agenda.pdf >>

Conference Call Number 3

Edmonton 780 421 1483

Calgary 403 232 0994

Canada/USA 1 877 385 4099
Moderator Access code: [redacted]
Participant Access code: [redacted]

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Fisheries and Oceans
Canada

PROTECTED when completed

Application for a *Species at Risk Act* Permit

1. Applicant Information

Applicant(s) Name	Hatfield Consultants
Contact Name (if applicable)	[redacted]

Address:

Street	200-850 Harbourside Drive		
City	North Vancouver		
Province / State	British Columbia		
Country	Canada	Postal Code / Zip	V7P 0A3

Phone	[redacted]	Fax	[redacted]	Cellular	

Email	[redacted]@hatfieldgroup.com
Date of Application	August 14, 2017

2. Qualifications of the applicant(s)

[redacted]
Please see attached his detailed curriculum vitae for further professional details.

☒ See attached curriculum vitae

3. Preferred Language of Correspondence

[redacted]

4. Has the applicant received a SARA permit before?

[redacted]

If yes, please provide the permit number(s): [redacted]

5. Activity name

Westslope cutthroat trout population baseline monitoring

6. Listed Species affected

List species at risk that may be affected by the proposed activities (common and scientific names).

Westslope cutthroat trout, Oncorhynchus clarkii lewisi

7. Purpose of the proposed activity(ies)

Select the option that most closely describes the purpose of your activity

- (●) Scientific research relating to the conservation of the species
- ( ) Activity beneficial to the species or required to enhance its chance of survival in the wild
- ( ) Affecting the species is incidental to the carrying out of the activity

Indicate and explain if different purposes apply to different species at risk

☐ See attached document(s), page(s):

8. Description of proposed activity(ies)

Provide a description of the activity(ies), and if applicable, a description of the project of which the activity is a part. Include an explanation of why each activity fits the category identified in the previous question

The primary objective of the proposed survey is to further assess the population status (e.g., presence/absence, distribution, relative abundance, habitat use etc.) and pertinent life history strategies of westslope cutthroat trout (WSCT) in both Blairmore Creek and Gold Creek watersheds by repeating the electrofishing transects completed during the 2016 surveys under 16-PCAA-00026 and provincial FRL 16-2611. The stock of WSCT in Gold Creek watershed has provincially been identified as a 'core population' (≥ 0.99 genetically pure) under Alberta's Westslope Cutthroat Recovery Plan (2012-2017) and is currently under a federal Habitat Protection Order while Blairmore Creek watershed is designated a provincial 'conservation population' with the exception of one tributary, which has been designated as 'core'.

The proposed activities form a key component for executing the 2017 baseline fisheries and aquatics program in support of the Grassy Mountain Coal Project (Riversdale Resources) Environmental Assessment. Collecting additional data in 2017 will enhance our understanding of the baseline conditions in the aquatic Local Study Area (LSA), thus improve our predictions of potential Project-related effects.

The underlying rationale for this work is that the 2016 baseline surveys were completed during a year of very low creek flows (approximately 1:10 dry year). Although these presented a baseline characterization of fish and fish habitat use during low flow years and a worst-case scenario for assessing predicted flow-related effects, WSCT populations and life-history have not been characterized under more typical flow conditions. Fish surveys conducted in 2016 revealed a potential population bottleneck within Gold Creek, given no WSCT young-of-the-year (fry) were observed or captured during field surveys. Local hydrological information in the area shows that 2017 is falling more in the range of average flow conditions in the study area. The proposed work will also provide a full two years of focused baseline information for key metrics adding confidence to the effect predictions in the Environmental Assessment.

The species-specific fish data generated will produce a repository of information that feeds specific research and monitoring goals/objectives as summarized in both the Alberta Westslope Cutthroat Recovery Plan 2012-2017 (Alberta Species at Risk Recovery Plan No. 28) and the federal Recovery Strategy for the Westslope Cutthroat Trout (Oncorhynchus clarkii lewisi), Alberta Populations in Canada (DFO 2014). At minimum, these would include:

Research
- Elucidate life-history requirements and characteristics;

- Elucidate habitat requirements;
- Improve knowledge of population genetics;
- Develop population models; and
- Understand limiting factors.

Monitoring
- Population Monitoring; and
- Habitat Monitoring

☐ See attached document(s), page(s):

9. Location of the proposed activity(ies)

Provide a detailed description of the location of the activity(ies).
Indicate if the activity occurs in a land claim settlement area, on an Indian Reserve, or any other lands that are set apart for an Indian band.
If the activity will take place at sea, please indicate Fishery Management areas, and vessel , platform or aircraft information including photos, name and Commercial Fishing Vessel/Registration number, country of registration, and Foreign Vessel Clearance (if applicable).

Located near the town Blairmore, Alberta (Crowsnest Pass) activities will be carried out in Blairmore Creek and Gold Creek at the same locations surveyed in 2016 under SARA Permit 16-PCAA-00026. Sampling locations in Gold Creek will be performed in identified critical habitat for Westslope Cutthroat Trout in Alberta (SARA) from 49°36'27.797"N -114°23'34.32"W, to an upstream location on Gold Creek, 49°42'27.914"N, -114°23'49.456"W.

☒ See attached map

10. Date of proposed activity(ies)

From (day, month, year) 01/09/2017 To (day, month, year) 15/09/2017

If applicable, describe the anticipated phases and their timelines

This time period targets the most active bioperiod (rearing) and when fry emergence has completed.

☐ See attached document(s), page(s):

11. Effects of the proposed activity(ies) on the species

a) Describe any changes that the activity may cause to the **individuals of the species**, and the effect of those changes. Include the nature of the effect, and the estimated number of individuals that may be affected. Describe the potential significance of those effects on the population as a whole. If multiple activities are part of the project, please provide this information for each activity.

	Activity	Change	Effect	Significance

	Activity	Change	Effect	Significance
+ -	Fish Inventories	Backpack electrofishing can cause physiological injury to individuals due to exposure to the electrical field; Stress on fish during capture with nets and handling for measurements; Channel walking can lead to suspension of fine sediment, if present.	Injury or mortality may result from hemorrhaging or spinal injuries; stress to individuals may occur during seine net process and overall during processing when measuring individuals; temporary suspension of fine sediment from crews walking in channel may irritate gills of nearby fish. Limited number of fish will be adversely affected as inventory sampling will only target select habitats.	Injury threatening survival or in extreme cases mortality may potentially occur, potentially affecting the population. Fish sampling personnel will be highly experienced in electrofishing techniques and will use minimal frequency to attract fish in order to minimize injury risk to individuals.

☐ See attached document(s), page(s):

b) If applicable, describe any changes that the proposed activity(ies) may cause to any **residences** of the individuals of the species, and the effect of those changes. Include the nature of the effect, and the estimated number of residences that may be affected. Describe the potential significance of those effects on the population as a whole. If multiple activities are part of the project, please provide this information for each activity

	Activity	Change	Effect	Significance
+ -	The proposed activities will not commence until confirmation of fry emergence.	No changes to any residence	None	Not applicable

☐ See attached document(s), page(s):

c) Describe any anticipated changes to the **habitat** of the species at risk. Include the amount and type of habitat to be impacted, and the life processes of the species supported by that habitat. Please indicate any habitat that is identified as critical habitat in a recovery strategy or action plan for the species. Describe the potential significance of those impacts on individuals of the species at risk or the population as a whole. If multiple activities are part of the project, please provide this information for each activity

	Activity	Change	Effect	Significance
+ -	Fish Inventories	Possible displacement of substrate/bed material due to fish sampling crews walking in channel	Possible suspension and/or displacement of substrate including fines, gravel and cobble.	Extremely minor. Care will be taken by crews not to disturb banks or channel substrate by excessive movement and will travel via the surrounding riparian area rather than in channel when moving between sites, where necessary.

☐ See attached document(s), page(s):

12. Alternatives Considered

Describe, in detail, all the alternatives to the proposed activity(ies) that were considered to avoid or reduce the impact on the species, including:

- other locations that have been considered that are outside of the species' range or outside of critical habitat, and why these locations were rejected in favour of the current location. If no other locations were considered, please provide your rationale.
- all alternative activities, technical or research designs, equipment or processes that were considered in order to achieve the outcomes of the proposed activity, and why these were rejected in favour of the proposed activity, design, equipment, or process (e.g., directional drilling instead of a stream crossing using trenching)
- other timelines that were considered that would avoid periods when the species are present or sensitive to disturbance and, why these were rejected in favour of the proposed timelines

Sampling at alternative locations outside of the species' range or critical habitat will not provide baseline information specific to the area that may be affected by the proposed Project. Since it is essential that the proposed locations within WSCT critical habitat be sampled to characterize baseline conditions in the LSA, the study design promotes the use of the least invasive methodology as possible. Passive methods (i.e., snorkeling) will be used as much as possible, with electrofishing only being employed where necessary (i.e., in shallow habitat). The proposed timeline (i.e., late summer) targets the most active bioperiod (rearing) and when fry emergence has most likely completed.

Explain why the current proposal is the best solution. If multiple activities are part of the project, please describe alternatives that were considered for each activity

Feasible measures will be taken to minimize impact of activity on species or critical habitat. Our sampling methods proposed are standard and we are not proposing any lethal sampling. The plan we have proposed is not considered to put any significant stress or harm on the WSCT in these watersheds. A blended approach of snorkeling and electrofishing will be used to effectively survey the range of habitat conditions in Gold and Blairmore creeks. Snorkeling will target deep-pool habitat and electrofishing will target shallower, riffle habitat. We are highly experienced in electrofishing and rarely observe adverse effects to individuals sampled. We completed electrofishing in the same areas during 2016 with no mortalities. Our extensive experience in this area also allows us to state a more accurate estimate of the population. The Albertan population of Westslope Cutthroat Trout has become listed largely due to a significant range reduction. This means that where pure populations exist, they still may be displaying secure numbers.

☐ See attached document(s), page(s):

13. Measures to Minimize Impacts

Describe all the measures that will be implemented to minimize the impact of the activity on the species, its habitat, or the residences of its individuals, including:

- a description of specific mitigation measures used to minimize impacts to the species (e.g., fish/mussel salvage, sediment and erosion control etc.) and the extent to which the measures have been demonstrated to be effective
- specific contingency measures in the event that the mitigation measures fail
- use of appropriate personnel to conduct the activities (e.g., the applicant has qualifications from a recognized institution, has demonstrated experience with the species, and/or has demonstrated experience with the proposed methodology)

If multiple activities are part of the project, please describe measures that will be implemented to minimize the impact of the activity on the species for each activity.

To minimize effects only qualified fish personnel with extensive experience in sampling methodologies and handling techniques will conduct the activities described. Certified and experienced electrofishing technicians will operate backpack electrofishing devices so that the lowest effective frequency required, and shocking strategy (recognizing pulses and effort/speed) will be used to minimize injury. Fisheries personnel will have extensive knowledge and experience in fish collection methods and the handling of fish in order to minimize stress and injury during processing. Fish will be held in clean, dark and aerated containers filled with location water. Once recovery is evident, fish will be returned to the habitat from where they were collected.

☐ See attached document(s), page(s):

14. Monitoring

Describe how you will monitor the effects of your activity on the species. This includes monitoring the effectiveness of measures to minimize impacts to the species to determine whether the implementation of the measures achieved the intended outcomes.

All fish and their conditions will be visually monitored during the sampling, processing, recovery and release stages for each of the fish population inventory surveys. Fish behaviour will be observed to ensure the adequate amount of electrical field is applied for effective shocking while minimizing injury risk. Fish condition will be checked for any signs of injury including hemorrhaging. During processing, fish will be monitored for stress by assessing swimming ability, colour, and respiration rate (i.e., gilling action) in recovery baths prior to release back to the watercourse(s).

☐ See attached document(s), page(s):

15. Describe, to your best understanding, why the proposed activity(ies) will not jeopardize the survival or recovery of the species

The proposed activities to be carried out are industry standard and acceptable monitoring practices/protocols. When performed by highly competent and qualified personnel (professional biologists), they can be successfully completed with minimal adverse effects to the stocks being assessed.

Furthermore, to better understand the current population status, distribution, and habitat use for WSCT that inhabit both the Blairmore Creek and Gold Creek watersheds, the proposed sampling programs will provide vital information that is outlined in the provincial and federal recovery strategies for the species.

☐ See attached document(s), page(s):

16. Offsetting measures

Will you be proposing offsetting measures to counterbalance residual adverse impacts that remain after implementing all reasonable alternatives to avoid impacts and all feasible measures to minimize impacts to the species?

Does your offsetting plan comply with the requirements of the DFO's Fisheries Productivity Investment Policy and additional requirements outlined in section 16 of this Application Guide?

Have you discussed your offsetting plan with DFO?

If yes to any of the above, please attach your offsetting plan to the application.

☐ See attached offsetting plan

Applicant's signature Date

The information you provide on this form is collected under the authority of the *Species at Risk Act* (SARA) for the purpose of applying for a SARA permit. The information will be used for processing the SARA permit. In addition, the information may be used by DFO's Fisheries Officers for the purpose of compliance and enforcement with SARA. Failure to provide this personal information may result in your request being denied. You have the right to the correction of, access to, and protection of, your personal information under the *Privacy Act* and to file a complaint with the Privacy Commissioner of Canada over DFO's handling of your information. Personal information collected through the processing of your application is described in SARA Permits Personal Information Bank DFO PPU 770 and can be accessed and assessed for accuracy. For more information, visit Info Source at www.infosource.gc.ca.

REVISION LOG

(to be filled out by authors/reviewers/word processors)

Version #	Date	Revised By	Approved By	Description
0.1	20160217	[redacted]		Applying Hatfield styles
0.2	20160219	[redacted]		Edits
0.3	20160222	[redacted]		Formatting
0.4	20160222	[redacted]		Edits
0.5	20160223	[redacted]		Formatting

For the initial draft of a CV, a senior review by a manager or partner should be conducted.
Partners/Managers: Please fill in the section below once a review has been done.

Senior Review done by:	Date
	2016mmdd

Pages 119 to / à 129

are withheld pursuant to section

sont retenues en vertu de l'article

19(1)

of the Access to Information Act

de la Loi sur l'accès à l'information

s.19(1)

Fisheries and Oceans Canada | Pêches et Océans Canada

1028 Parsons Road
Edmonton, AB
T6X 0J4

August 21, 2017

Your file *Votre référence*
N/A

Our file *Notre référence*
17-HCAA-01126

Hatfield Consultants
Attention: [redacted]
200-850 Harbourside Drive
North Vancouver, BC
V7P 0A3

Dear [redacted]

Subject: Receipt of application for a permit under the *Species at Risk Act* (SARA).

The Species at Risk Program (the Program) of Fisheries and Oceans Canada would like to acknowledge receipt of your application for a permit under the *Species at Risk Act* which was received on August 14, 2017.

Your application will be reviewed and a response informing you of the decision to issue or decline to issue a permit will be provided within 90 days of the date of this letter, in accordance with the *Permits Authorizing an Activity Affecting Listed Wildlife Species Regulations*, unless one of the following conditions apply:

- additional consultations are necessary, including Aboriginal consultations;
- a decision first needs to be made under another federal law (e.g. the *Canadian Environmental Assessment Act*) before a permit can be legally issued;
- the terms and conditions of a SARA permit that was previously issued to you have not been met;
- you request or agree that the time limit not apply; or
- the activity described in the permit application is modified before DFO provides a response to you.

You will be notified within 90 days if one of these conditions applies to your application.

If any changes are made to your application during this time, please contact us with the updated information.

.../2

If you have any questions, please contact Jason Shpeley office at <contact information removed> or by email at <email address removed> ________________________. Please refer to the file number referenced above when corresponding with DFO.

Yours sincerely,

<Original signed by>

Jason Shpeley
A/Senior Fisheries Protection Biologist
Fisheries Protection Program
Fisheries and Oceans

cc: [redacted] – Hatfield Consultants
[redacted] – Millennium EMS Solutions Ltd.

RE: 17-HCAA-01126

Hi Jason,

Thanks again for chatting yesterday. As discussed, Hatfield is postponing the proposed electrofishing programs on Gold and Blairmore creeks under SARA permit application 17-HCAA-01126.

Regards, [redacted]

____

[redacted]

Hatfield Consultants | www.hatfieldgroup.com <http://www.hatfieldgroup.com/>

Tel: 604.926.3261 | Dir: [redacted] | Cel/SMS: [redacted]

<email address removed>

From: Shpeley, Jason D [<mailto:

Sent: Friday, August 25, 2017 2:56 PM

To: [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>>

Subject: RE: 17-HCAA-01126 SARA permit application - westslope cutthroat trout

Thanks [redacted]

On the topic of snorkel surveys: is the snorkeling survey for the purpose of observing the presence of fish and fish habitat and not for retention of any specimens for data collection? Just to be clear, any sampling of westslope cutthroat trout conducted for research that could involve measuring or other data capture must be conducted under a species at risk permit.

Jason

From: [redacted] [<mailto [redacted]@hatfieldgroup.com>]

Sent: 2017-August-25 3:19 PM

To: Shpeley, Jason D

Cc: [redacted]; [redacted]

Subject: RE: 17-HCAA-01126 SARA permit application - westslope cutthroat trout

Hi Jason,

s.19(1)

AEP and U of L recent sampling data has not been provided and is not yet publicly posted to the AEP's online database. I am hopeful to connect with AEP early next week to see if they can make their data available. Also, I have reached out to U of L, but I have yet to receive any response. Any and all data is potentially useful, although both datasets most likely do not align with the EA objectives and study design thus would not allow for appropriate data comparison across years.

Having said that, we are currently finishing our snorkel surveys on both Gold and Blairmore creeks, which do align with last summer's field program. I will follow up with you on Monday once I have received and had opportunity to evaluate the data.

Regards, [redacted]

____

[redacted]

Hatfield Consultants | www.hatfieldgroup.com <http://www.hatfieldgroup.com/>

Tel: 604.926.3261 | Dir: [redacted] | Cel/SMS: [redacted]

From: Shpeley, Jason D <<email address removed> <mailto:<email address removed>

Sent: August 25, 2017 9:29 AM

To: [redacted]

Subject: RE: 17-HCAA-01126 SARA permit application - westslope cutthroat trout

Good morning [redacted]

DFO needs additional justification regarding 2017 sampling in the Blairmore and Gold creeks watersheds.

Here is the context:

· When considering issuing a permit or not, DFO needs to consider, when possible, that fieldwork be coordinated with other researchers working on similar species/locations to minimize the potential impact on all species at risk.

· Section 73(2)(b) of the Species at Risk Act - a permit is issued only if the competent Minister is of the opinion that the activity benefits the species or is required to enhance its chance of survival in the wild; and,

· 73(3)(a) all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted.

o In this case, a reasonable alternative may be using data that already exists to validate predictions.

Based on the information that I have been able to gather, it is my understanding that there is a graduate student conducting sampling in these areas and, the Province of Alberta has also conducted sampling. I am unclear on the accessibility of the students data. Provincial data should be accessible. I am also unclear on whether or not these data sets would contribute to satisfying the questions that Hatfield is posing in support of Benga's environmental assessment.

These watercourses have been sampled several times in the recent past and there is always the risk of mortality associated with sampling. Considering the westslope cutthroat trout is designated threatened, unnecessary mortality associated with sampling and handling should be avoided.

Please advise. Regards-Jason

From: Shpeley, Jason D

Sent: 2017-August-23 2:06 PM

To: [redacted]

Subject: RE: 17-HCAA-01126 SARA permit application - westslope cutthroat trout

Thanks [redacted]

I've spoken with [redacted] about this application. Jason

From: [redacted] [<mailto:[redacted]@hatfieldgroup.com>]

Sent: 2017-August-23 11:37 AM

To: Shpeley, Jason D

Subject: RE: 17-HCAA-01126 SARA permit application - westslope cutthroat trout

Good morning Jason,

We haven't been issued our 2017 FRL yet, but [redacted] is currently working with our application. I can pass on his contact information if you'd like to contact him directly about any of your questions.

This is the 2016 FRL we were issued last year from AEP. It includes guidance on our sampling protocol. Similar to the SARA application, the 2017 FRL application we submitted this year was the same as 2016 but excluded mark-recapture and tissue sampling. There were some informal instructions regarding labelling genetic samples that came after we had completed our 2016 program, which I expect will be included in the 2017 FRL.

Happy to provide more information if needed, just let me know.

Cheers,

[redacted]

[redacted]

Hatfield Consultants | www.hatfieldgroup.com <http://www.hatfieldgroup.com/>

From: Shpeley, Jason D [<mailto:<email address removed> >]

Sent: August-23-17 8:41 AM

To: [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>>

Subject: RE: 17-HCAA-01126 SARA permit application - westslope cutthroat trout

Morning [redacted]

I recall Hatfield receiving some provincial guidance associated with sampling protocol, but I don't remember if it was a part of the 2017 program or 2016. Is there an email/guidance from Alberta Environment and Parks (AEP) associated with the 2017 sampling and fish research licence (FRL) application? If you could advise or make that available, I'd like to have it as a part of the file. If the 2017 FRL number is available it would be nice to have for our records. This will serve to identify AEP's position with respect to the sampling of a species at risk and assist DFO in understanding provincial concerns.

Thanks-Jason.

From: Shpeley, Jason D

Sent: 2017-August-21 3:48 PM

To: [redacted]

Subject: RE: SARA permit application - westslope cutthroat trout

Great. Thanks [redacted]

From: [redacted] [<mailto [redacted]@hatfieldgroup.com>]

Sent: 2017-August-21 3:15 PM

To: Shpeley, Jason D

Cc: [redacted]

Subject: RE: SARA permit application - westslope cutthroat trout

Hi Jason,

Our proposed activities are slightly different this year, as we are not planning on doing the mark-recapture program we did in 2016. Under the heading "Description of the Activity" on page 2 of the attachment, activity #1 does not apply to this year (it can be deleted). In addition, for activity #2 we are following AESRD sampling protocol for the recruitment and juvenile population assessment. The following is a revised description for you:

2. Recruitment and juvenile population assessment: At 10 locations on Gold and Blairmore Creek, three (3) sites of approximately 300 m linear metres each will be individually sampled for fish densities using a backpack electrofisher for a single pass. The fork length and weight of each fish captured will be recorded. All fish will be released within the mesohabitat unit in which they were captured.

And that's all the changes I see.

Cheers,

[redacted]

[redacted] MSc, RPBio | Environmental Specialist

Hatfield Consultants | www.hatfieldgroup.com <http://www.hatfieldgroup.com/>

200-850 Harbourside Drive, North Vancouver, BC V7P 0A3, Canada

Tel: [redacted] | Fax: 604.926.5389

From: Shpeley, Jason D [<mailto: <email address removed> >]

Sent: Monday, August 21, 2017 1:35 PM

To: [redacted]

Cc: [redacted]

Subject: RE: SARA permit application - westslope cutthroat trout

Hi [redacted]

Is there anything in the 2016 species at risk permit that needs to be changed for the 2017 permit request? Based on what I can tell, the works are the same at the same time of year.

Please advise-thanks.

Jason Shpeley

Phone/Tél: (780) 495-8494

Fisheries Protection Program Website:

www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html <http://www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html>

From: [redacted] [<mailto [redacted] @hatfieldgroup.com>]

Sent: 2017-August-21 11:31 AM

To: Shpeley, Jason D

Cc: [redacted] <[redacted]@mems.ca <mailto:[redacted]@mems.ca>> ([redacted]@mems.ca <mailto:[redacted]@mems.ca>)

Subject: RE: SARA permit application - westslope cutthroat trout

Thanks for your follow-up, Jason. Please let myself or [redacted] know if there is any additional information you require.

I look forward to DFO's response.

Regards,

____

[redacted]

Hatfield Consultants | www.hatfieldgroup.com <http://www.hatfieldgroup.com/>

Tel: [redacted] | Dir: [redacted] | Cel/SMS: [redacted]

From: Shpeley, Jason D [<mailto: <email address removed> >]

Sent: Monday, August 21, 2017 10:21 AM

To: [redacted] <[redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>>

Cc: [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>>; Mike Bartlett <[redacted]@mems.ca <mailto:[redacted]@mems.ca>> ([redacted]@mems.ca <mailto:[redacted]@mems.ca>) <[redacted]@mems.ca <mailto:[redacted]@mems.ca>>

Subject: RE: SARA permit application - westslope cutthroat trout

Good morning [redacted]

Fisheries and Oceans Canada would like to acknowledge receipt of your application for a permit under the Species at Risk Act which was received on August 14, 2017.

Regards,

Jason Shpeley

Phone/Tél: <contact information removed>

Fisheries Protection Program Website:

www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html <http://www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html>

From: [redacted] [<mailto:[redacted]@hatfieldgroup.com>]

Sent: 2017-August-14 1:51 PM

To: Shpeley, Jason D

Cc: [redacted]

Subject: SARA permit application - westslope cutthroat trout

Hello Jason,

Please accept the attached species at risk permit application to conduct surveys on westslope cutthroat trout for the Grassy Mountain Coal Project. Two additional files have been provided to supplement the application [redacted]' CV and an overview map of the proposed sampling locations).

If you have any questions or require any further information please don't hesitate to contact me.

Cheers,

[redacted]

Hatfield Consultants | www.hatfieldgroup.com <http://www.hatfieldgroup.com/>

200-850 Harbourside Drive, North Vancouver, BC V7P 0A3, Canada

Tel: [redacted] | Fax: 604.926.5389

From: Shpeley, Jason D [<mailto: <email address removed>

Sent: August-11-17 9:43 AM

To: [redacted]@mems.ca <mailto:[redacted]@mems.ca>>

Cc: Patreau, Elizabeth <<email address removed> <mailto:<email address removed> >>; [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>>; [redacted] [redacted]@hatfieldgroup.com <mailto [redacted]@hatfieldgroup.com>>; <email address removed> <mailto:<email address removed> >; Utting,Tracy [CEAA] (<email address removed> <mailto:<email address removed>) <<email address removed> <mailto:<email address removed> acee.gc.ca>>

Subject: RE: 14-HCAA-00788 Grassy Mountain Fish Sampling Discussion

Hi [redacted]

Please send the species at risk permit application to me. Fisheries Protection Program will coordinate with the Species at Risk Program where necessary to process Benga's request.

Regards,

Jason Shpeley

DFO Offset Planning Additional Comments Post October 27, 2017 Meeting

Meeting Attendees: Jason Shpeley (DFO), Elizabeth Patreau (DFO), Anna Kessler (CEAA), [redacted] (Benga), [redacted] (Hatfield), [redacted] (MEMS).

Meeting Regrets: [redacted]

Jason

As discussed, the following comments were provided by DFO post meeting held on October 27, 2017. These comments were not necessarily discussed during the meeting; however, have some applicability to the process and project in general.

We can discuss these more a future offset meeting, as appropriate.

- The existing Recovery Strategy does include an unnamed tributary to Blairemore Creek as well as Gold Creek and its tributaries. The amended list of Critical Habitat is likely to include Blairmore Creek and its tributaries and Gold Creek and its tributaries. The 'Recovery Plan' is a Provincial document whereas the Federal Recovery Strategy and Action Plan are currently being updated,
- It will also be important to note and consider within any Offsetting Plan that any destruction of Critical Habitat will be considered for permitting only if the Minister is of the opinion that: a) all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted; b) all feasible measures will be taken to minimize the impact of the activity on the species or its Critical Habitat or the residences of its individuals; and, c) the activity will not jeopardize the survival or recovery of the species.
- It is strongly recommended to discuss any such options with the Provincial biologists as well and to include a record of such discussions and the outcome in the Offsetting Plan. The proposed removal of a portion of the headwater section of Blairmore and Gold Creeks may (in the case of Blairmore) result in the total removal of identified Critical Habitat, and severely negative impacts. It is not clear from the documentation provided, that alternatives have yet been considered.
- The Offsetting Plan must support the Recovery Plan and Recovery Strategy, identify residual harm to the SARA species, level of uncertainty and time lag, capability of the applicant to carry out the offsetting plan (based on experience, resources, history), how monitoring will be conducted, contingencies, and the risk to the species should the offsetting fail to meet its objectives.

- There are many near-pure and hybrid Westslope Cutthroat Trout in or near the project in the affected watercourses, and these fish should be considered as especially 'sensitive' in the review of impacts to fisheries and in offsetting considerations.
- Any proposed Scientific sampling for SARA species such as Westslope Cutthroat Trout requires a SARA permit. This includes angling.

Regards

MILLENNIUM
EMS Solutions Ltd.

DFO Offset Planning Meeting Minutes

October 27, 2017

14:00 – 15:00MT

Attendees: Jason Shpeley (DFO), Elizabeth Patreau (DFO), Anna Kessler (CEAA), [redacted] (Benga), [redacted] (Hatfield), [redacted] MEMS).

Regrets: [redacted]

1. **Introductions and Intent of Meeting**
   - Round of introductions. Clarified intention of meeting: to discuss future Offset Plan for the Grassy Mountain Coal Project (the Project), to provide DFO an opportunity to reiterate DFO's offset planning process, and where appropriate expectations for this Project.
2. **DFO Offset Plan Process and Expectations**
   - DFO clarified that the primary intent of an Offset Plan is to support or protect fisheries productivity. The current Westslope cutthroat trout Recovery Plan (provincial) and Recovery Strategy (federal) will be used to guide the future offset plan. Key outcomes of an offset plan will be to ensure the fish population is self-sustaining, and/or have a potential to contribute to another pure population within the species historical range in Alberta
   - DFO's hierarchy to prevent impacts to fish (and fish habitat) is 1) Avoidance, 2) Mitigation, 3) Offsetting (for any residual impact)
   - Once the residual impact has been defined (quantified), the final Offset Plan will need to include rationale of why it is being proposed, how it supports applicable objectives of the Recovery Plan, DFO's Fisheries Productivity Investment Policy, and a Monitoring Plan to monitor the efficacy of the offset plan. Discussions with DFO would be required to determine the appropriate offset ration (1:1 or greater than 1:1 to account for uncertainty).
   - During the EA stage, construction ready plans are not required. The plan will required to be submitted and approved by DFO (and as required an application under Section 35(1) of the Fisheries Act along with a Letter of Credit, for a 35(2) Authorization).

3. Preliminary Offset Plan presented in Project Integrated Application

- No formal discussion of the presented options
- Hatfield inquired if the same approach that will be taken on Gold Creek (based on SARA status) will be applied to Blairmore Creek. The existing Recovery Strategy does include an unnamed tributary to Blairmore Creek as well as Gold Creek and its tributaries. DFO indicated that specific SARA requirements will only be applied to where SARA listed species are present. It was also stated that the federal Recovery Strategy will have an update; however, details of timing and changes were not available at this time. It will be important to determine if there are any changes for the Gold Creek as well as the Blairmore Creek watersheds for the Project's Offset Plan.
- Five options have been presented; however, there may be other options available through future discussions with DFO (e.g., the creation of a permanent barrier on Blairmore Creek).

4. Next Steps

- Once the AER decide to issue a Notice of Application (NoA), CEAA have previously notified the Federal Review Team, that they will be requested (by the Agency) to conduct and/or finalize a Technical Review of the IA. The intent of this pre-joint panel technical review is to try and maintain a coordinated review process with the province. A decision by the AER to go to a formal hearing with the Agency has not been announced, but is anticipated to occur within Q4 2017.
- In regard to AER involvement with the offset plan, DFO clarified that the AER would need to be aware of the content of the final Offset Plan so they can determine if there are any impacts from the plan itself (i.e., an example of an end pit lake was provided, whereby the spatial footprint of the lake might be deemed a residual impact to vegetation and wildlife). For clarification in these meeting minutes, an end pit lake will not be part of this Projects Offset Plan.

5. Actions

- Meeting minutes to be issued.
- MEMS to follow up with DFO regarding a future meeting agenda.

End of Document

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date: 2017/10/27 Action ID No.: 71

Telephone meeting

Attendees: Jason Shpeley (DFO), Elizabeth Patreau (DFO), Anna Kessler (CEAA), [redacted] (Benga), [redacted] (Hatfield), [redacted] (MEMS).

Offset discussion

From: Shpeley, Jason D
Sent: Monday, October 30, 2017 9:08 AM
To: [redacted]
Subject: RE: 14-HCAA-00788 Meeting-Fisheries Offset discussion

I'm glad it was productive. I agree that there was good discussion.

From: [redacted] [mailto:[redacted]@mems.ca]
Sent: 2017–October-27 4:55 PM
To: Shpeley, Jason D
Subject: RE: 14-HCAA-00788 Meeting-Fisheries Offset discussion

Jason

Really appreciate your time today. I thought it was a good meeting, hopefully you did as well. I'll compile meeting minutes, and any subsequent discussions will focus on the recovery plan (and any pending changes) and options as appropriate. We will not table agenda items regarding timing of process or technical IRs in any future discussions, we'll keep it to Offset Planning only.

Have a good weekend.

Thanks again.
[redacted]

From: Shpeley, Jason D [mailto: <email address removed>]
Sent: Thursday, October 26, 2017 10:24 AM
To: [redacted]@mems.ca>
Subject: RE: 14-HCAA-00788 Meeting-Fisheries Offset discussion

Well put. We'll make sure that the recovery plan comes up as you've indicated; i.e., the main document influencing appropriate offset for potential project impacts.

From: [redacted] [mailto:[redacted]@mems.ca]
Sent: 2017–October-26 10:05 AM
To: Shpeley, Jason D
Subject: RE: 14-HCAA-00788 Meeting-Fisheries Offset discussion

Hi

I think an assumption that can be clarified for this Project is that the Recovery Plan is the foundation for anything related to the required monitoring and offsetting plans. Just stating that as, I agree, sometimes it's not referenced directly, but it is the main document we are working with.

[redacted]

From: Shpeley, Jason D [mailto: <email address removed>
Sent: Thursday, October 26, 2017 9:59 AM
To: [redacted] <[redacted]@mems.ca>
Subject: RE: 14-HCAA-00788 Meeting-Fisheries Offset discussion

s.19(1)

Hahaha. I did notice that.

I'm sure we'll discuss the relevance of the recovery plan. Not sure if it needs to be highlighted on the agenda or if we just integrate it into the discussion.
J

From: [redacted] [mailto:[redacted]@mems.ca]
Sent: 2017–October-25 5:47 PM
To: Shpeley, Jason D
Subject: RE: 14-HCAA-00788 Meeting-Fisheries Offset discussion

No idea why I typed meeting from 14:00 to 15:**53** MT … a very precise meeting time.

Thanks
[redacted]

From: Shpeley, Jason D [mailto:<email address removed>]
Sent: Wednesday, October 25, 2017 12:50 PM
To: [redacted]@mems.ca>
Cc: Patreau, Elizabeth <<email address removed> ; Utting,Tracy [CEAA] (<email address removed> <email address removed> ; Kessler,Anna [CEAA] (<email address removed>) <<email address removed> acee.gc.ca>
Subject: RE: 14-HCAA-00788 Meeting-Fisheries Offset discussion

Afternoon [redacted]

No comments on the agenda at this point. Please provide meeting details to Liz, Tracy, Anna and I.

Regards,

Jason Shpeley
Phone/Tél: <contact information removed>
Fisheries Protection Program Website:
www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html

Fisheries and Oceans Canada Pêches et Océans Canada Canada

From: [redacted] [mailto[redacted]@mems.ca]
Sent: 2017–October-24 3:29 PM
To: Shpeley, Jason D
Cc: Patreau, Elizabeth; Utting,Tracy [CEAA] (<email address removed>); Kessler,Anna [CEAA] (<email address removed>)
Subject: RE: 14-HCAA-00788 Meeting-Fisheries Offset discussion

Hi Jason

Thanks for providing these options. Friday, Oct 27 works best for us.

I can arrange for a teleconference with screen share capabilities between 14:00MT – 15:53MT to yourself, Elizabeth, Tracy, and Anna if that works. From our side, [redacted] (Benga), [redacted] (Hatfield – [redacted]), and myself will attend. We're thinking a call for this intial meeting, and if deemed required would could arrange for a face to face.

Our suggested Agenda for the meeting is outlined in the bullets below. Please review, comment, add/delete as necessary. Once we land on a final agenda, I'll circulate it in the meeting invite.

- Overview of DFO Offsetting Process (I.e., typical steps/procedues in the process) – presented by Jason
- Overview of Grassy Preliminary Offset Plan as provided in the August 2016 IA – presented by [redacted]
- Update on the current responses to the December 05, 2016 IRs, and March 17, 2017 IRs – presented by [redacted] and/or [redacted] [overview by [redacted] technical clarification by [redacted]
- Confirmation of next steps for DFO as it relates to the Grassy review – Jason
- Overview of objectives both Benga and DFO can work towards short (2017) and long (2018) term to develop a sound and defensible Offset Plan for the Project – All (to discuss)
- Identification of any interim actions for Benga to start on concurrent ot review (if applicable) – All (to discuss)

Regards
[redacted]

From: Shpeley, Jason D [<email address removed>]
Sent: Tuesday, October 24, 2017 9:09 AM
To: [redacted]@mems.ca>
Cc: Patreau, Elizabeth <<email address removed> >; Utting,Tracy [CEAA] <email address removed> <email address removed> >; Kessler,Anna [CEAA] (<email address removed>) <<email address removed> acee.gc.ca>
Subject: 14-HCAA-00788 Meeting-Fisheries Offset discussion

Good morning [redacted]

DFO is available for a meeting to talk about offsetting October 26, after 14:00MT and October 27, after 14:00MT. As per our chat last Friday, I'd like an agenda in advance of the meeting. CEAA may attend as well. Will this be a call, or a face-to-face?

Jason Shpeley
Phone/Tél: <contact information removed>
Fisheries Protection Program Website:
www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html
Fisheries and Oceans Canada Pêches et Océans Canada Canada

MILLENNIUM
EMS Solutions Ltd.

DFO Offset Planning Meeting Minutes

December 6, 2017

9:30 – 10:30MT

Attendees: Jason Shpeley (DFO), [redacted] (Hatfield), [redacted] (MEMS).

1. **Introductions and Intent of Meeting**
    - Second meeting to discuss future Offset Plan for the Grassy Mountain Coal Project (the Project). Review of the process flow chart developed by Hatfield to ensure offset decisions and/or development is clear for all parties involved.
2. **Current EIS Review and requests for Additional Information**
    - The CEAA Agency (the Agency) along with supporting federal departments (including DFO) are currently reviewing the EIS and preparing additional information requests (IR). An IR requesting a detailed offset plan can be anticipated.
    - Included as part of this IR (or as a separate IR) will include details of an associated or supporting Offset Plan/Fisheries Monitoring Plan.
3. **Offset Plan Discussion**
    - It was identified that the seven (7) criteria for effective monitoring presented in the EIA's Consultant Report #6, Appendix A4, Table 6.1 of the preliminary offsetting plan should be expanded upon as it would serve as a good outline for the monitoring plan required for the future detailed Offset Plan.
    - It was reiterated that the plan should be ensure it answers/clarifies the following:
        - How will the offset plan meet the WSCT Recovery Plan/Strategy;
        - How will the offset aid in the recovery of WSCT, e.g., complementary measures, multiple offset projects on mine site, maintenance of the species;
        - Provide clear rationale around how offsetting options are selected (all in context of Recovery Strategy).

- DFO does not require construction-ready drawings during the EIS review phase; however, the Plan must be detailed enough that meets DFO's Policy.
- The (offset) monitoring Plan must be very clear when identifying the objectives of the plan, and how effectiveness of the offset measure(s) will be assessed.
    - No specific dates are necessary at this stage (for when monitoring will be conducted), but should highlight when specific monitoring components will be performed (e.g., seasonal level).
    - It was mentioned that the monitoring plan should be developed to the point that it identifies milestones and why those milestones have been selected as a factor that proves/disproves the efficacy of the offset(s).
- Brook Trout suppression will be considered by DFO as a portion of the offset in the context of complementary measures, if presented. Has been applied on another Project in Alberta, which is currently under review.
- If invasive control is being considered as a portion of the offset, (ie., WSCT genetics: if the status of hybridization with rainbow trout in Blairmore Creek is understood), DFO would consider it as a part of an offsetting plan, if presented.
- Confirming barrier status (e.g., on Blairmore Creek) and making permanent (i.e., manipulating the population) will also be considered as an offsetting option, if presented.
- Upper watershed riparian habitat loss (ecosystem effect, but primarily centered around potential loss of lower productivity; food supply) should be accounted for in the offset plan (i.e., to address uncertainty in the predicted effects, given the amount of riparian habitat being lost due to mine footprint). Capture in offset quantity, and monitoring (i.e., aimed to confirm predicted effects from riparian loss), and include contingency measure (i.e., if an effect is identified, what is the proponent's response?).
- Offset plan should account for time lag, uncertainty, underlying habitat (if necessary).

4. Next Steps

- Ongoing communications between proponent and DFO can continue through the technical IR phase until the panel has been selected. Once panel is in place, any discussions become more formal (minutes posted to CEAA project website).

5. Actions

- Meeting minutes to be issued.
- MEMS to follow up with DFO regarding a future meeting agenda.

End of Document

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30
		Action Date:	2017/12/06	Action ID No.:	75

Grassy Offset Discussion

Upload meeting minutes when they are finalized.

As a follow up to our initial discussion, we'd like to touch base about the next step in determining the appropriate offset(s) for the Grassy Mountain Project.

We'll forward some supporting information prior to the meeting.

Regards

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR		
PATH File No.:	14-HCAA-00788	Habitat File No.: N/A	Receive Date: 2014/06/30

Action Date: 2018/06/14 Action ID No.: 83

DFO Offset Planning Meeting Minutes

June 14, 2018

1:30 - 3:30MT

Attendees: Jason Shpeley (DFO), Ernie Watson (DFO), Ashley Gilespy (DFO), Mike Hunka (AER), Anna Kessler (CEAA), [redacted] Benga), [redacted] (Hatfield) [redacted] (Hatfield), [redacted] (MEMS).

1. **Introductions and Intent of Meeting**
   - Meeting to present the proposed approach for the Grassy Mountain Coal Project (the Project) Offsetting Plan, to receive feedback on the presented strategy, and to clarify the regulatory path regarding the Offset and Monitoring Plan expectations for a future joint panel, and for future permitting post-panel (e.g., application for Authorization and/or Approval) .
2. **Presentation by Hatfield**
   - Purpose of presentation was to provide a progress update on the Project's Offsetting Plan, introduce the proposed offsetting strategy, and to receive feedback on the approach and its alignment with both the WSCT Recovery Plan/Strategy, and the Fisheries Productivity Investment Policy.
   - Provided summary of progress from Jan 2017 (submission of Preliminary Habitat Offsetting Plan) to June 2018.
   - Presented the selection of two offsetting opportunities:
     - Counterbalance adverse effects on habitat (degradation, fragmentation) through enhancement activities targeting aquatic and riparian habitat in Gold and Blairmore creeks;
     - Mitigate threat of invasive species by investigating the status of WSCT population isolation and its effects on species persistence; and
     - Contingency measures such as invasive species suppression and other potential habitat enhancements.
   - Presented Equivalency Metrics and next steps to establish an appropriate ratio between losses and gains.

3. **Offset Plan Discussion**
   - Discussion and agreement that overwintering habitat appears to be one of the limiting factors for both Gold and Blairmore creeks, based on Hatfield's field work to date (which is further supported by work out of the UofL). The proposed approach to increasing and enhancing low quality aquatic habitat provides a secondary benefit of improving habitat connectivity in Gold Creek.
   - A suite of criteria is being applied to identify candidate sites. Regarding design of pools: groundwater contribution was discussed and identified as an important criterion. Suggestion that groundwater monitoring near candidate sites and/or to identify candidate sites would be beneficial.
   - Equivalency metrics between losses and gains should be further developed to capture potential impact of the project and to ensure an appropriate offset ratio is defined.

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

	Action Date:	2018/06/14	Action ID No.:	83

- It was recommended by DFO that conservative estimates of losses would be a preferred approach when assessing residual losses from project activities.
- DFO-SARA emphasized that the Proponent consider/evaluate different currency options when evaluating the offset of residual riparian habitat effects (losses).
- Understanding groundwater/surface water interaction a key element for DFO with respect to defining predicted residual effects, offset efficiency, and reducing uncertainty.
- A key point raised by DFO involved a detailed offset monitoring plan to support the final offset plan. The Monitoring Plan must identify the objectives of the Offsetting Plan, and how effectiveness of the offset measure(s) will be assessed. Baseline characterization (multi-season, multi-year) is important for establishing targets for the Monitoring Plan, which are directly related to efficacy. Monitoring framework presented in the Preliminary Habitat Offsetting Plan needs to be developed in more detail for next submission.
- Another key point raised by DFO-SARA involved clearly identifying any uncertainty in the plan; how that would be assessed and managed. The Offsetting Plan must be particularly risk averse due to the presence of SAR.
- Regarding expectations for the Offsetting Plan, DFO does not require construction-ready drawings during the EIS review phase; however, the Plan must be detailed enough to meet DFO's Policy. The Offsetting Plan is considered a form of mitigation for potential residual effects to fish and fish habitat assessed in the EIS.
- The offset monitoring plan should be well developed prior to the joint panel.
- Regarding an authorization application, that would occur post joint panel hearing, and timelines associated with it include a 60-day (conformity) review, and assuming all details are in place, an authorization would be issued within 90-days after that. A separate SARA permit may be required and/or the authorization could be issued as SARA compliant.
- Indigenous consultation and engagement as part of the Offsetting Plan is recommended early in the process.

4. Next Steps

- Benga to provide more detailed offsetting and supporting monitoring plan to CEAA/DFO through a second round of technical information requests.

5. Actions

- Meeting minutes to be issued.
- DFO-SARA to inquire with AEP for opportunities to coordinate methodology/share data relevant to Gold and Blairmore creeks.
- Continued dialogue between the Proponent and DFO can occur after the panel has been struck but would require formal documentation of engagement.

End of Document

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR		
PATH File No.:	14-HCAA-00788	Habitat File No.: N/A	Receive Date: 2014/06/30

Action Date: 2018/06/29 Action ID No.: 84

RE: 14-HCAA-00788 Grassy Mountain-Potential Fisheries Offset Discussion Meeting Jun14 2018

Hi [redacted]

Here are comments from a species at risk perspective to inform your discussion with Hatfield.

- The plan must not only meet *Fisheries Act* requirements (serious harm), but also *Species at Risk Act* (SARA) legislative requirements. In step 1, they have only quantified the serious harm to fish. They must also characterize the jeopardy to the recovery of Westslope Cutthroat Trout (WSCT), and ultimately develop offsets that addresses that jeopardy. If jeopardy to the survival/recovery of species cannot be avoided, the project cannot be approved;
- Step 2 should be to identify ways to avoid harm to a SARA species (SARA requirement);
- Step 3 should be to identify all reasonable measures to mitigate (SARA requirement);
- The analysis must include a full assessment and statement of the impacts resulting from the project. This does not seem to have been included; i.e., state potential impacts, then equate those impacts to proposed offsets;
- There is no mention of potential impacts of degraded water quality (i.e. Selenium / TSS) on survival/fitness of WSCT. Unlike DFO's Fisheries Act responsibilities, our SARA responsibilities include ALL potential impacts on WSCT, including any potential impacts as a result of changes to water quality, and must be addressed;
- How does the proposed plan meet the goals of the Recovery Strategy? There is a statement that it will, but not a statement how it does.
- Riparian equivalencies must take into account the condition of the riparian habitats;
- I would suggest that Alberta Environment and Parks (AEP), and not the proponent, should be relied on for the Genetic Information / Analysis. There must be coordination on this;
- The province (AEP), with DFO participation, is currently conducting detailed Action Planning for WSCT recovery. The actions contained in the plan should be consistent with that plan. There must be coordination with AEP on any measures that are proposed for offsetting / meeting recovery objectives.

Trust this assists in guiding the development of a suitable offset plan. If you require additional discussion prior to your meeting, please give me a call.

Regards,

Jason Shpeley
A/Senior Fisheries Protection Biologist
Phone/Tél: <contact information removed>
Fisheries Protection Program Website:
www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html <http://www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html>

From: [redacted]@mems.ca>]
Sent: 2018-June-29 11:17 AM
To: Shpeley, Jason D
Subject: RE: 14-HCAA-00788 Grassy Mountain-Potential Fisheries Offset Discussion Meeting Jun14 2018

Hi

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date:	2018/06/29	Action ID No.:	84

Ok thanks, that would be great if there's any other feedback to pass on.

Regarding FN consultation on the plan: Benga have done a really good job on FN Consultation over the years, but we'll ensure this plan is specifically brought more to the forefront again.

Thanks again,

[redacted]

From: Shpeley, Jason D [<mailto: <email address removed> >]
Sent: Friday, June 29, 2018 8:54 AM
To: [redacted]@mems.ca <mailto [redacted]@mems.ca>>
Subject: RE: 14-HCAA-00788 Grassy Mountain-Potential Fisheries Offset Discussion Meeting Jun14 2018

Good morning [redacted]

In the field yesterday-I'll follow up with Ernie.

Very good discussion during our June 14, 2018 meeting. I will once again stress how important it is for the Proponent to engage potentially interested Indigenous communities including First Nation and Metis groups. Typically, communities have quite a bit of interest in offsetting and it is important to engage in discussion very early in the planning process. DFO is always open to participating in these meetings.

Regards,

Jason Shpeley
A/Senior Fisheries Protection Biologist
Phone/Tél: <contact information removed>
Fisheries Protection Program Website:
www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html <http://www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html>

From: [redacted] [<mailto: [redacted]@mems.ca>]
Sent: 2018-June-27 4:40 PM
To: Shpeley, Jason D
Subject: RE: 14-HCAA-00788 Grassy Mountain-Potential Fisheries Offset Discussion Meeting Jun14 2018

Hi Jason

Just following up on this.

I will be heading out to Vancouver next Wednesday to meet with [redacted] and his team to further refine this. Just wondering if there are any additional comments from yourself, and whether Ernie had anything else to add?

Cheers

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR		
PATH File No.:	14-HCAA-00788	Habitat File No.: N/A	Receive Date: 2014/06/30

Action Date: 2018/06/29 Action ID No.: 84

[redacted]

From: [redacted]
Sent: Tuesday, June 19, 2018 3:51 PM
To: 'Shpeley, Jason D' <email address removed>
Subject: RE: 14-HCAA-00788 Grassy Mountain-Potential Fisheries Offset Discussion Meeting Jun14 2018

Hi Jason

Draft version of the meeting minutes from our meeting last Thursday.

Please review and add anything that may have been missed.

If possible, are you able to provide any feedback from Ernie (he had a laundry list, not sure if we addressed everything).

Thanks
[redacted]

-----Original Appointment-----
From: Mike Bartlett **On Behalf Of** Shpeley, Jason D
Sent: Friday, June 08, 2018 8:58 AM
To: Gary Houston; Sarah Thomasen; Mike Bartlett; Watson, Ernest; [redacted]@hatfieldgroup.com <mailto:[redacted]@hatfieldgroup.com>; <email address removed>
Cc: Kessler,Anna [CEAA] (<email address removed>)
Subject: FW: 14-HCAA-00788 Grassy Mountain-Potential Fisheries Offset Discussion Meeting Jun14 2018
When: Thursday, June 14, 2018 1:30 PM-3:30 PM (UTC-07:00) Mountain Time (US & Canada).
Where: DFO - 1028 Parsons Road, Edmonton AB

-----Original Appointment-----
From: Shpeley, Jason D [<mailto:<email address removed>]
Sent: Friday, June 08, 2018 7:39 AM
To: Shpeley, Jason D; [redacted] Watson, Ernest; [redacted]@hatfieldgroup.com <mailto[redacted]@hatfieldgroup.com>;
<email address removed>
Cc: Kessler,Anna [CEAA] (<email address removed>
Subject: 14-HCAA-00788 Grassy Mountain-Potential Fisheries Offset Discussion Meeting Jun14 2018
When: Thursday, June 14, 2018 1:30 PM-3:30 PM (UTC-07:00) Mountain Time (US & Canada).
Where: DFO - 1028 Parsons Road, Edmonton AB

Good morning all.
[redacted] thank you for coordinating all parties for a discussion on fisheries offsetting related to Grassy Mountain Coal Mine

s.16(2)(c)
s.19(1)

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date:	2018/06/29	Action ID No.:	84

proposal.

Please forward an agenda and this meeting request to those that I have missed. Any material relevant to our discussion would be appreciated ahead of time so that all can be prepared and able to make the best use of our time.

For those of you calling in:

1 877-413-4781

Participant code: [redacted]

Moderator (DFO): [redacted]

Thanks, and we'll see you on Thursday June 14th.

Jason Shpeley

A/Senior Fisheries Protection Biologist

Phone/Tél: <contact information removed>

Fisheries Protection Program Website:

www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html <http://www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html>

From: [redacted] [<mailto:[redacted]@mems.ca>]
Sent: 2018-June-07 5:06 PM
To: Shpeley, Jason D; Watson, Ernest
Cc: Kessler,Anna [CEAA] <email address removed>
Subject: RE: 14-HCAA-00788 Grassy Mountain-Potential Fisheries Offset Discussion Meeting Jun14 2018

Hi Jason

Seems as though all are available. For travel from Calgary and Vancouver to Edmonton, can we go with a 1:30 to 3:30 time slot?

The PPT itself will be about 30 mins, just setting a buffer to get settled, and for any subsequent discussion.

Let me know if that works for you.

[redacted]

From: Shpeley, Jason D [<mailto:<email address removed>
Sent: Thursday, June 07, 2018 9:43 AM
To: [redacted]@mems.ca <mailto[redacted]@mems.ca>>; Watson, Ernest <<email address removed>
<email address removed>
Cc: Kessler,Anna [CEAA] <email address removed>
<email address removed>
Subject: 14-HCAA-00788 Grassy Mountain-Potential Fisheries Offset Discussion Meeting Jun14 2018

Hi [redacted]

Thursday June 14th works well for me for a discussion on the fisheries offset required as part of the Grassy Mountain project proposal. DFO is happy to host here in Edmonton. I left Ernie a message, so I am unclear if he is available, but hopefully we can coordinate a time.

Ideally we will be able to meet before 12:00MST or after 13:30MST here in Edmonton. We can try a WebEx, or, at minimum, distribute a presentation to those that may not be able to attend in person.

Anna: if you are available, it would be great to have a CEAA presence by phone, or in person.

Regards,

Jason Shpeley

A/Senior Fisheries Protection Biologist

Phone/Tél: <contact information removed>

Title:	Coal Mine-Grassy Mountain Coal-Gold and Blairmore Creeks-Blairmore, Alberta-SAR				
PATH File No.:	14-HCAA-00788	Habitat File No.:	N/A	Receive Date:	2014/06/30

Action Date:	2018/06/29	Action ID No.:	84

Fisheries Protection Program Website:
www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html <http://www.dfo-mpo.gc.ca/pnw-ppe/fpp-ppp/index-eng.html>

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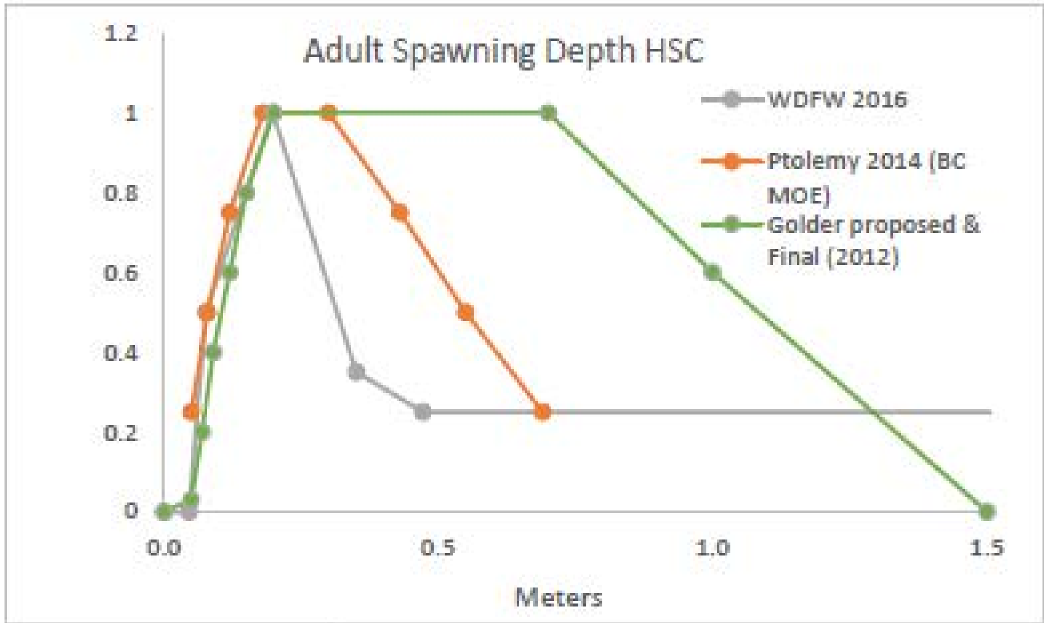
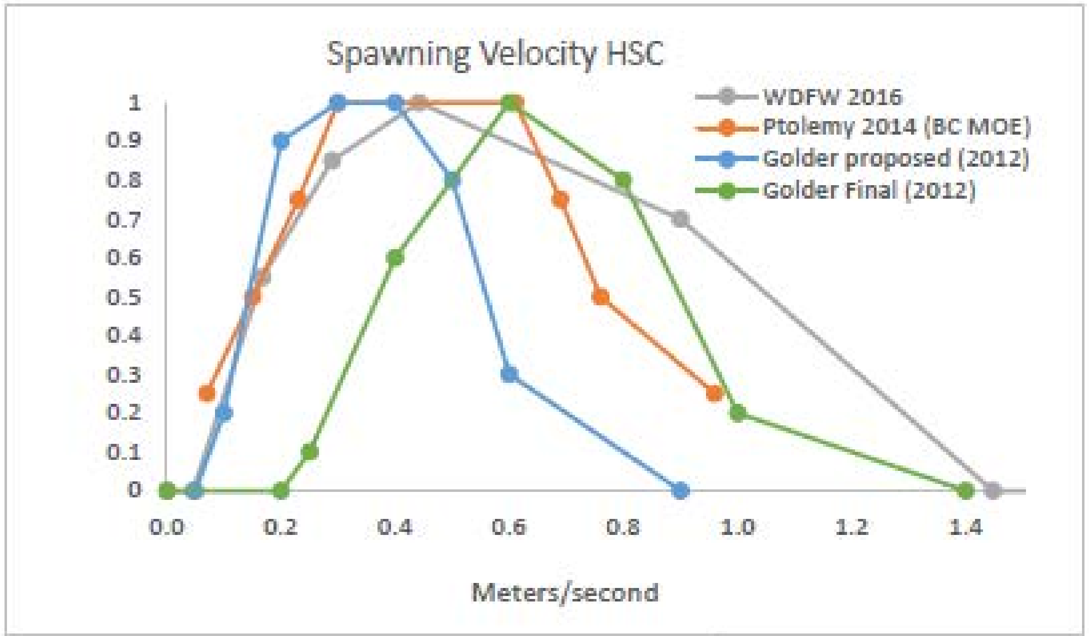
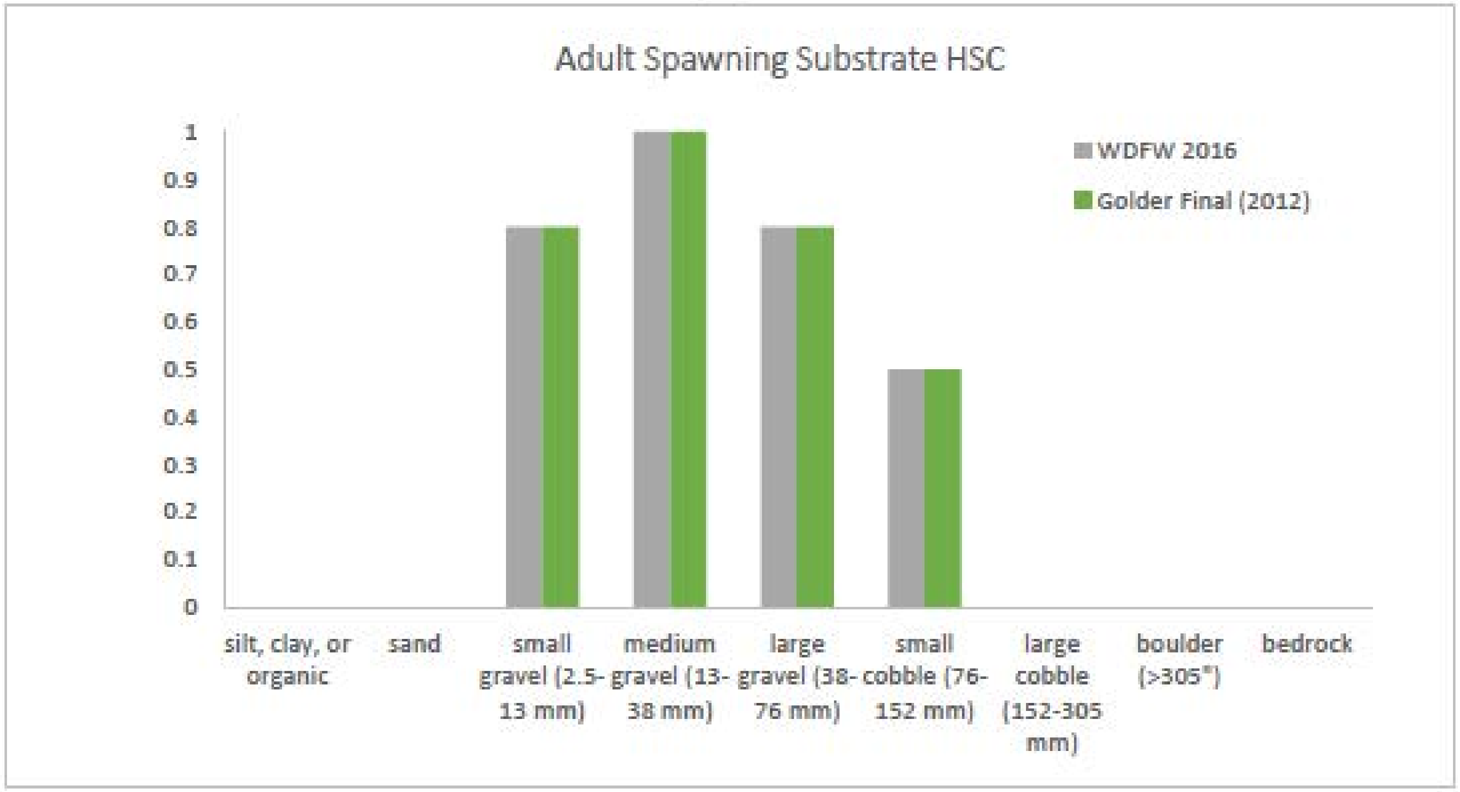
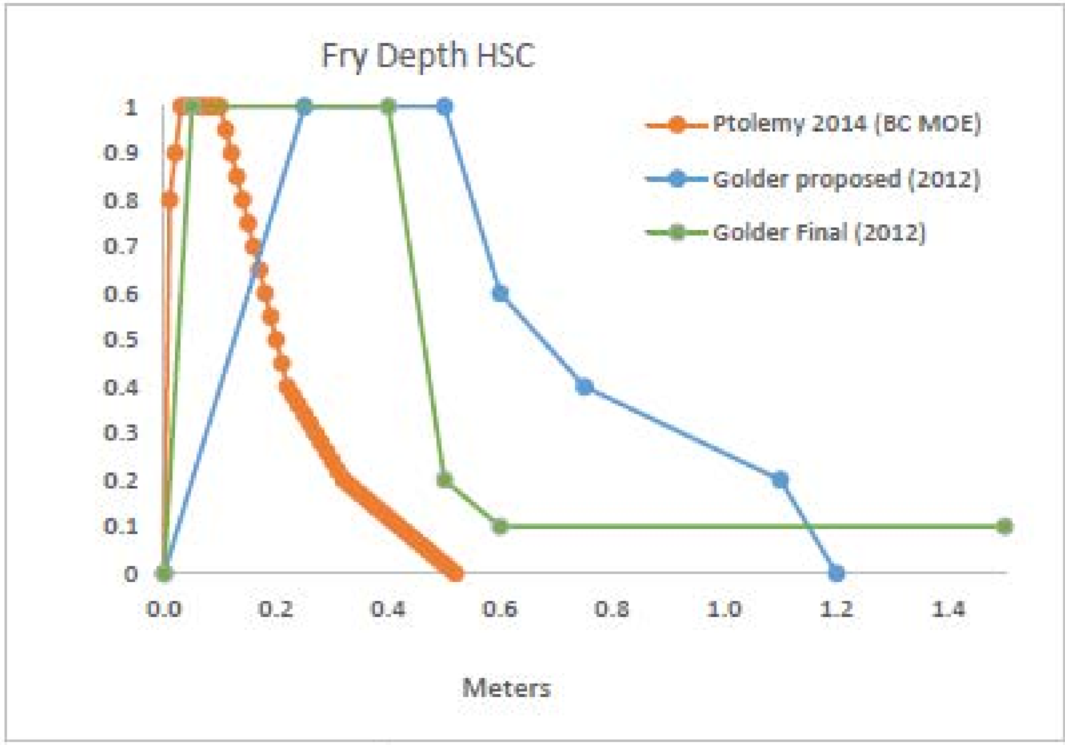
WSCT Spawning Habitat Suitability Criteria Curves

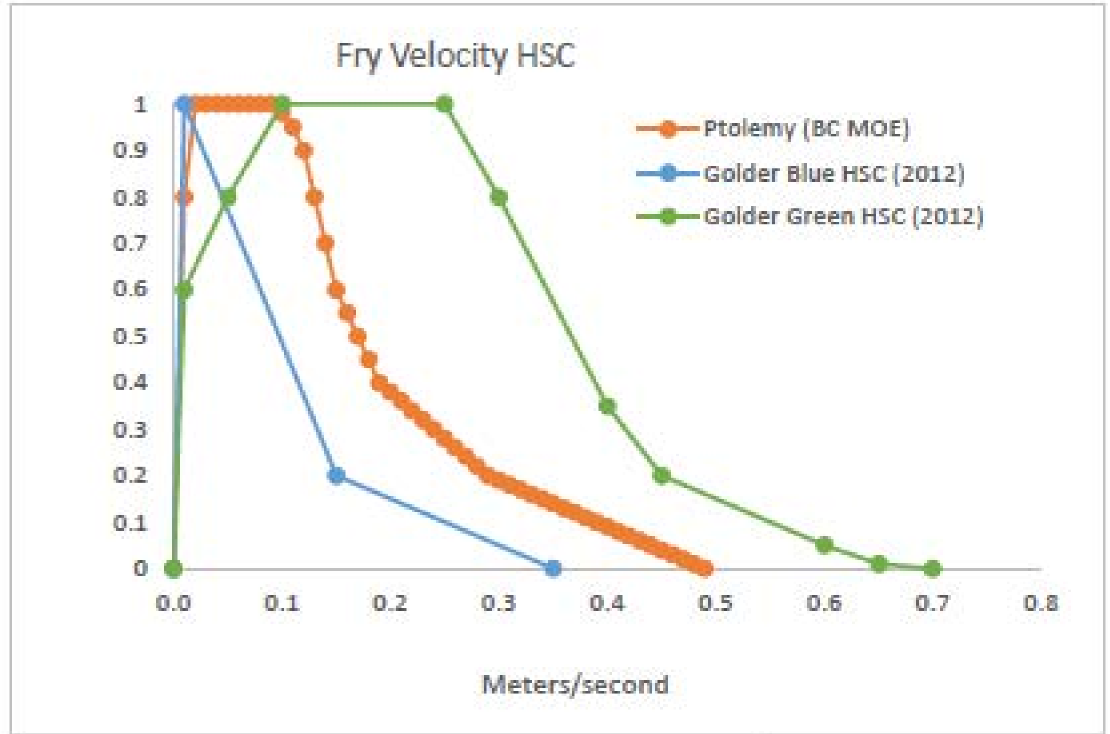


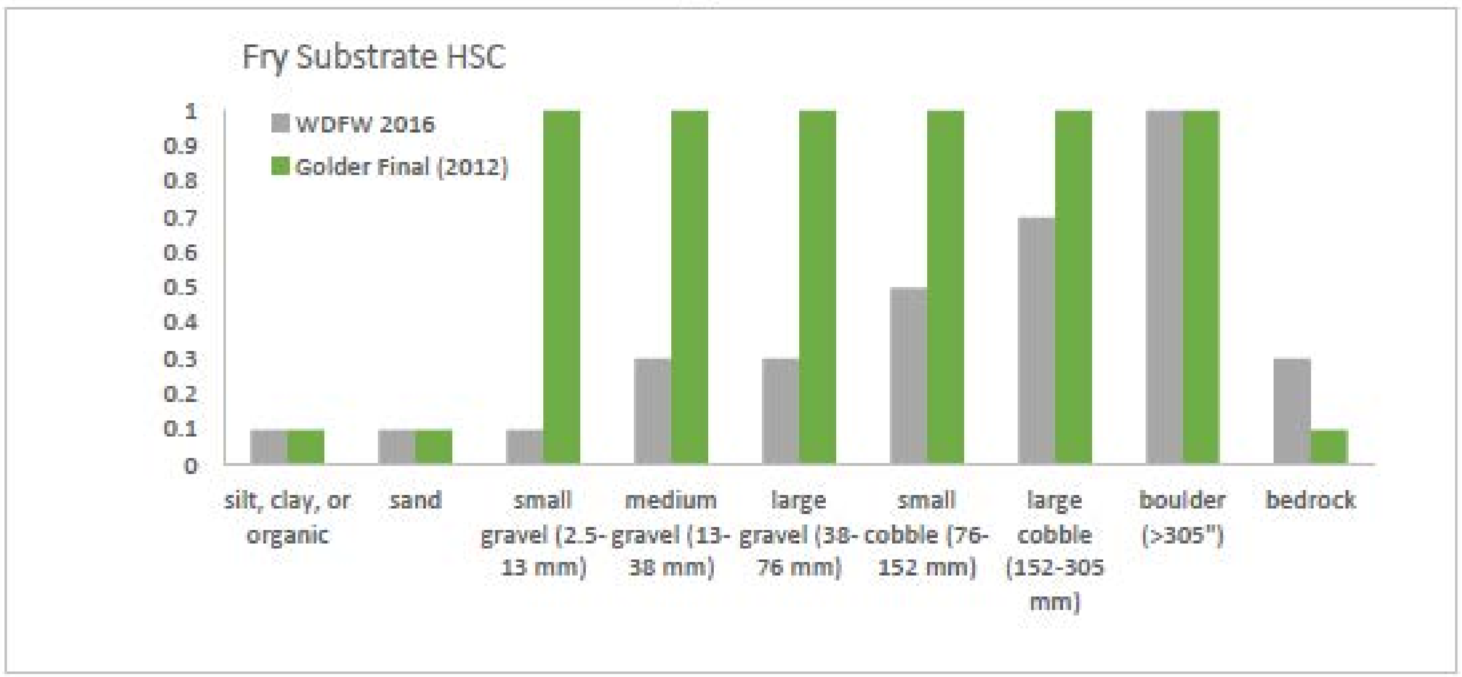




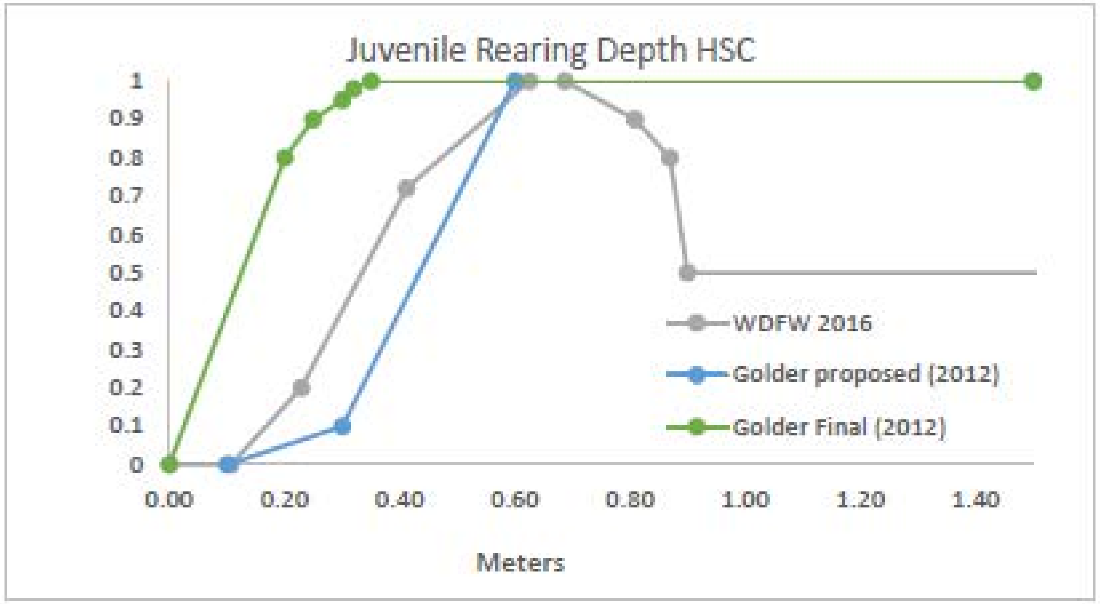
WSCT Fry (Rearing) Habitat Suitability Criteria Curves

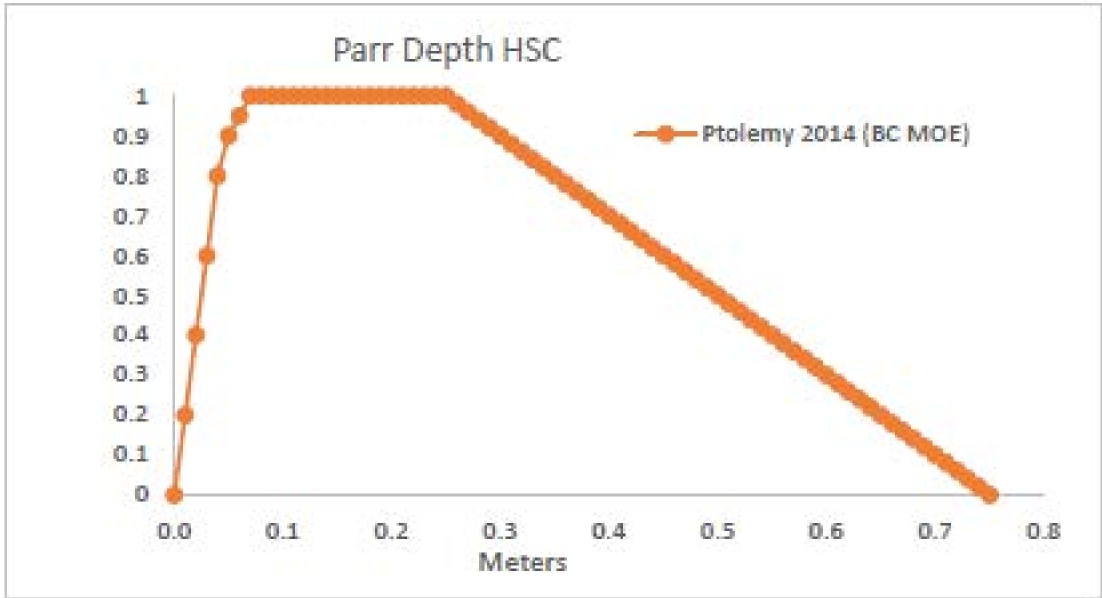


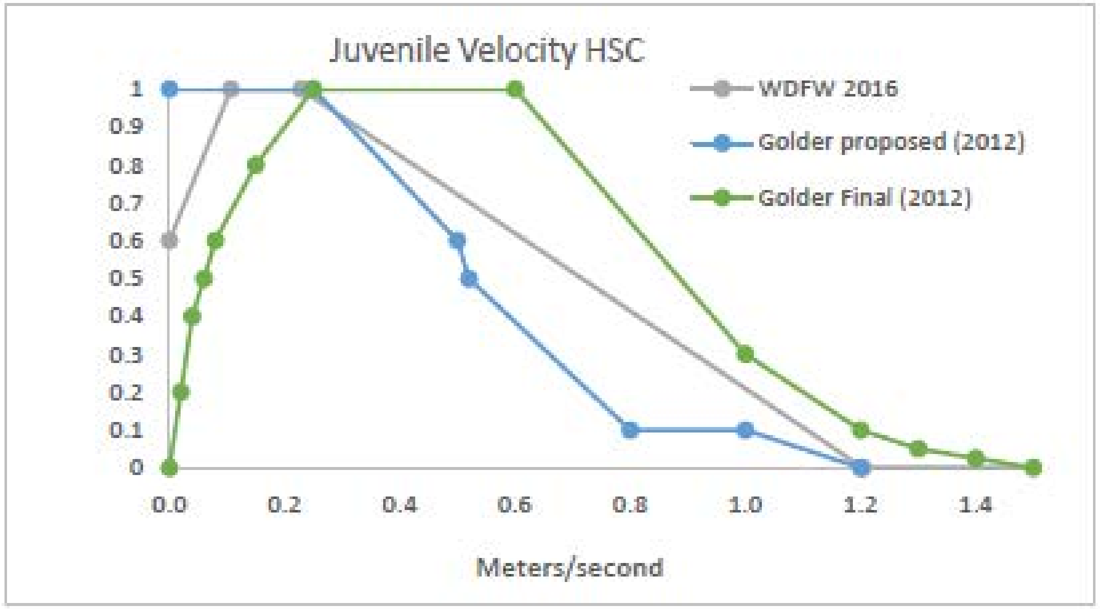


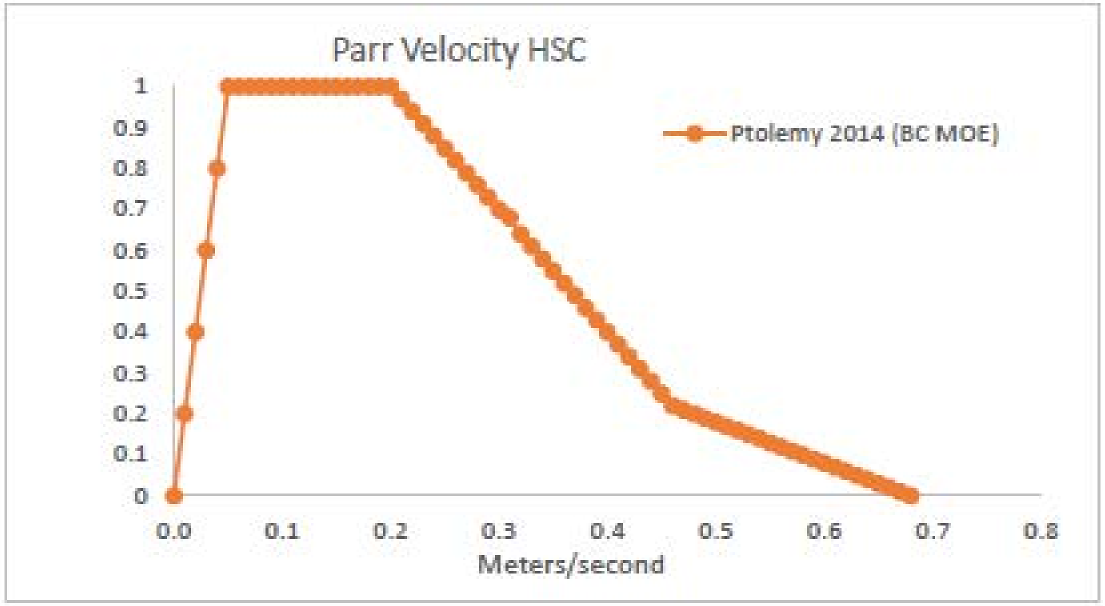


WSCT Juvenile (Rearing) Habitat Suitability Criteria Curves

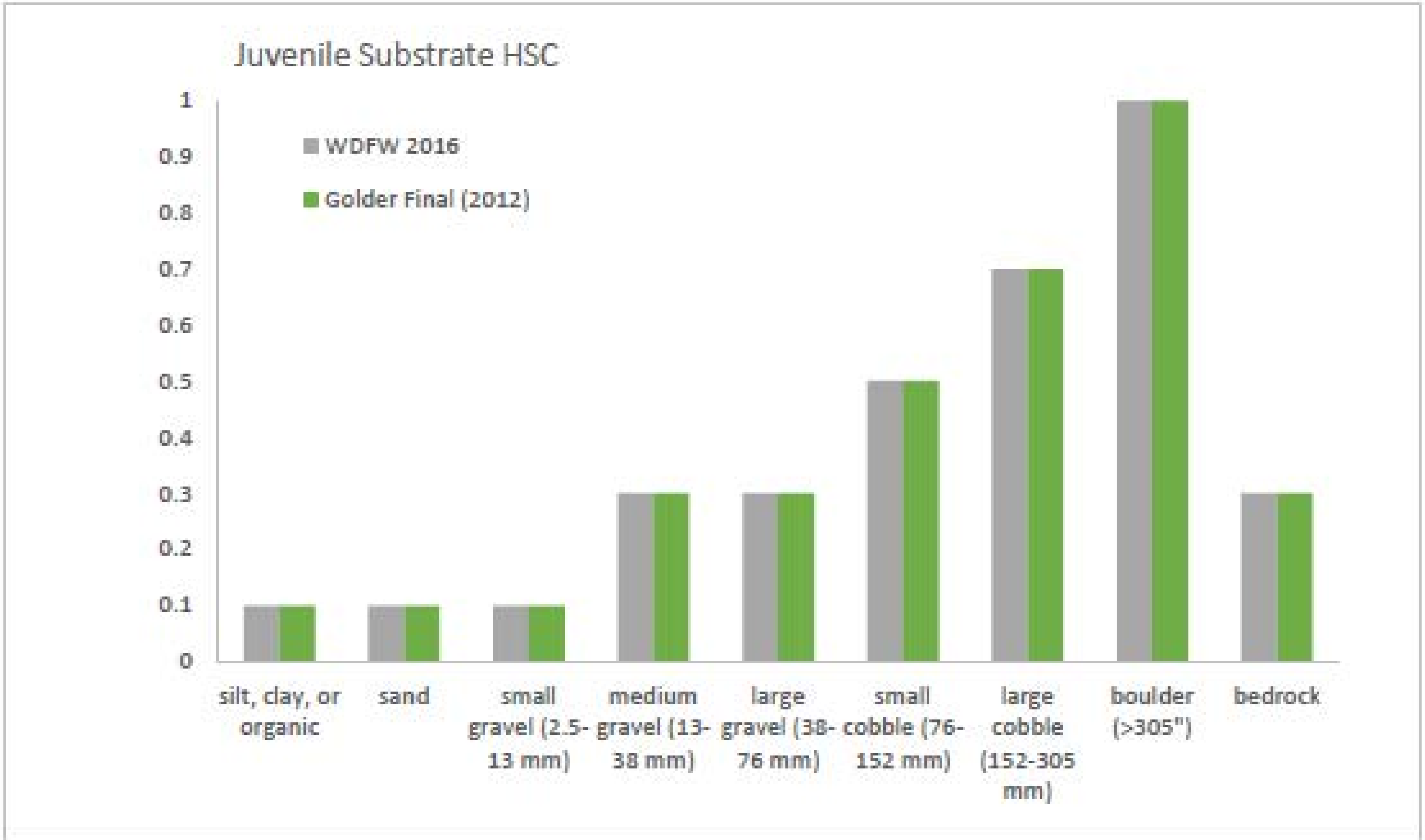




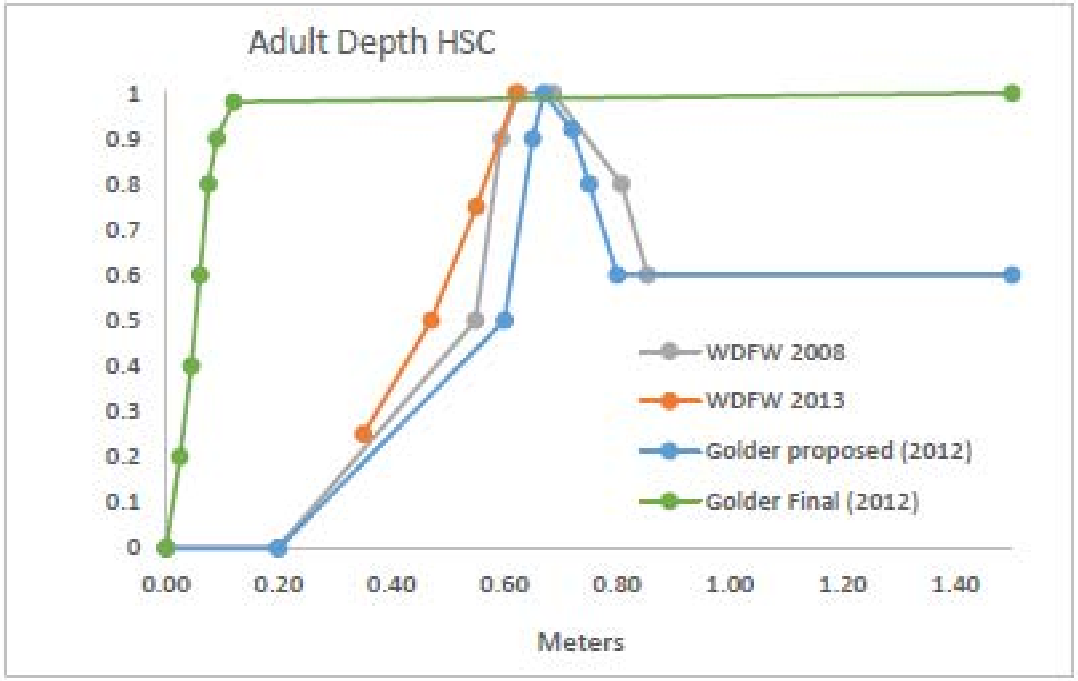


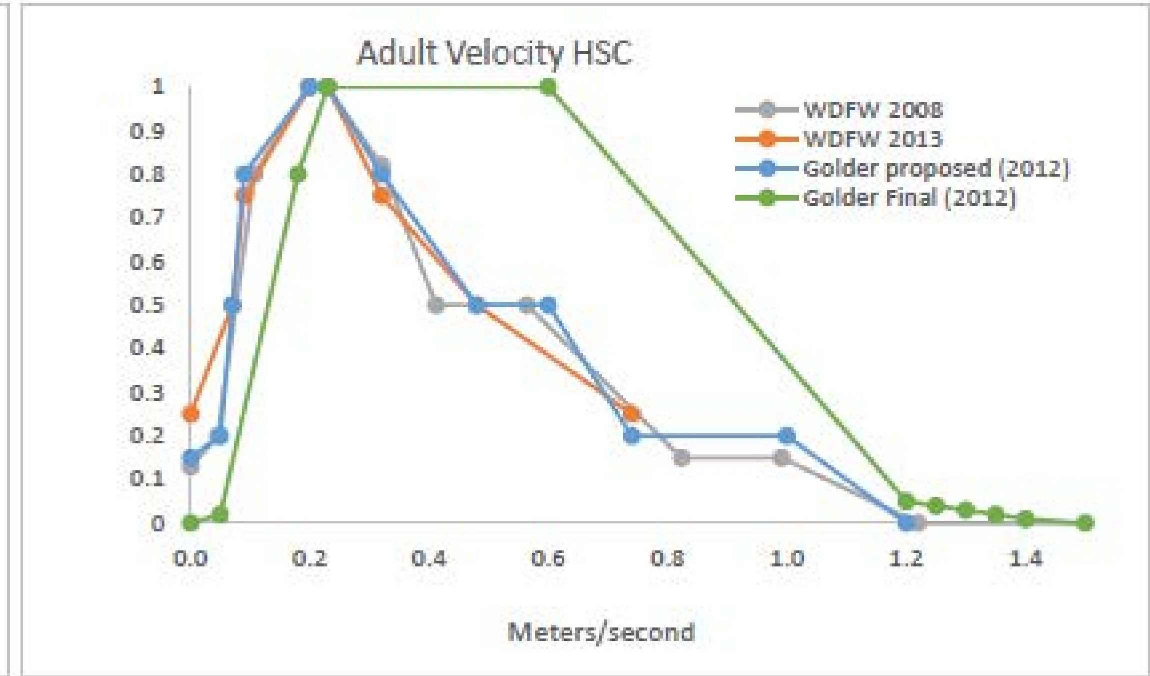


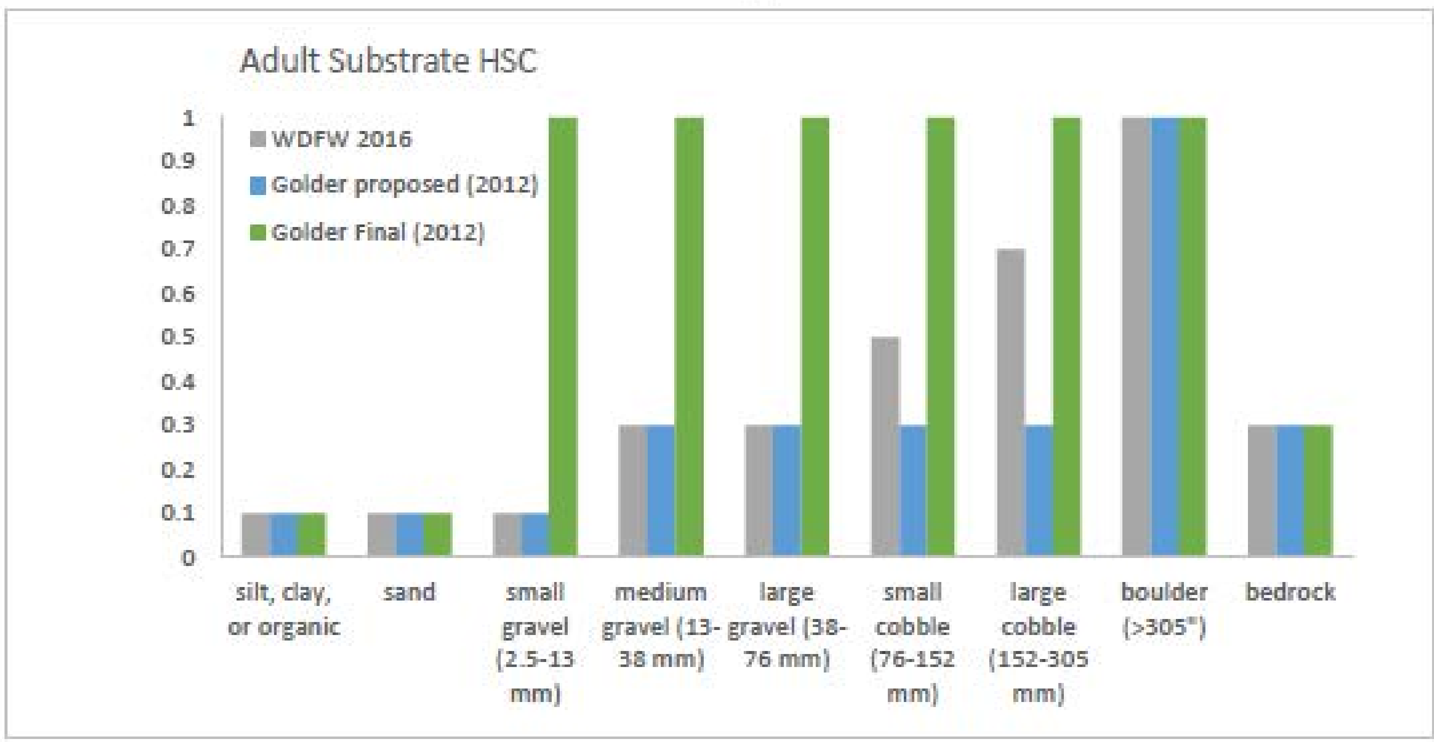
WSCT Juvenile (substrate) Habitat Suitability Criteria Curves



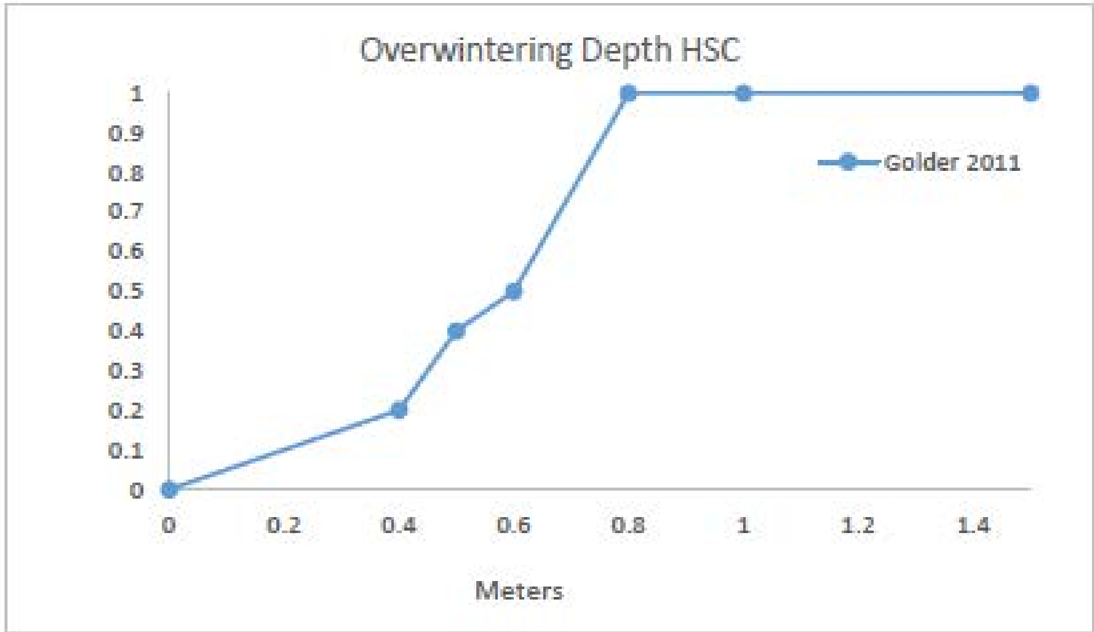
WSCT Adult (Rearing/Holding) Habitat Suitability Criteria Curves

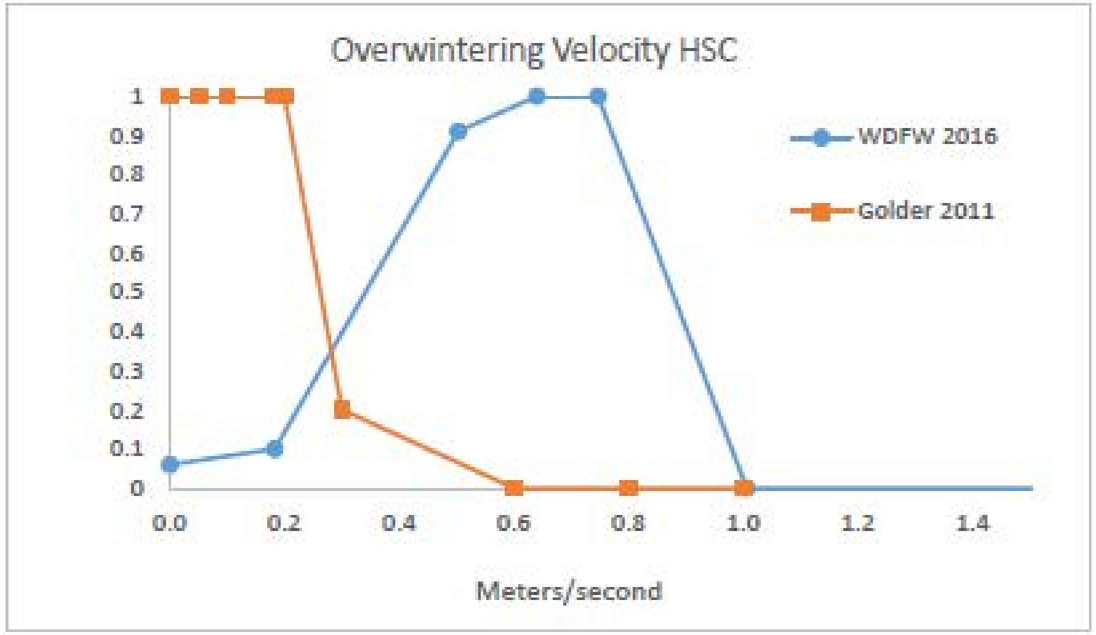


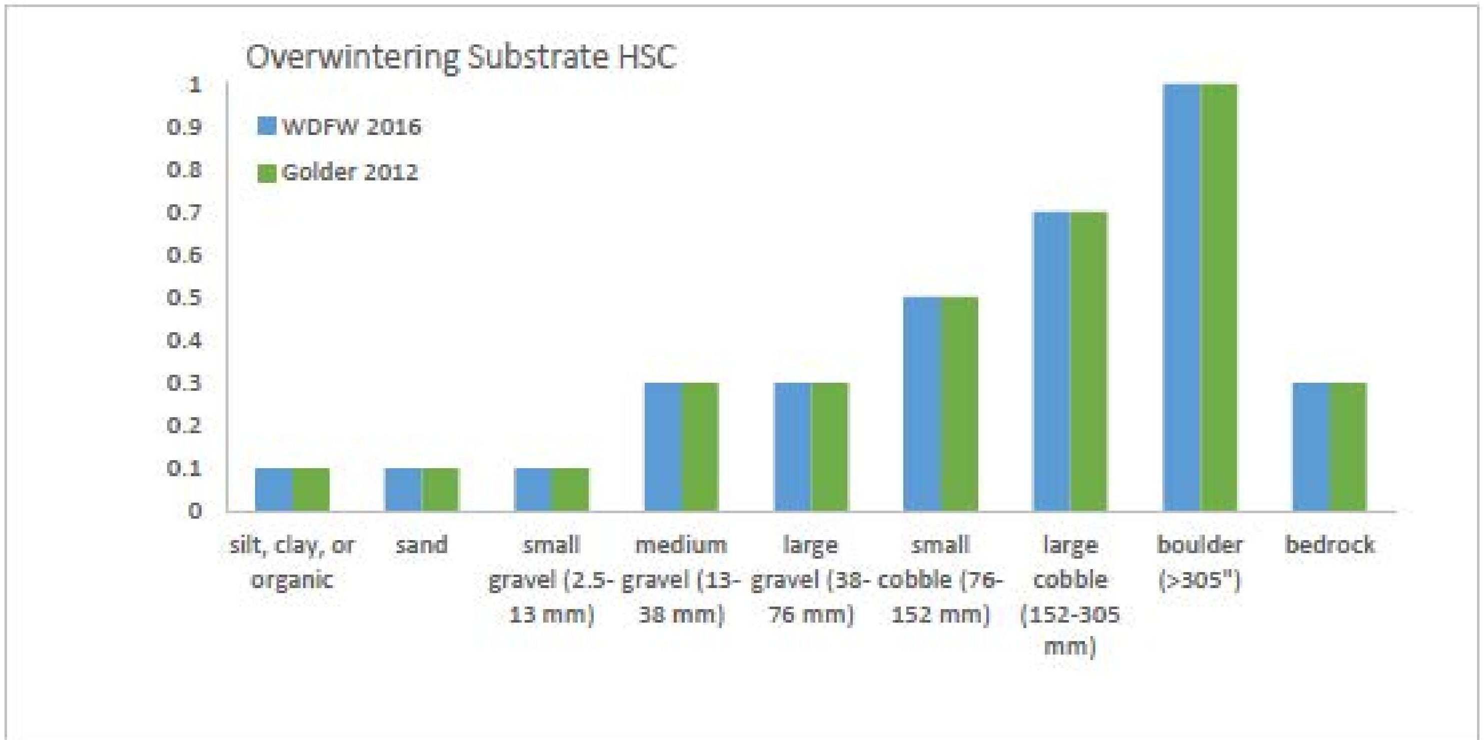




WSCT Overwintering Habitat Suitability Criteria Curves







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APPENDICES TO CPAWS SUBMISSION

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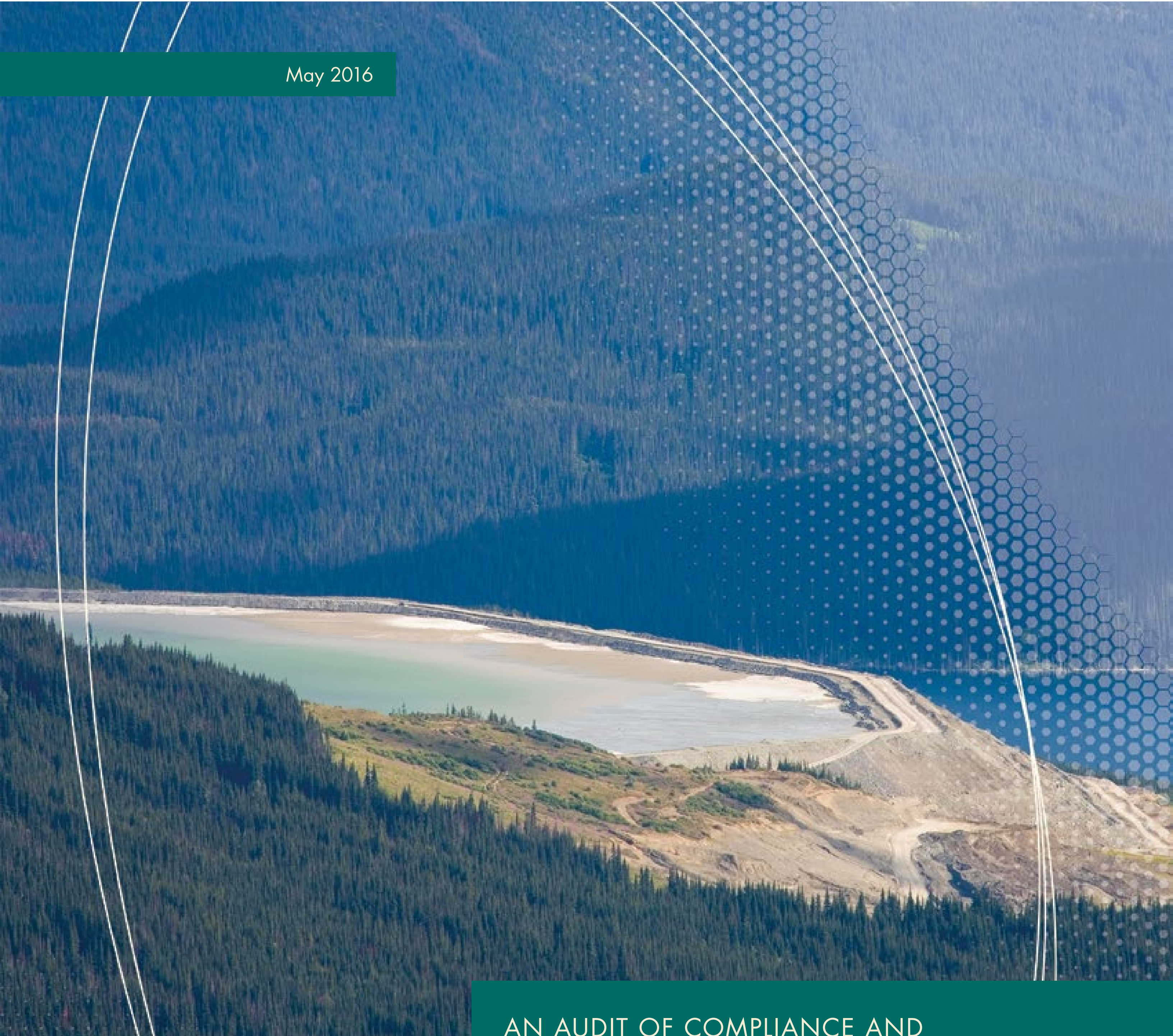
May 2016



AN AUDIT OF COMPLIANCE AND ENFORCEMENT OF THE MINING SECTOR

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The Honourable Linda Reid
Speaker of the Legislative Assembly
Province of British Columbia
Parliament Buildings
Victoria, British Columbia
V8V 1X4

Dear Madame Speaker:

I have the honour to transmit to the Legislative Assembly of British Columbia my report, *An Audit of Compliance and Enforcement of the Mining Sector*.

We conducted this audit under the authority of section 11 (8) of the *Auditor General Act* and in accordance with the standards for assurance engagements set out by the Chartered Professional Accountants of Canada (CPA) in the CPA Canada Handbook – Assurance, and in accordance with Value-for-Money Auditing in the Public Sector.

<Original signed by>

Carol Bellringer, FCPA, FCA
Auditor General
Victoria, B.C.
May 2016

Cover Page - Tailings pond of Huckleberry open pit copper mine in northwestern British Columbia. Owned by Imperial Metals Corp. Source: Stock Photo.

AUDITOR GENERAL'S COMMENTS

THE MINING INDUSTRY has a long history in British Columbia and continues to be an important source of employment for thousands of people. Government has stated its plan to continue to support and develop this industry by creating opportunities for new investment. However, the recent decline in commodity prices has left many mining companies struggling to survive. Regardless of whether the mining industry is experiencing growth or slow-down, protection of the environment needs to be ensured. This is only possible through strong regulatory oversight. We conducted this audit to determine whether the regulatory compliance and enforcement activities of the Ministry of Energy and Mines (MEM) and the Ministry of Environment (MoE), pertaining to mining, are protecting the province from significant environmental risks.

CAROL BELLRINGER, FCPA, FCA
Auditor General

We found almost every one of our expectations for a robust compliance and enforcement program within the MEM and the MoE were not met.

We found major gaps in resources, planning and tools. As a result, monitoring and inspections of mines were inadequate to ensure mine operators complied with requirements. The ministries have not publicly disclosed the limitations with their compliance and enforcement programs, increasing environmental risks, and government's ability to protect the environment.

During the course of this audit, these risks became a reality and disaster occurred when the tailings dam at Mount Polley failed – releasing approximately 25 million cubic metres of wastewater and tailings into adjacent water systems and lakes. It may be many years before the financial, environmental and social implications are fully known.

AUDITOR GENERAL'S COMMENTS

After the failure at Mount Polley and during our audit, we felt it necessary to review MEM's performance as regulator for this site. We noted the same issues in the Mount Polley file as we did throughout the audit – that is, too few resources, infrequent inspections, and lack of enforcement.

Our advice, to reduce the risk that unfortunate and preventable incidents like Mount Polley don't happen again, is for government to remove its compliance and enforcement program for mining from MEM. MEM's role to promote mining development is diametrically opposed to compliance and enforcement. This framework, of having both activities within MEM, creates an irreconcilable conflict. Because compliance and enforcement is the last line of defence against environmental degradation, business as usual cannot continue.

I am therefore disappointed in the resistance to this overall recommendation as it is consistent with many other jurisdictions' response to similar incidences. In addition, it is disconcerting that government will not be disclosing its rationale for decisions that it makes in the public's interest under section 137 of the *Environmental Management Act*. The next opportunity to discuss these and other areas of disagreement and the contents of this report, will be at a meeting of the Select Standing Committee on Public Accounts.

This was a very large and involved audit. I appreciate the dedication and commitment that everyone, both in the ministries and my Office, showed to see it through to completion.

<Original signed by>

Carol Bellringer, FCPA, FCA
Auditor General
May 2016

SUMMARY

Mining is an important economic driver for British Columbia. More than 30,000 people are employed in mining and related sectors, and in 2013, the total value of production at B.C. mines was about $7 billion and mineral exploration spending reached $476 million.

In B.C., there are 13 major coal and metal mines in operation, over 160 temporarily or permanently **closed mines**, and several mines moving through the permitting approvals process. While the degree of environmental risk varies for each mine, many sites will require ongoing oversight by government that includes a robust compliance and enforcement program to manage the risk.

The major risk to the environment from mining activities is water contamination from the chemical processes of **acid rock drainage** and **heavy metal and non-metal leaching**. Once these processes begin, they can continue indefinitely. In some cases, the only solution is water treatment and monitoring – in perpetuity – which can cost millions of dollars a year.

While most major mines will not require perpetual water treatment, government has estimated that approximately 10% of the major mines in B.C. either have water treatment facilities or will require them in the future (see sidebar). Industry is responsible for both building and maintaining these facilities indefinitely; however, the lifespan of mines and mining companies is finite, creating a risk that taxpayers may bear the costs. So, while the benefit from mining occurs for a limited time, the costs, including government's obligation to monitor these sites, may continue for a very long time.

Just over 10% of B.C. major mines have or will likely require long-term or perpetual water treatment.

- 14 major mines currently have water treatment facilities.
- Government has estimated that another 12 existing mines will require water treatment facilities.

Several laws apply to mining in B.C., but for this audit we focused on those that are the responsibility of the Ministry of Energy and Mines (MEM) and Ministry of Environment (MoE), as both of these ministries:

- are the primary permitting agencies for major mine operations in the province, and
- have environmental protection mandates and associated compliance and enforcement responsibilities under provincial legislation.

MEM's responsibilities apply generally *within the mine site*. MEM must ensure the mine is designed, built, operated and reclaimed to an acceptable standard. Under the *Mines Act*, MEM is empowered to require that mines provide a financial security deposit that is held by government. This deposit is designed to ensure that taxpayers will not have to contribute to

Click on the terms that are **bold** and **blue** to go to the definition in the glossary (**Appendix B**).

SUMMARY

mine reclamation costs if a company defaults on its environmental obligations.

MoE's responsibilities apply generally to regulating the impact of mining activities that *extend beyond the borders of the mine site*. MoE regulates the quantity and quality of any waste discharges from metal and coal mines to ensure the protection of the environment.

OVERALL AUDIT FINDINGS

MEM and MoE's compliance and enforcement activities of the mining sector are inadequate to protect the province from significant environmental risks

Overall findings of MEM's and MoE's regulatory program:

Planning

- MEM's mandate to promote the mining industry conflicts with its role as a regulator, thus reducing its regulatory effectiveness.
- MEM has a limited compliance and enforcement program and weak planning, and therefore its regulatory oversight activities are inadequate.
- Although MoE has adopted a compliance and enforcement framework, there are significant gaps in how the framework is applied.
- Neither ministry coordinates with the other on their compliance and enforcement activities.
- Both ministries lack sufficient resources and tools to manage environmental risks from mining activities.
- To meet the provincial goals for new mines and mine expansions, MEM and MoE are focusing on permit applications. As a result, there are few resources dedicated to the regulatory activities of monitoring, compliance and enforcement.

Permitting

- Neither ministry ensures that permits are consistently written with enforceable language.
- Neither ministry uses a permitting approach that reduces the likelihood taxpayers will have to pay costs associated with the environmental impacts of mining activities (known as the **polluter-pays principle**).
  - MEM is not holding an adequate amount of security to cover the estimated environmental liabilities at major mines. The ministry has estimated the total liability for all mines at more than $2.1 billion, yet has obtained financial securities for less than half that amount ($0.9 billion).
  - MoE has not reviewed or revised its fee schedule for pollutants issued under an *Environmental Management Act* permit since 2004. And, in some cases, the waste discharge fees do not reflect the environmental impacts.

SUMMARY

Compliance promotion

- Both MEM and MoE have created guidance documents and worked with stakeholders to promote compliance. However, neither ministry could demonstrate that its activities and guidance materials were effective in achieving voluntary compliance or government's environmental outcomes.

Compliance verification

- Neither MEM nor MoE are conducting adequate monitoring and site inspections and neither have assessed how this is impacting risks.

Enforcement

- Both MEM's and MoE's enforcement responses have significant deficiencies and MEM's enforcement tools are in some cases, ineffectual. This is resulting in delayed or unsuccessful enforcement by the ministries and inaction by industry in several instances.

Ensuring continuous improvement

- Neither MEM nor MoE have adequately evaluated the effectiveness of their regulatory programs. Both ministries are aware that deficiencies in their regulatory activities are resulting in risks to the environment. In at least two instances—the tailings breach at Mount Polley mine and the degradation of water quality in the Elk Valley—these risks have manifested into real environmental impacts.

Reporting

We found that the two ministries are not informing the public and legislators about the long-term risks from mining, the effectiveness of the agencies' regulatory oversight, and the overall performance of the companies being regulated.

SUMMARY

OTHER COMPLIANCE AND ENFORCEMENT MATTERS

The impacts of an ineffective regulatory regime are increased risks to the environment and the potential for deterioration of the province's water systems, loss of wildlife habitat, and damage to culturally significant areas and values. In recent years, this risk has become a reality and resulted in actual environmental damage, such as at the Mount Polley mine site and in the Elk Valley.

Compliance and enforcement at the Mount Polley Tailings Dam

On August 4, 2014, a breach occurred within the Perimeter Embankment of the **tailings storage facility (or tailings dam)** at the Mount Polley copper and gold mine in south-central B.C. The breach resulted in the release of an estimated 25 million cubic metres of wastewater and tailings. The mining company has since been working on the clean-up from this event, but the full extent of the environmental repercussions from the breach are still not known.

In response to this event, government convened an independent, expert, engineering investigation and review panel (panel) to determine the mechanics of ***how*** the dam failed. Their conclusion was that the primary cause of the breach was dislocation of a part of the Perimeter Embankment due to foundation failure. The specifics of the failure were triggered by the construction of the downstream rockfill zone at a steep slope. They noted that had the downstream embankment slope been flattened in recent years as proposed in the original design, failure would have been avoided.

Our assessment differed from the panel's review in that we focused on ***why*** the dam failed and the Ministry of Energy and Mines' (MEM) overall compliance and enforcement activities. We found that the ministry did not ensure that the tailings dam was being built or operated according to the approved design, nor did it ensure that the mining company rectified design and operational deficiencies. MEM continued to allow the mine to operate and to approve permit amendments to raise the tailings dam.

In relation to the Perimeter Embankment where the dam failed, MEM's weak regulatory oversight allowed inconsistencies with the intended dam design to persist over several years. This included: an over-steepened Perimeter Embankment slope and inadequate management of the tailings beach. At the Main Embankment, in addition to accepting a steep embankment slope and an inadequate tailings beach, MEM also did not ensure that buttressing was built to the height and extent included in the dam design.

We concluded that MEM did not enforce the design due to the following:

Over reliance on qualified professionals

It is not MEM's practice to carry out its own technical review (or to oversee an independent technical review) to confirm that tailings dams are built in accordance with the design.

SUMMARY

Inadequate standards to guide both inspectors and industry

We expected that MEM would have ensured that their design standards were clear for both industry and inspectors to enforce. However, MEM had adopted the Canadian Dam Association's Dam Safety Guidelines for dam construction that were not specific to the conditions in B.C. or specific to tailings dams. These guidelines were open to interpretation by the Engineer of Record and MEM inspectors, and this resulted in a tailings dam that was built below generally accepted standards for tailings dams.

Inspections did not meet policy

MEM performed no geotechnical inspections for a number of years, even though their policy requires a minimum of an annual inspection. Although these inspections would not have identified the weak foundation layer, staff could have identified that the operator was not actually building or operating the tailings dam to the prescribed design and was raising the dam without any long-term planning. Also, additional inspections would have provided MEM the opportunity for increased onsite vigilance.

Lack of enforcement culture

MEM has adopted a collaborative approach to compliance and enforcement that emphasizes cooperation and negotiation. In the case of Mount Polley, this approach failed to produce the desired results. MEM has the ability to compel a mining company to take corrective action when necessary, and has done so in the past using enforcement mechanisms under the Act, Code and permit. However, at Mount Polley, MEM did not use most of these enforcement mechanisms to compel the mine operator to build or operate the dam as designed and intended.

MoE has not publicly disclosed the risks associated with permitting coal mines in the Elk Valley

Lack of sufficient and effective regulatory oversight and action by MoE to address known environmental issues has allowed degradation of water quality in the Elk Valley. Coal mining, which has been underway in the area for over 100 years, has resulted in high concentrations of selenium in the water system. As selenium accumulates up the food chain, it can affect the development and survival of birds and fish, and may also pose health risks to humans.

For 20 years, MoE has been monitoring selenium levels in the Elk Valley and over that time has noted dramatic annual increases of selenium in the watershed's tributaries. MoE tracked this worsening trend, but took no substantive action to change it. Only recently, has the ministry attempted to control this pollution through permits granted under the *Environmental Management Act.*

We examined the Line Creek Expansion Permit, the Area-Based Management Plan and the Area-Based Management Permit (Valley Permit)[1] to understand how they support MoE's responsibility to minimize risks to the environment. We found that these documents do not address several risks, including the following:

- MoE staff, with input from external experts, concluded that the selenium levels in the

[1] Line Creek mine is one of five coal mines that Teck Resources Ltd. is operating in the Elk Valley.

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proposed Line Creek Expansion Permit were not likely protective of the environment. The statutory decision-maker could not approve the permit. Subsequently, the permit was granted by Cabinet. This was the first time that Cabinet used this approval process. The rationale for the decision was not publicly disclosed.

- The Line Creek Expansion Permit allows mining activities to be extended into an area inhabited by Westslope Cutthroat Trout, a species listed as being of "**special concern**" under the federal *Species at Risk Act*. This approved expansion of mining operations creates a risk of further decline of this species.
- The Area-Based Management Plan commits industry to developing six water treatment facilities in the Elk Valley. This creates a future economic liability for government to monitor these facilities in perpetuity and ensure that they are maintained.
- There is a risk that if MoE is unable to enforce the Area-Based Management Permit and the mine exceeds its permit limit for selenium at Lake Koocanusa, the outcome could be a violation of the 1909 *Treaty relating to boundary Waters and Questions arising along the Boundary between Canada and the United States* (the Treaty). The Treaty forbids the pollution of water bodies on either side of the border.
- The levels for selenium in the Area-Based Management Permit are inconsistent with the **precautionary principle**. The proposed targets over the next seven years show a reduction in selenium, but are still significantly higher than current concentrations creating a high risk of further environmental impacts.

The ministry has not disclosed these risks to legislators and the public.

Ultimately, despite the addition of water treatment facilities, the current permit levels of selenium are above the water quality guidelines set by B.C. to protect aquatic life, and for human health and safety. Selenium from both historical mining activities and the ongoing expansion is likely to continue to impact the environment far into the future.

SUMMARY OF RECOMMENDATIONS

WE FOUND OVER a decade of neglect in compliance and enforcement program activities within the Ministry of Energy and Mines, and significant deficiencies within the Ministry of Environment's activities. Overall, we concluded that compliance and enforcement activities of the two ministries are inadequate to protect the province from significant environmental risks.

The independent expert panel for Mount Polley stated clearly that "business as usual cannot continue." We reached a similar conclusion at the end of this audit regarding compliance and enforcement, and we have one overall recommendation.

OVERALL RECOMMENDATION

WE RECOMMEND THAT THE GOVERNMENT OF BRITISH COLUMBIA create an integrated and independent compliance and enforcement unit for mining activities, with a mandate to ensure the protection of the environment.

Given that the Ministry of Energy and Mines (MEM) is at risk of **regulatory capture**, primarily because MEM's mandate includes a responsibility to both promote and regulate mining, our expectation is that this new unit would not reside within this ministry.

Establishment of such a unit will:

- show all stakeholders concerned about regulatory oversight that government has put a sound system in place
- enable government to demonstrate that it will meet its public commitment to be a sound environmental steward

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SUMMARY OF RECOMMENDATIONS

In addition to this overall recommendation, we have included 16 recommendations that provide further guidance to government in the development of this new unit. These recommendations are themed by activity: Planning, Permitting, Compliance Promotion, Compliance Verification, Enforcement, Evaluation and Adjustment, and Reporting.

Each recommendation was in response to specific findings. In some cases, the recommendation was made due to specific issues as a result of the Ministry of Environment's or the Ministry of Energy and Mines' performance, and in other cases, the recommendation was applicable to both ministries.

Planning

1.1 **Strategic planning**
We recommend that government develop a strategic plan that would detail the activities of an integrated and coordinated regulatory approach, and the necessary capacity, tools, training and expertise required to achieve its goals and objectives.

Permitting

1.2 **Permit language**
We recommend that government ensure both historical and current permit requirements are written with enforceable language.

1.3 **Security – adequate coverage**
We recommend that government safeguard taxpayers by ensuring the reclamation liability estimate is accurate and that the security held by government is sufficient to cover potential costs.

1.4 **Security – catastrophic events**
We recommend that government review its security mechanisms to ensure taxpayers are safeguarded from the costs of an environmental disaster.

1.5 ***Environmental Management Act* waste discharge fees**
We recommend that government review its fees under the *Environmental Management Act* and ensure that the fees are effective in reducing pollution at mine sites.

SUMMARY OF RECOMMENDATIONS

1.6 **Cost recovery**

We recommend that government adopt a cost recovery model for permitting and compliance verification activities that is consistent across all ministries in the natural resources sector.

1.7 **Decision-making – Use of section 137 of the *Environmental Management Act***

We recommend that government publically disclose its rationale for granting a permit under section 137 of the *Environmental Management Act*. Specifically, information should include how factors such as economic, environmental, and social attributes were considered in the determination of public interest.

Compliance Promotion

1.8 **Reclamation guidance**

We recommend that government develop clear and comprehensive reclamation guidance for industry.

1.9 **Incentives**

We recommend that government create effective incentives to promote environmentally responsible behavior by industry.

SUMMARY OF RECOMMENDATIONS

Compliance Verification

1.10 **Risk-based approach**

We recommend that government develop a risk-based approach to compliance verification activities, where frequency of inspections are based on risks, such as industry's non-compliance record, industry's financial state, and industry's activities (e.g., expansion), as well as risks related to seasonal variations.

1.11 **Systematic compliance verification**

We recommend that government systematically monitor and record compliance with high-risk mine permit requirements.

1.12 **Qualified Professionals**

We recommend that government establish policies and procedures for the use and oversight of qualified professionals (QP) across the natural resources sector. These policies and procedures should have the following:

- guidance for staff that outlines the specific nature and amount of oversight expected of a QP's work
- guidance for staff as to expected timeframe for review and response to QP reports
- updated guidance for staff for recognizing and responding to misconduct by a QP
- controls in place to ensure that there is no undue influence on the QPs by industry
- controls in place to ensure that recommendations by QPs are adhered to

1.13 **Mine design**

We recommend that government adopt appropriate standards, review mine designs to ensure that they meet these standards, and ensure that mines, as constructed, reflect the approved design and standards.

SUMMARY OF RECOMMENDATIONS

Enforcement

1.14 **Policies, procedures and tools**

We recommend that government develop policies, procedures and enforcement tools for responding to non-compliances when industry does not meet government's specified timeline.

Evaluation & Adjustment

1.15 **Evaluation & adjustment**

We recommend that government regularly evaluate the effectiveness of its compliance promotion, compliance verification, and enforcement activities and tools, and make changes as needed to ensure continuous improvement.

Reporting

1.16 **Public reporting**

We recommend that government report publicly the:

- results and trends of all mining compliance and enforcement activities
- effectiveness of compliance and enforcement activities in reducing risks and protecting the environment
- estimated liability and the security held for each mine

RESPONSE FROM GOVERNMENT

The Ministry of Energy and Mines (MEM) and Ministry of Environment (ENV) acknowledge receipt of the Auditor General's Report: An Audit of Compliance and Enforcement of the Mining Sector (Audit Report). Government wishes to thank the Auditor General for undertaking the audit and her staff for their efforts.

We note there are areas of agreement between the Audit Report's 16 sub-recommendations and the combined 26 recommendations by the Mount Polley Independent Expert Engineering Investigation and Review Panel (Expert Panel) and the regulatory investigation of the Chief Inspector of Mines. Government has accepted all of the recommendations put forward by the Expert Panel and Chief Inspector of Mines and implementation is well underway.

We accept the majority of the recommendations in the Audit Report; however, there are five points where we feel obliged to share our perspective for the public record.

APPROPRIATE STANDARDS

There is a lack of clarity in the Audit Report on what the operational effectiveness of the compliance and enforcement programs should be measured against. Often the measure or standard of expected performance stated in the Audit Report is unclear and/or unsupported by reference to an identified, established authority, such as the legislation and regulation that guides the actions of C&E staff in both ministries. This concern applies at various points in the Audit Report, with the Report's general reference to the Organisation for Economic Co-operation and Development or the International Network for Environmental Compliance and Enforcement rather than the laws of BC, the stated objectives of the Ministries, or Canadian industry standards.

As a specific example in relation to Mount Polley, the Province is criticized for adopting the Canadian Dam Association's (CDA) Dam Safety Guidelines which, the audit report states, "resulted in a tailings dam that was built below generally accepted standards for tailings dams." Not only do we disagree with this assertion of opinion, the CDA guidelines are in fact professionally recognized guidelines that are used throughout Canada by geotechnical engineers. Whether the guidelines could be improved is a separate question, one which the CDA is currently reviewing. Further, the Minister of Energy and Mines has struck a committee that is tasked with reviewing the Health, Safety and Reclamation Code for Mines in BC to determine whether and in what ways requirements may appropriately be improved or clarified.

RESPONSE FROM GOVERNMENT

PROFESSIONAL PUBLIC SERVANTS

The Audit Report suggests that professional public servants are unable to differentiate between mandate components or that they are unwilling to enforce existing regulations. The Audit Report contains no factual evidence that the current ministry structure results in any such risk, or in a mind-set of acquiescence on the part of staff involved. The Report lists a number of indicators of potential risk of regulatory capture. But there is nothing whatsoever in the Report to suggest any actual causal linkage. Specifically, there is no evidence that decisions were made at Mount Polley, in relation to the Elk Valley, or anywhere else to ease or enhance the position of the mining companies involved.

We do not accept that mere appearances are sufficient to warrant the act of removing compliance and enforcement from MEM. No one is more aware of the need to find the appropriate balance between promotion and regulation of mining in ministry decision-making than those who are asked to do so on a daily basis. It is the legislative framework in BC that drives compliance and enforcement activities not the organizational structure.

DISCLOSURE OF INFORMATION

The Audit Report implies that the Ministries failed in their duty to disclose information regarding decisions on mining operations.

In the instance of Mount Polley, there was no breach of any duty to disclose information to the public or to the Legislature. The Information and Privacy Commissioner recently ruled that there was no failure by MEM to meet the disclosure requirements of section 25 of the Freedom of *Information and Protection of Privacy Act* in relation to environmental risk at Mount Polley.

With respect to the permitting of mining operations in the Elk Valley, there was also no breach of any duty on the part of ENV and no failure on the part of Cabinet to disclose information to the public or to the Legislature. Before addressing that point, it may be of assistance for the government to set out the decision making process that did occur, the extensive consultations that were undertaken, and to clarify the legal authority under which decisions were made.

As the Audit Report notes, mining in this area has been going on for more than 100 years and over the past 20 years, ENV has been monitoring the health of the watershed with increasing concern. Emerging science began to indicate the potential effects of selenium and other water quality parameters in the Elk Valley watershed, including Fording River, Elk River and Lake Koocanusa. With ENV staff bringing these issues to the attention of the Minister of Environment,

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the Minister used powers under the *Environmental Management Act* to issue an Order requiring the mining operator to immediately begin to stabilize and reverse the water quality trends.

The Order required the development of an Area Based Management Plan (ABMP) which meets specific environmental objectives and outcomes such as protection of aquatic ecosystems, protection of human health and protection of groundwater. The ABMP also sets out short, medium and long-term water quality targets. The ABMP lays out a schedule for the installation of nine active water treatment plants over the next 18 years. The long-term targets consider: 1) current contaminant concentrations, 2) current and emerging economically achievable treatment technologies, 3) sustained balance of environmental, economic and social costs and benefits, and 4) current and emerging science regarding the fate and effects of contaminants.

Substantial public and stakeholder consultations were undertaken during the development of the ABMP and after permits were granted, various news releases and media interviews by ministers set out for the general public the nature of government decisions. The ABMP was developed by a technical advisory committee with representatives from the mining operator, the local environmental group (Wildsight), the Province, Government of Canada, U.S. Government, the State of Montana, the Ktunaxa Nation, and an independent scientist from UBC. Parallel to the technical advisory committee work, the Province was engaged in a government-to-government process to ensure the Ktunaxa Nation's interests and concerns were addressed. The Ktunaxa Nation Council's public support for the ABMP and the subsequent Elk Valley permit is a reflection of the commitment of the Province, the Ktunaxa Nation and the mining operator to see water quality levels stabilize and improve.

In November 2014, the Minister of Environment approved the ABMP which became policy for the ministry statutory decision maker to consider when making permitting decisions in the Elk Valley. The comprehensive Valley permit, subsequently issued by the ministry statutory decision maker, authorizes water quality discharges and sets legal requirements for the mining company to install nine treatment plants and to implement widespread monitoring to ensure water quality trends are stabilizing and reversing. A tangible result of this unprecedented effort in problem solving and public and First Nations consultation is the recent announcement of the completion of the commissioning phase of the first treatment plant. The recognition of the ministry's efforts to effectively and responsibly address a historically generated water quality problem while balancing economic, social, cultural and environmental interests was not addressed in the Audit Report.

The Audit Report criticized Cabinet for approving the Line Creek Expansion Permit via an Order-in-Council (OIC) in 2013 on the grounds that the rationale for the decision was not publicly disclosed. Decisions, when they are issued in the form of OICs such as this one, are always published on the BC Laws website. Furthermore, section 137 of the *Environmental Management Act* specifically outlines what factors Cabinet may consider. These considerations extend to factors such as social and economic needs and whether it is in the public interest to ensure a functioning industry so that longer term investments can continue to be made in areas such as research and development and water treatment technologies.

AUDIT SCOPE

The fourth point relates to audit planning decisions as to what was properly within or outside the audit scope.

For example, it is difficult for us to understand why, in a case study examining permitting in the Elk Valley in detail, the Audit Report failed to record the concerted efforts that ENV has undertaken in order to ensure these permits are complied with. After the Minister of Environment approved the ABMP in 2014, the ministry statutory decision maker approved a valley-wide permit for Teck Coal Limited that specified the regulatory requirements for reducing selenium levels. Permit requirements will bend down the curve of growth in selenium levels in Lake Koocanusa by requiring additional investment in water diversion and treatment facilities over the next two decades. The Audit Report does not comment on the extensive efforts by the ministry to ensure that Teck Coal Limited complies with these regulatory requirements. For instance, in 2014, ENV created a dedicated management position supported by two technical officers to oversee Teck Coal Limited. A compliance plan has been developed that specifies a schedule of inspection frequency and water sampling. The amount of resources and effort that has been focused on compliance of these five particular mines is significant and the ministry has no intention of reducing that attention.

We also wonder why, in examining whether compliance and enforcement activities of the mining sector are protecting the Province from significant environmental risk, the Audit Report did not consider the key role played by the Environmental Assessment Office (EAO) in upholding the *Environmental Assessment Act*. Many of the mines in British Columbia (new and expansions) have been subject to the Environmental Assessment process and received environmental assessment certificates with legally binding requirements. Permitting by MEM and ENV happens subsequent to that environmental review process. Additionally, the EAO has its own compliance and enforcement program, which includes oversight of mines and functions complementarily to MEM and ENV. The Auditor General recently reviewed EAO's progress in addressing the recommendations from the 2011 audit on the EAO's oversight of major projects. In that follow-up, the Auditor General acknowledged significant improvements in oversight of environmental assessments projects, including mines.

MOUNT POLLEY

The Audit Report contains the inference that MEM might have been able to, through proper exercise of their regulatory powers, act to prevent the dam failure at Mount Polley. The Audit opinion is contrary to the Expert Panel finding of cause and is not reflective of the regulatory regime in place at the time. Specifically:

The Panel found that inspections of the TSF would not have prevented failure and that the regulatory staff are well qualified to perform their responsibilities. The Panel found that the performance of the Regulator was as expected.

RESPONSE FROM GOVERNMENT

It is important to understand that mine design, at Mount Polley just as at mines around the world, is not static and evolves throughout the life of operation. This is appropriate engineering practice. Operating mines evolve their designs over time regularly, all with the approval of licensed engineers. Starting in 1995, there were nine design stages over the life of the Tailings Storage Facility (TSF) at Mount Polley. All stages, including the design stage in place at the time of the breach had been approved by the design engineer. Each stage of construction was certified by the Engineer of Record (EOR) in the as-built reports. MEM authorized permit amendments for each stage of the TSF. The failure of the TSF was not a compliance and enforcement issue.

It is also important for the reader to understand the difference in design, actions and recommendations for each of the three embankments: Perimeter Embankment, Main Embankment, and South Embankment. Specifically, the Audit Report seems to suggest that items identified by both the EOR and ministry staff at the Main Embankment can be translated, or are somehow related, to the failure of the Perimeter Embankment. Such inferences are not supported by facts or engineering and do not offer supporting evidence that the breach of the Perimeter Embankment was somehow preventable through compliance and enforcement actions.

The Ministry appreciates that the purpose and process of the audit may have been different than those of the Expert Panel and the regulatory investigation of the Chief Inspector of Mines. We are nonetheless concerned about the different findings on fundamental facts that have come out of these processes. The Expert Panel, which was empowered in its Terms of Reference to examine any matters it deemed necessary, including the "regulatory oversight by the Ministry of Energy and Mines and the Ministry of Environment" and "to comment on what actions could have been taken to prevent this failure and to identify practices or successes in other jurisdictions that could be considered for implementation in BC" concluded:

The Panel finds that the MEM Geotechnical Staff and the Contract Inspectors are well qualified to perform their responsibilities. The team is well organized and has clear targets and schedules for annual inspections. The Panel considers the technical qualifications of the MEM Geotechnical Staff as among the best that it has encountered among agencies with similar duties.

The Panel further concluded:

Additional inspections of the TSF would not have prevented the failure.

Similarly, the extensive investigation by the Chief Inspector of Mines, which considered over 100,000 pages of documents and hundreds of hours of interviews, did not find that the company breached its obligations under the *Mines Act*, the Health, Safety and Reclamation Code for Mines in British Columbia, its permit conditions or any orders to prosecute. This is the regulatory framework that governs the Ministry's compliance and enforcement actions. We of course await the results of the Ministry of Environment's investigation of potential breaches of its legislation.

RESPONSE FROM GOVERNMENT

The Audit Report states that "government has adopted an approach to reduce the regulatory burden on industry." The public relies on Qualified Professionals in many areas. Examples of qualified professionals include architects, accountants, lawyers, physicians, pharmacists and engineers. In each case, the qualified professionals are regulated by their respective governing body or association to ensure members meet their association's standards of conduct or code of ethics. If qualified professionals do not adhere to these standards or codes, then the associations are responsible for disciplinary actions. This is the system that holds professional engineers accountable across Canada. The OAG concern about over-reliance on qualified professionals is a criticism of professional bodies' ability to regulate their professions.

Furthermore, the Audit Report's assertion that there is over-reliance on qualified professionals is not substantiated in the context of mining. Reliance on engineers and other qualified professionals in the mining industry has been a fact of life in British Columbia for decades. The long standing model used in engineering throughout the world relies on professional engineers to prepare and seal designs; government then reviews these plans. Through legislation like the *Engineers and Geoscientists Act,* government has created technical bodies to formalize accountability and protect the public interest.

Just as the original design for the Mount Polley TSF was prepared and signed by a Professional Engineer in 1995 and then reviewed by government staff, this was the same for subsequent lifts. In fact, the Expert Panel found:

MEM geotechnical engineers addressed significant issues during the reviews and inspections of the Mount Polley TSF. They had insightful questions for the designers at many instances during their review of the design documents, as noted above. The EOR responded to these questions based on their observations and understanding of site conditions. The EOR is responsible for the overall performance of the structure as well as the interpretation of site conditions. The Regulator has to rely on the expertise and the professionalism of the EOR as the Regulator is not the designer.

Both the Expert Panel and the CIM investigation concluded that the fundamental cause of the Mount Polley failure was the lack of appropriate subsurface site characterization when the dam was designed and built. We respectfully point out that this was not a question of the number of ministry staff on the ground, the number of inspections performed, or an increase in professional reliance since.

In conducting the Mount Polley case study, the audit team – quite understandably – augmented their own knowledge of environmental principles, geotechnical engineering and regulatory law. They did so by consulting a panel of subject matter experts, comprising an environmental academic, environmental lawyer, engineer and a former employee. We understand this to be consistent with normal audit practice.

However, proceeding in that manner did not give the Ministries the opportunity to know who was on the panel, what data the panel may have considered on specific points, what opinions they might have offered, or to challenge the thinking of panel members with additional engineering evidence and/or competing legal or scholarly opinions.

RESPONSE FROM GOVERNMENT

Government wishes to thank the Auditor General for undertaking the audit and her staff for their efforts. In particular, we appreciate the extended processes by which the Audit Team allowed the Ministries to raise and discuss factual and legal concerns arising in connection with successive drafts of the Audit Report.

The Audit Team responded to many of our concerns, but points of disagreement remained which we believed could not be left unanswered. While we do not accept that the Ministries have been deficient in protecting the environment, or the recommendation to reorganize the compliance and enforcement programs within a separate agency, we do believe the 16 sub-recommendations provide meaningful and constructive guidance that will complement current initiatives already underway.

PART 1: RECOMMENDATIONS FOR GOVERNMENT	
Recommendation by OAG	Ministry Response
RECOMMENDATION 1.0 —***Overall:*** *We recommend that the Government of British Columbia create an integrated and independent compliance and enforcement unit for mining activities, with a mandate to ensure the protection of the environment. Given that the Ministry of Energy and Mines is at high risk of* ***regulatory capture****, primarily because MEM's mandate includes a responsibility to both promote and regulate mining, our expectation is that this new unit would not reside within this ministry.*	It is the legislative framework in BC that drives compliance and enforcement activities not the organizational structure. Many provincial governments across Canada have agencies and ministries with the role of promoting and regulating an industry. In the absence of evidence by the Auditor General that this has compromised the integrity of the ministry or its staff, Government does not support the need for a reorganization of the ministries, however we are prepared to further discuss this with the OAG. Government will establish a Mining C&E Board that will address the need for greater integration between the ministries, as well as with the Environmental Assessment Office.

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RESPONSE FROM GOVERNMENT

PART 2: RECOMMENDATIONS FOR MINISTRY OF ENERGY AND MINES AND MINISTRY OF ENVIRONMENT	
Recommendation by OAG	Ministry Response
RECOMMENDATION 1.1 ***Strategic Planning****—We recommend that government develop a strategic plan that would detail the activities of an integrated and coordinated regulatory approach, and the necessary capacity, tools, training and expertise required to achieve its goals and objectives.*	A Mining C&E Board will be established to oversee an integrated and coordinated regulatory approach to mining in the Province of B.C. The Board will be accountable to the Deputy Minister of Energy and Mines, the Deputy Minister of Environment and the Associate Deputy Minister of the Environmental Assessment Office. The Board will develop compliance and enforcement plans to map out proactive annual activities based on a risk-based approach. The board will also be responsible for furthering longer term strategic improvements in other areas such as: enhancing training; developing policies, procedures and tools; conducting evaluations; and expanding public reporting. MEM will appoint a new Deputy Chief Inspector of Mines for compliance and enforcement to oversee and implement improved C&E.
RECOMMENDATION 1.2 ***Permit Language****—We recommend that government ensure both historical and current permit requirements are written with enforceable language.*	The ministries agree that permits must be written with measureable and enforceable requirements. Both ministries will develop policy to ensure enforceable and measurable requirements are used in all new and amended permits.
RECOMMENDATION 1.9 ***Incentives****—We recommend that government create effective incentives to promote environmentally responsible behavior by industry.*	The ministries agree that it is useful to consider incentives as part of the compliance and enforcement regime governing mines and will continue to consider additional opportunities to recognize and reward good environmental performers. Furthermore, it is expected that expanded public reporting of compliance and enforcement activities will serve as a very effective incentive for promoting environmentally responsible behaviour.
RECOMMENDATION 1.10 ***Risk-Based Approach****—* *We recommend that government develop a risk-based approach to compliance verification activities, where frequency of inspections are based on risks such as industry's non-compliance record, industry's financial state, and industry's activities (e.g., expansion), as well as risks related to seasonal variations.*	Compliance verification activities conducted by the ministries are founded on a risk-based approach; however, the ministries commit to review policies in this regard. The annual compliance and enforcement planning that will take place at the Mining C&E Board, established under recommendation 1.1, will also be risk-based to optimize the capacity and effectiveness of the ministries' collective compliance and enforcement resources.

RESPONSE FROM GOVERNMENT

PART 2: RECOMMENDATIONS FOR MINISTRY OF ENERGY AND MINES AND MINISTRY OF ENVIRONMENT	
Recommendation by OAG	Ministry Response
RECOMMENDATION 1.12 ***Qualified Professionals—*** *We recommend that government establish policies and procedures for the use and oversight of qualified professionals (QP) across the natural resources sector. These policies and procedures should have the following:* ◆ *guidance for staff that outlines the specific nature and amount of oversight expected of a QP's work* ◆ *guidance for staff as to expected timeframe for review and response to QP reports* ◆ *updated guidance for staff for recognizing and responding to misconduct by a QP* ◆ *controls in place to ensure that there is no undue influence on the QPs by industry* ◆ *controls in place to ensure that recommendations by QPs are adhered to*	MEM's efforts are guided by the *Mines Act* and the Health, Safety and Reclamation Code for Mines in British Columbia. In particular, the Code Review currently underway is considering specific matters such as the need for a qualified individual designated as a mine dam safety manager to oversee all work associated with a tailings storage facility and will clarify the roles and responsibilities of the Engineer of Record at a mine. The Mining C&E Board, established under recommendation 1.1, will consider how MoE and MEM can strengthen the use and oversight of qualified professionals in the mining sector specifically. The Ministry of Forests, Lands and Natural Resource Operations has established a Qualified Persons in the Natural Resource Sector Framework. This framework guides the development and implementation of Qualified Persons policies and procedures specifically for the mining sector. The framework is based on the three essential components of guidance, competency and accountability and ensures the interests of government, resource users, qualified persons and other stakeholders are recognized and addressed.
RECOMMENDATION 1.14 ***Policies, Procedures and Tools****—We recommend that government develop policies, procedures and enforcement tools for responding to non-compliances when industry does not meet government's specified timeline.*	The ministries agree on the importance of clear policies, procedures and tools to aid in their compliance and enforcement activities. The ministries will review these in light of the recommendations. The establishment of the Mining C&E Board, under recommendation 1.1, will serve to further inter-ministry collaboration and sharing of best practices. Government will also introduce amendments to the *Mines Act* to provide for Administrative Monetary Penalties in the spring 2016 legislative session.

RESPONSE FROM GOVERNMENT

PART 2: RECOMMENDATIONS FOR MINISTRY OF ENERGY AND MINES AND MINISTRY OF ENVIRONMENT	
Recommendation by OAG	Ministry Response
RECOMMENDATION 1.15 ***Evaluation and Adjustment—*** *We recommend government regularly evaluate the effectiveness of its compliance promotion, compliance verification, and enforcement activities and tools, and make changes as needed to ensure continuous improvement.*	Annual compliance and enforcement planning and reporting will provide a means to evaluate the effectiveness of the program, to ensure ongoing improved targeting of areas of concern and recognition of strong performers. The ministries will address this recommendation through the establishment of a Mining C&E Board under recommendation 1.1.
RECOMMENDATION 1.16 ***Public Reporting****—We recommend that government report publicly the:* ◆ *results and trends of all mining compliance and enforcement activities* ◆ *effectiveness of compliance and enforcement activities in reducing risks and protecting the environment* ◆ *estimated liability and the security held for each mine.*	The ministries support public reporting and have been making progress in this area. The Ministry of Environment has been reporting its enforcement actions for many years through published reports and an online searchable database. It reports all of its enforcement actions including orders, administrative sanctions, administrative monetary penalties, violation tickets and court prosecutions. The ministry will work with Ministry of Energy and Mines to explore including their enforcement actions in the reporting. In 2012, the Ministry of Environment published all of its permits for industrial and municipal facilities that discharge waste into the environment, including mines. This dataset provides the opportunity for citizens to access province-wide data on those facilities, including information on fees, locations and discharges. The Ministry of Energy and Mines published all dam safety inspections, emergency response plans and related documents online in 2015. The ministry will continue to publish further documents for all major mines in British Columbia. The ministries will report on trends and effectiveness of C&E in the mining sector.

RESPONSE FROM GOVERNMENT

PART 3: RECOMMENDATIONS FOR MINISTRY OF ENERGY AND MINES	
Recommendation by OAG	Ministry Response
RECOMMENDATION 1.3 ***Security—Adequate Coverage****—We recommend that government safeguard taxpayers by ensuring the reclamation liability estimate is accurate and that the security held by government is sufficient to cover potential costs.*	As seen in the 2014 Chief Inspector's Annual Report, "In the past few years, the value of security deposits has increased to reflect more closely the true costs of reclamation. The total value of securities held by the Province has risen from $10 million in 1984 to more than $773 million by the end of 2014."
RECOMMENDATION 1.4 ***Security—Catastrophic Events****—We recommend that government review its security mechanisms to ensure taxpayers are safeguarded from the costs of an environmental disaster.*	Environmental disasters, like the one seen as a result of the Mount Polley tailing facility breach, can result in damage both on and off a mine site. It is the responsibility of the mine operator to ensure sufficient environmental liability insurance is held to meet the risk of such disasters. The *Environmental Management Act* contains authority for spill response actions and cost recovery to require persons in possession or control of any polluting substance to prepare contingency plans and to implement those plans at their expense in the event of a spill. The Act also provides for the recovery of costs should action to respond to a spill be declared by the Minister. This Act is being amended to proactively require potential polluters to pay into a spill preparedness and response organization. These amendments are due for introduction to the Legislature this year.
RECOMMENDATION 1.8 ***Reclamation Guidance****—We recommend that government develop clear and comprehensive reclamation guidance for industry.*	Internal work has begun on developing additional guidance materials on a range of reclamation aspects, including erosion and sediment control plans, closure management manuals, reclamation security, etc.
RECOMMENDATION 1.11 ***Systematic Compliance Verification****—We recommend that government systematically monitor and record compliance with high-risk mine permit requirements.*	As with Recommendation 1.10 above, a risk-based approach to compliance and enforcement workforce planning will uncover poor performers for closer scrutiny.

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RESPONSE FROM GOVERNMENT

PART 3: RECOMMENDATIONS FOR MINISTRY OF ENERGY AND MINES	
Recommendation by OAG	Ministry Response
RECOMMENDATION 1.13 ***Mine Design****—We recommend that government adopt appropriate standards, review mine designs to ensure that they meet these standards, and ensure that mines, as constructed, reflect the approved design and standards.*	This recommendation is presented at the conclusion of the Audit Report section on the Mount Polley TSF breach. There had been nine design stages over the life of the TSF at Mount Polley Mine. All stages, including the design stage in place at the time of the breach had been prepared by the design engineer; a qualified professional. MEM reviewed and authorized permit amendments for each stage of the TSF. Each stage of construction was certified by the Engineer of Record in the as-built reports. The failure of the TSF was not an enforcement issue. Through legislation like the *Engineers and Geoscientists Act*, government has created technical bodies to formalize accountability and protect the public interest. As appropriate in their role, in response to the Expert Panel findings on Mount Polley the Association of Professional Engineers and Geoscientists BC is developing professional practice guidelines for dam site characterization assessments. Government is also undertaking a review of the Mining Code with labour, First Nations and industry representatives to determine how best to implement the expert panel findings.

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RESPONSE FROM GOVERNMENT

PART 4: RECOMMENDATIONS FOR MINISTRY OF ENVIRONMENT	
Recommendation by OAG	Ministry Response
RECOMMENDATION 1.5 ***Environmental Management Act Waste Discharge Fees***—*We recommend that government review its fees under the Environmental Management Act and ensure that the fees are effective in reducing pollution at mine sites.*	The Ministry of Environment is committed to reviewing the fee structure for waste discharges under the *Environmental Management Act*. Work has already been initiated to assess current fees, as well as conduct a cross-jurisdictional scan of fees imposed by other provinces and territories.
RECOMMENDATION 1.6 ***Cost Recovery***—*We recommend that government adopt a cost recovery model for permitting and compliance verification activities that is consistent across all ministries in the natural resources sector.*	The Ministry of Environment recognizes that other natural resource sector ministries, including the Environmental Assessment Office, have begun imposing fees on industry for permitting and compliance verification activities. The ministry will be examining the imposition of fees for these activities. Effective April 1, 2015 permit fees were introduced under the *Mines Act* and the existing inspection fees were raised. This enabled a budget increase of approx. $9.3M to the Ministry of Energy and Mines in Budget 2016.
RECOMMENDATION 1.7 ***Decision Making—Use of section 137 of the Environmental Management Act***—*We recommend that government publically disclose its rationale for granting a permit under section 137 of the Environmental Management Act. Specifically, information should include how factors such as economic, environmental, and social attributes were considered in the determination of public interest.*	As provided for in Section 137 of the *Environmental Management Act*, Cabinet may consider factors that are in the public interest and beyond those that a ministry director may consider. Discussions underlying the approval of an OIC are a matter of Cabinet confidentiality. However, the results of Cabinet decisions, when they are issued in the form of OICs, are published on the BC Laws website.

BACKGROUND

MINING IN B.C.

Mining has been a part of B.C.'s economy since the mid-1800s. Starting with coal mines on Vancouver Island and gold **placer mining** in the Cariboo, mining has expanded to all parts of the province.

Today, mining is a key driver of B.C.'s economy. Coal and metal mines are the largest revenue-generating commodities, and mining and related sectors employ more than 30,000 people. In 2013, the total value of production at B.C. mines was about $7 billion. Mineral exploration spending was $476 million in 2013 and $338 million in 2014. Currently in operation, are six coal mines, seven metal mines, more than 30 industrial mineral mines, and hundreds of quarries and aggregate pits.

B.C. is Canada's largest copper producer, largest exporter of metallurgical coal, and the only producer of molybdenum. Coal and metal mines are referred to as *major mines* and are the focus of this report (see Exhibit 1).

Mining is a temporary activity: it only lasts as long as the economically extractable resource (e.g. coal, copper) is available. This could be up to 30 years or more. Mining is also a volatile industry that relies on commodity prices, resulting in cycles of "boom and bust." Currently, B.C. mines are being affected by a sharp decline in commodity prices.

In addition to the 13 operating major mines, the province has about 160 others that are temporarily closed or permanently closed. Over one-third of these **closed mines** are still the responsibility of the mining companies and continue to have environmental obligations under their permits. Government's role, through continued monitoring and inspections, is to ensure that mine operators meet these obligations.

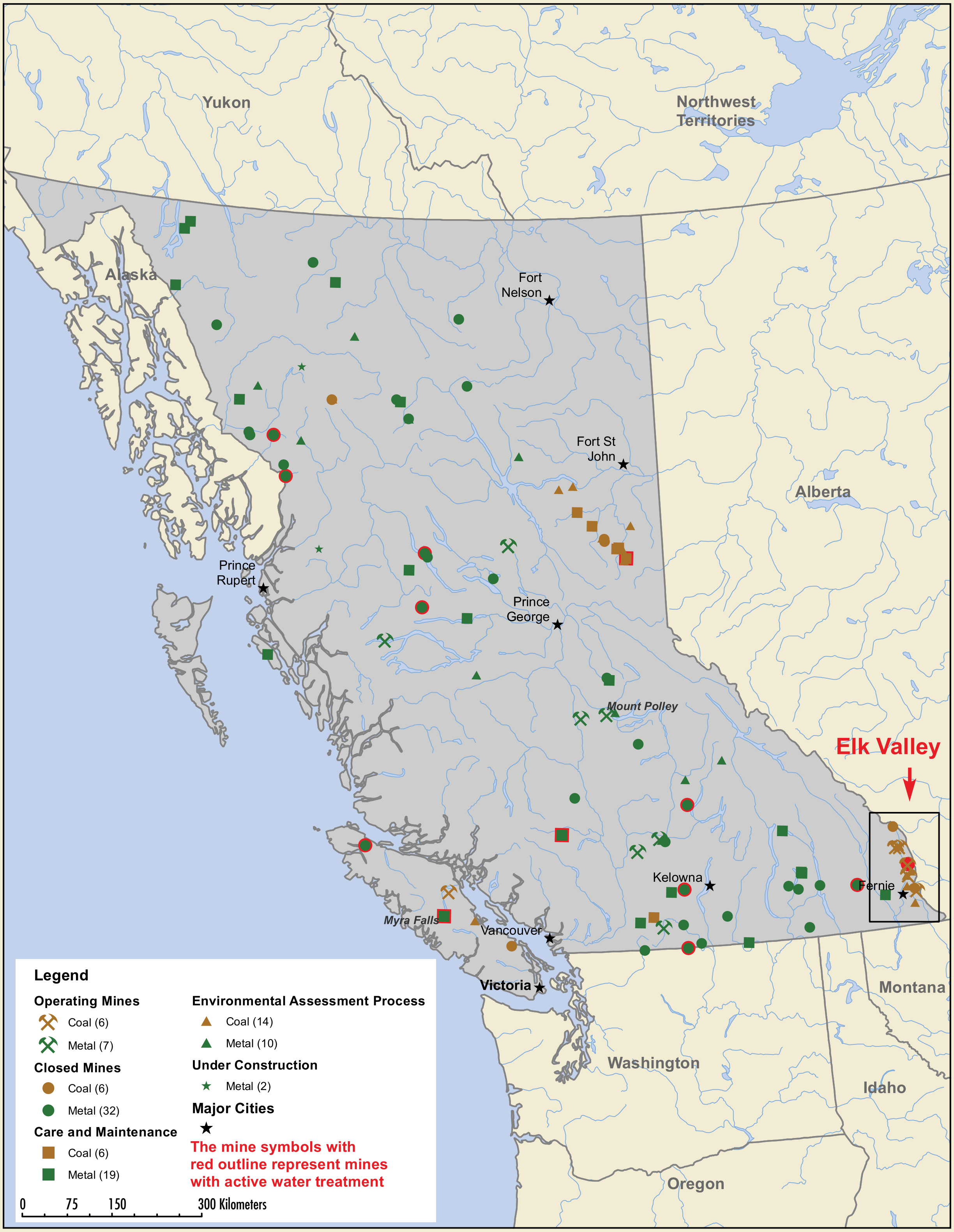
The remaining sites are generally older, smaller mines that predate 1969 – the year that government enacted legislation requiring mine operators to meet more stringent environmental standards. For these older mines, government could be left with the full cost of remediation if water quality issues were to develop at these mine sites.

The Government of B.C. supports the continued growth of the mining industry, as indicated in the 2012 BC Jobs Plan. That plan included a target of having eight new major mines in operation by the end of 2015 and expanding nine existing mines. MEM reported in June 2015 that two new mines had started operation and seven had expanded. The ministry cited that low commodity prices during 2014/15 impacted the rate of mine expansions.

Click on the terms that are **bold** and **blue** to go to the definition in the glossary (**Appendix B**).

BACKGROUND

Exhibit 1: Major mines in British Columbia as of August 2015



Source: Created by GeoBC for the Office of the Auditor General of British Columbia

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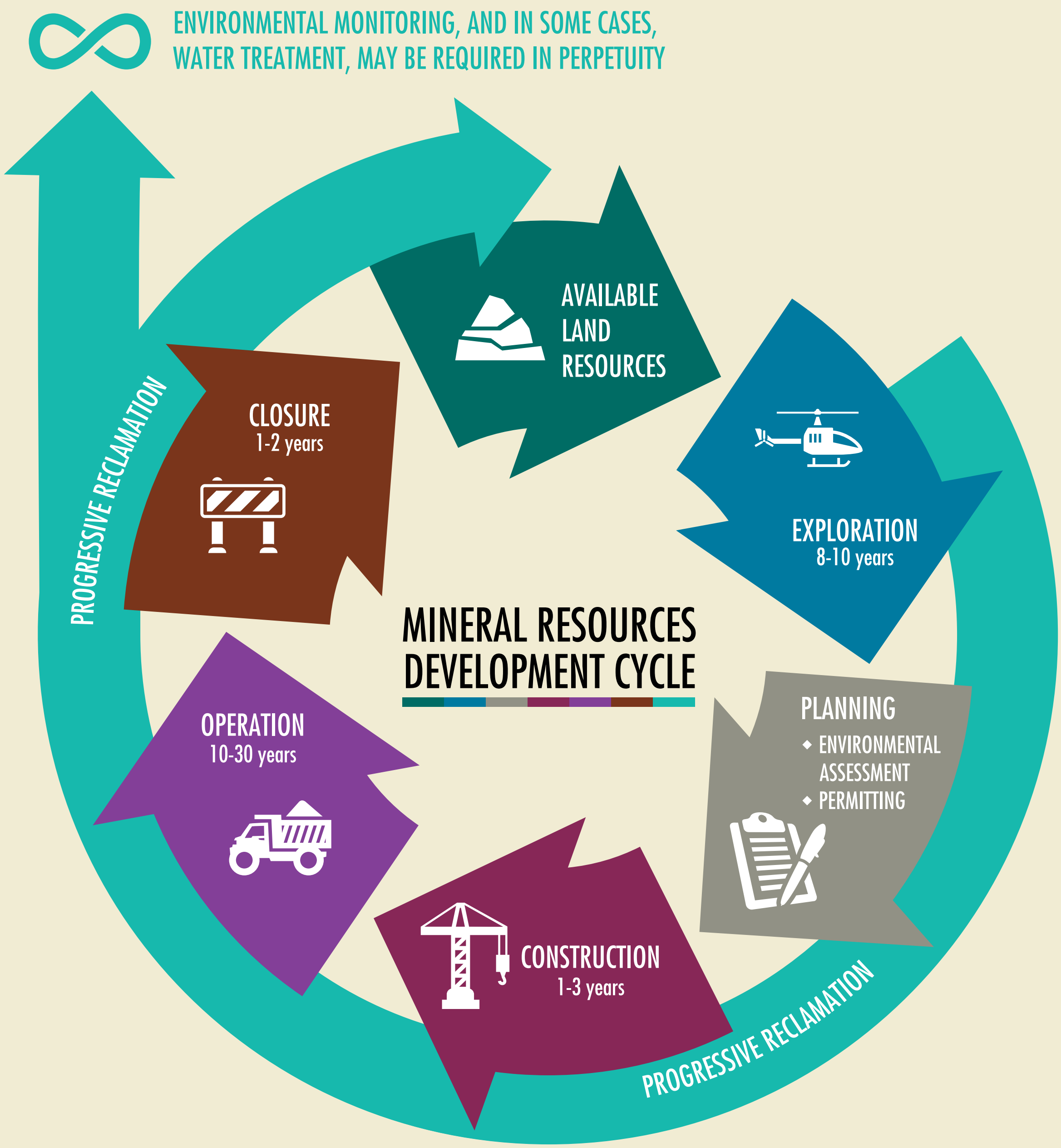
BACKGROUND

At the same time, government has a long-standing commitment to ensure that mining activities protect the province's environmental values. There is a tension between fulfilling this commitment and working to grow the economy and create jobs, but government has stated that it embraces this dynamic. Mining activities inherently involve several environmental risks such as erosion, loss of habitat, carbon emissions, dust and sedimentation. However, the greatest environmental risk from mining is water contamination.

Given the tension and these risks, a robust compliance and enforcement program is essential to ensure that the environment is protected.

BACKGROUND

Exhibit 2: The life cycle of a mine
MEM supports the concept of progressive reclamation – that is, pro-active and ongoing reclamation that begins early in mine development and continues over the life of the mine. In many cases, reclamation continues after closure for a defined period (until closure obligations are met by the mine operator). However, a mine that is generating, or has the potential to generate, contaminated water must be monitored indefinitely by the mine operator, and may require long-term or perpetual water treatment.



Source: Office of the Auditor General of British Columbia, adapted from Mineral Resources Education Program of BC

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ENVIRONMENTAL CONCERNS WITH MAJOR MINES

The mining process

The life cycle of a mine begins with geoscience surveys and exploration to discover valuable coal or mineral deposits. Discovery leads to construction, operation and eventual closure when the extractable resource is depleted or no longer economically viable to extract (see Exhibit 2).

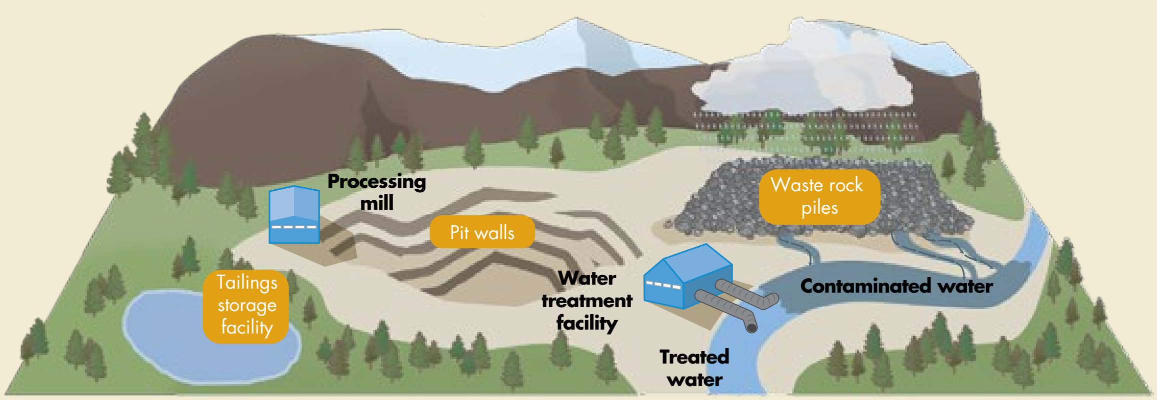
How the mining process can generate pollution

Ore is mineralized rock containing a valued metal (such as gold or copper) or other mineral substances (such as coal). In **open pit** mines, ore is extracted from an excavated open pit. Acid and metals, if contained in exposed pit walls, can leach into the surrounding environment. The extracted ore also includes large quantities of waste rock (material not containing the target mineral) that gets stored at the mine site. These waste rock piles, which may contain acid-generating sulphides, heavy metals and other contaminants, can become a source of **pollution**.

The ore that contains the valued metal or mineral is crushed and ground into fine particles the size of sand or silt. This ore is then processed using various chemicals and separating methods to extract the final desired metal or mineral. The by-products of this process are the **tailings**. Mine tailings often contain the same potentially toxic heavy metals and acid-forming minerals as waste rock, and may also contain the chemical agents used in processing, such as cyanide or sulphuric acid. Tailings are usually stored above ground in containment areas or ponds.

Both waste rock and tailings, if improperly secured, can leach out contaminants into surface water and groundwater, resulting in significant pollution and adverse effects (see Exhibit 3).

Exhibit 3: Potential sources of water pollution in an open pit mine: pit walls, waste rock piles and tailings



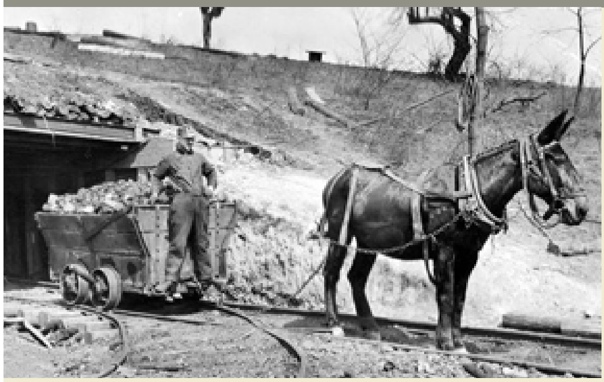
Source: Office of the Auditor General of British Columbia, adapted from the International Network for Acid Prevention's *Global Acid Rock Drainage Guide* and adapted from the *Elk Valley Water Quality Plan*.

BACKGROUND

Advances in mechanization and technology in the mining industry make it profitable for companies to mine more materials than ever before. The result, however, is that mine waste in some of Canada's larger mines has multiplied enormously – from 100s of tonnes per day in the early 1900s to 100,000–200,000 tonnes a day in some of Canada's larger mines now. This creates a greater potential source of pollution (see Exhibit 4).

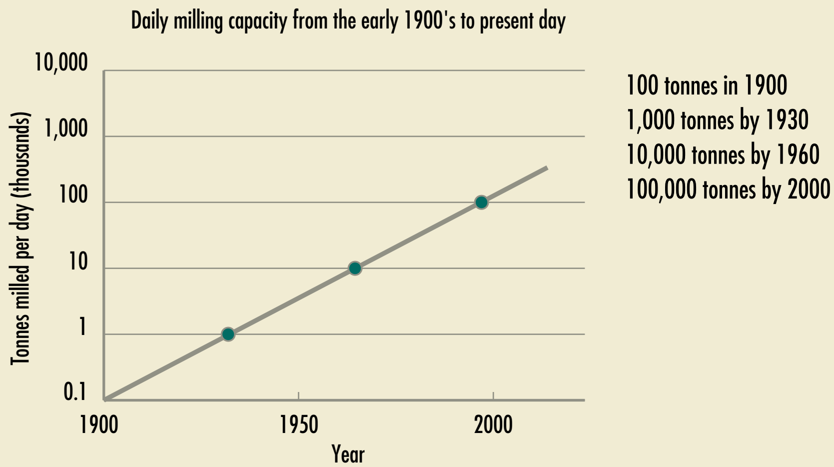
In B.C., metal mines are typically low grade, meaning greater quantities of waste material are now being generated in order to extract target minerals (see Exhibit 5).

Exhibit 4: Growth of production in Canada's largest mines



Coal mining in the early 1900's
Source: www.brooklineconnection.com

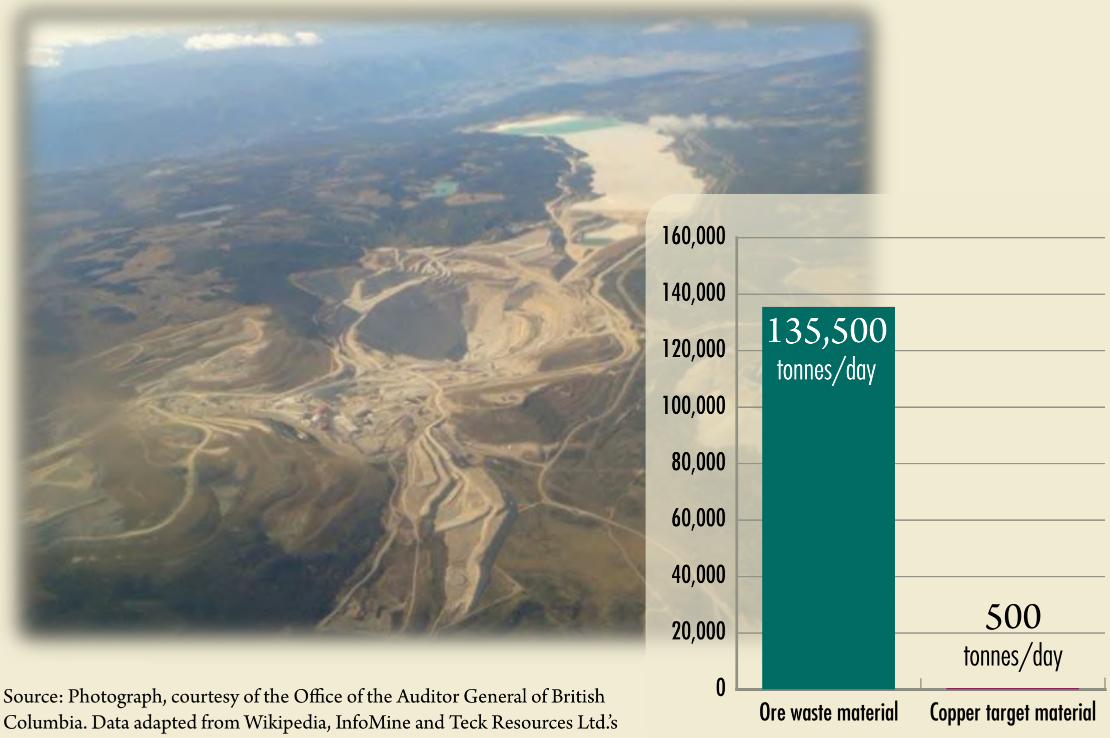
Present-day haul trucks have the capacity to move hundreds of tonnes of material.
Source: Stock image



Source: Office of the Auditor General of British Columbia, adapted from Robertson GeoConsultants Inc., *Mine Water Solutions in Extreme Environments*

BACKGROUND

Exhibit 5: Highland Valley copper mine's production



Source: Photograph, courtesy of the Office of the Auditor General of British Columbia. Data adapted from Wikipedia, InfoMine and Teck Resources Ltd.'s 2014 *Annual Report*

Water pollution and environmental impacts from mining

The most serious environmental issues facing the mining industry, government and the public is water contamination resulting from the chemical processes associated with **acid rock drainage** (ARD) and **heavy metal and non-metal leaching** (leaching).

ARD can occur when mineral deposits are excavated from an open pit or exposed in an **underground mine** and then react with air and water to produce acid (see Exhibit 6). While ARD is a natural process, the scale can be magnified as a result of mining activities. ARD has the potential to severely degrade water quality, kill aquatic life and make water virtually unusable.

Leaching can occur when minerals containing heavy metals and non-metals (such as arsenic, copper, cadmium, lead, zinc and selenium) in excavated rock or exposed mine walls come into contact with water and then seep from the rock into the environment. Metal and non-metal dissolving and transportation may be accelerated in the acidic conditions created by ARD.

BACKGROUND

Exhibit 6: Acid rock drainage on land and in water

Source: iStock (top) and Office of the Auditor General of British Columbia (bottom)

The contaminants that result from ARD and leaching can be carried from a mine site and deposited into streams, rivers, lakes and groundwater. The result can be a slow, but severe, degradation of water quality and subsequent damage to fish populations and aquatic life. In the case of a sudden tailings dam breach, the result can be immediate and cause catastrophic damage.

Within the U.S. and Canada, ARD and leaching have contaminated rivers, caused significant ecological damage, loss of aquatic life and resulted in multimillion-dollar clean-up costs for industry and government (see Exhibit 7).

Challenges in dealing with ARD and leaching

Planning and working to prevent ARD and leaching is an important part of avoiding environmental degradation and declining quality of aquatic habitat and drinking water. From a regulatory and environmental risk perspective, considerable emphasis in mine development is placed on preventing or mitigating ARD and leaching. There are various provincial and national committees focused on conducting research and sharing good practices between government and industry.

In recent years, technological advances and improvements to mining practices have helped in this regard, though significant environmental risks remain. ARD and leaching are dynamic and complex chemical processes that are challenging to predict. The actual environmental impact varies, depending on factors such as the size and location of the mine and the characteristics of the surrounding environment. Furthermore, the rates and timing of ARD and leaching onset vary in response to a wide range of site-specific mining, geological and environmental factors. For example, at some mine sites, onset is instantaneous; at others, it has taken anywhere from 10 to 20 years.

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Exhibit 7: The Faro Mine, Yukon

The Faro Mine, located in south central Yukon, is one of the largest and most complex contaminated sites in Canada. It was an open-pit lead-zinc mine from 1969 until it went into receivership in 1998 and ultimately closed. The site covers approximately 2,500 hectares and includes nearly 400 million tonnes of tailings and waste rock. These materials contain high levels of heavy metals that could leach into the environment in the absence of remediation. Yukon taxpayers will pay an estimated $700 million for the clean up of this site.

Source of photograph: Aboriginal Affairs and Northern Development Canada

Once initiated, these processes can persist for hundreds or even thousands of years (see Exhibit 8).

Mine companies can mitigate the effects of ARD and leaching, but there is no walk-away solution. A mine that is generating, or has the potential to generate, contaminated water must be monitored indefinitely, and may require long-term or perpetual water treatment.

A common practice in B.C. to prevent ARD and reduce leaching is to store the acid-generating rock under water in tailings ponds to minimize the oxidation process. These ponds must remain permanently flooded. There are other mitigation options, such as surface covers, but MEM's ARD and leaching guidelines state that these options are less reliable than underwater storage. Where other strategies are unsuccessful, drainage collection and chemical treatment may be the only feasible means of preventing impacts. MEM also states in these guidelines that water treatment should generally be the mitigation strategy of last resort.

In practice, however, water treatment is not unusual in B.C., and government does approve mines that require water treatment from the outset — 14 major mines currently have water treatment facilities. MEM has

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ranked 45 additional mines as having moderate to high potential of ARD and/or leaching, and has estimated that 12 of these mines will require perpetual water treatment.

While water treatment is a common practice in B.C. and other jurisdictions, some areas – the Northwest Territories, Manitoba and Wisconsin – do not allow mining operations that require long-term water treatment. This is due to the increased risk that taxpayers will ultimately be left with the cost of remediation.

These water treatment plants (see Exhibit 9) must be monitored by industry and government, maintained and periodically replaced, in perpetuity. This assumes that mining companies are willing and able to take on these costs indefinitely – a risky assumption given the boom and bust nature of mining and the reality that companies do not exist forever.

If industry is unable to maintain and replace these facilities or fulfill the environmental obligations in their permit, there is a risk that the taxpayer will have to bear these costs. In B.C., to reduce the possibility of taxpayers being left with the financial burden of these facilities and environmental **reclamation** costs of mine sites, mining companies must provide a **financial security deposit**. This deposit is designed to ensure, with "reasonable assurance" (as decided by the Chief Inspector of MEM), that taxpayers will not have to contribute to reclamation costs if a company defaults on its reclamation obligations. This includes any ongoing requirements for management and monitoring to achieve environmental protection.

Exhibit 8: Roman era mine in Spain dating back 2,000 years, but still producing acidic wastewater.

Source: The International Network for Acid Prevention's Global Acid Rock Drainage Guide

BACKGROUND

GOVERNMENT'S ROLE AS AN ENVIRONMENTAL PROTECTION REGULATOR

Under existing B.C. legislation and policies, mining companies are fully responsible for environmental protection and reclamation at their mine sites. The companies must demonstrate that their plans for the development, operation and closure phases of the mines will be effective. It is government's role to ensure that the activities undertaken by the mine operators are protecting the environment.

Legislation and regulations under several agencies apply to mining in B.C. For this audit, however, we focused on those that are the responsibility of MEM and MoE because these two ministries:

- are the primary permitting agencies for major mine operations, and
- have environmental protection mandates and associated compliance and enforcement responsibilities under provincial legislation.

While their mandates overlap somewhat, there are also key differences.

MEM's responsibilities apply generally *within the mine site*. The Chief Inspector of Mines, appointed by the Minister of Energy and Mines, administers the *Mines Act* and the Health, Safety and Reclamation Code for Mines in British Columbia to ensure the protection and reclamation of the land and watercourses affected by the mine. MEM grants a permit under the *Mines Act* to ensure mines are designed, built, operated and reclaimed to an acceptable standard. MEM collects a financial security deposit from mining companies to help ensure that reclamation obligations are kept.

MoE's responsibilities are generally defined as *extending beyond the borders of the mine site*. MoE regulates, through the granting of a permit under the *Environmental Management Act*, the quantity and quality of any waste discharges from metal and coal mines to ensure the protection of the environment.

Exhibit 9: The water treatment facility at Equity Silver Mine in central B.C.

Source: Office of the Auditor General of British Columbia

This mine operated from 1980 to 1994, and did not include a plan for water treatment, as ARD was not predicted to become an issue. However, ARD did occur and the costs to treat it have continued to grow, even though the mine is closed. Costs include $8 million to build the new water treatment facility shown above, and increasing lime costs to neutralize the acid. The mining company has borne these costs. A security deposit is currently held by MEM of $62 million which provides a safety net for taxpayers.

AUDIT OBJECTIVE AND CONCLUSION

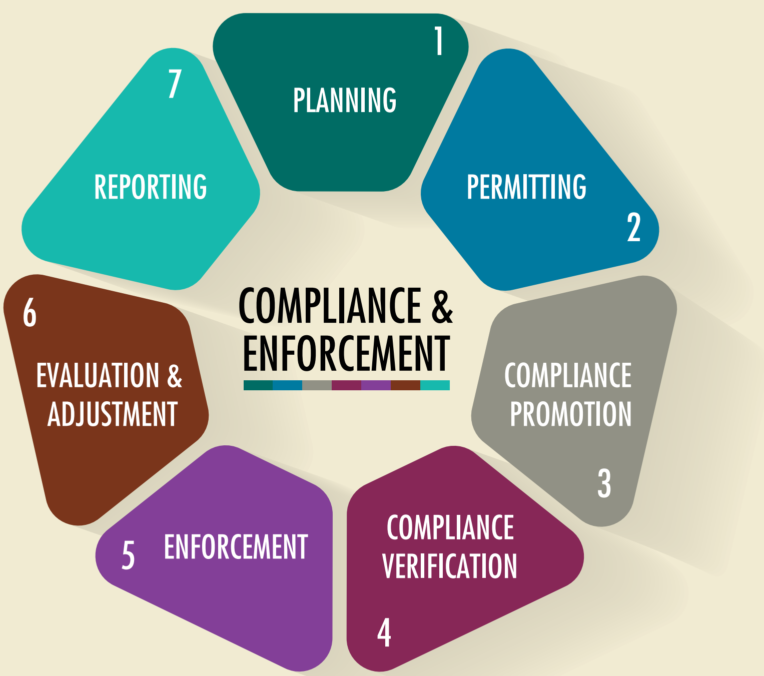
WE CONDUCTED THIS audit to determine whether the regulatory compliance and enforcement activities of the Ministry of Energy and Mines and the Ministry of Environment pertaining to the mining sector are protecting the province from significant environmental risks.

We expected the compliance and enforcement program of the two ministries to have the seven key elements – defined by good practice – that would make such a program effective (shown below). We also expected that MEM and MoE would be working together to achieve their combined objective of protecting the environment. (For more details on the audit expectations and scope, see Appendix A).

We concluded that MEM and MoE's compliance and enforcement activities of the mining sector are inadequate to protect the province from significant environmental risks.

The following two sections of the report address our key audit findings for each ministry. The first section pertains to MEM and the second section to MoE.

Seven key elements of a comprehensive compliance and enforcement program



Source: Office of the Auditor General of British Columbia, adapted from the Organisation for Economic Co-Operation and Development's *Ensuring Environmental Compliance: Trends and Good Practices* and MOE's *Compliance Management Framework*

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MEM CONCLUSION

We concluded that the Ministry of Energy and Mines' compliance and enforcement activities of the mining sector are inadequate to protect the province from significant environmental risks.

SUMMARY OF KEY FINDINGS

MEM's compliance and enforcement program is limited. As a result, the ministry is deficient in carrying out most of the expected regulatory activities, such as creating guidance documents, undertaking inspections, monitoring data provided by industry, and enforcing non-compliance. The ministry lacks the resources, training and tools necessary for compliance and enforcement. Furthermore, MEM does not coordinate its compliance and enforcement activities with those of MoE. MEM has not publicly reported on the effectiveness of its regulatory oversight. MEM has estimated that its financial security deposits for major mines are under-secured by more than $1.2 billion, yet the ministry has not disclosed this to the public or to legislators, or communicated the potential risk this poses.

MEM'S ROLES AND RESPONSIBILITIES

MEM's service plan has two goals:

- Goal 1: Globally competitive energy and mining sectors that create jobs and grow the economy
- Goal 2: Safe, environmentally and socially responsible energy and mineral resource development and use

To achieve these goals, MEM has two main regulatory tools: the *Mines Act*, which governs all activities that occur on mine sites; and the Health, Safety and Reclamation Code (Code) for Mines in British Columbia, which regulates all mining activities. The purpose of the *Mines Act* and the Code is to:

- Protect the health and safety of workers and public from mining activities.
- Protect and reclaim the land and watercourses affected by mining.
- Support and monitor the efficient development of the Crown's mineral and coal resources, while managing environmental impacts.
- Facilitate successful reclamation (see sidebar) and closure of mine operations.
- Regulate environmental and reclamation liabilities at mines through permitting and bonding to ensure that public funds will not be required to pay the costs of mine clean up.

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Health, Safety and Permitting Branch

Within MEM's Health, Safety and Permitting Branch is the permitting group. Unlike MoE, staff responsibilities within this group include both permitting and compliance and enforcement. There are two sections within this group: geotechnical and reclamation.

The geotechnical section is responsible for many activities, including:

- technical review of proposed mining projects
- geotechnical review of incidents and responding to mine inquiries
- geotechnical advice and policy development
- inspections that focus on a range of activities, including the performance of tailings dams, waste rock dumps, open pit slopes and underground openings

The reclamation section is responsible for many activities, including:

- technical review of proposed mining projects
- conducting ARD and leaching (water quality) assessments
- review of various environmental plans and reports
- administering reclamation security deposits on behalf of the province
- inspections of mine reclamation activity

As of July 2015, the permitting group consisted of nine staff, including two geotechnical engineers, two reclamation scientists, four environmental geoscientists specializing in geochemistry and water quality, plus the Deputy Chief Inspector of Mines.

WHAT IS RECLAMATION?

Mining companies are required to reclaim all lands disturbed by mining. While MEM has not defined what it means to *reclaim all lands*, MEM has established broad reclamation standards within the Health, Safety and Reclamation Code for revegetation, growth media, metal uptake, landforms, watercourses, water quality, disposal of chemicals and reagents, and monitoring and post-closure land use.

The Act and the Code require that mine or mineral exploration operators place an adequate financial security in trust with the province before receiving their permit to operate. This security is returned only after reclamation is completed to a level deemed satisfactory by the Chief Inspector. It ensures that the costs of reclamation will not be borne by taxpayers if a mining company defaults on its obligations. Companies continually reclaim land throughout the life of a mine in order to reduce their reclamation liability at closure.

MEM must collect sufficient security for mines that require long-term or perpetual management, which includes monitoring and maintenance of water treatment facilities and waste rock dumps.

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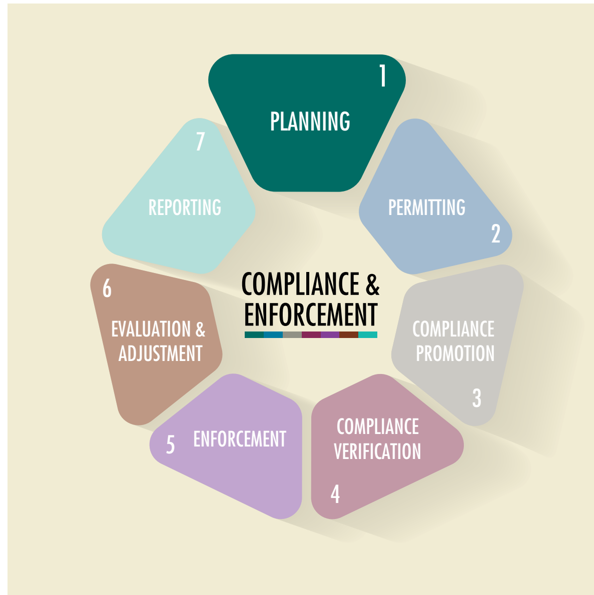
OUR EXPECTATIONS

We expected MEM to have a strategic plan that would detail the activities of the ministry's regulatory approach, including how MEM works with the Ministry of Environment (MoE). This plan would demonstrate how these activities intend to achieve MEM's objective of ensuring the protection of the environment; and, it would include all the elements – defined by good practice – that are critical to ensuring compliance (see page 28). Such practices include:

- setting regulatory requirements that are enforceable
- promoting compliance (to achieve high rates of voluntary regulatory compliance)
- verifying compliance (to ensure that industry is meeting government's regulatory requirements)
- enforcing regulatory requirements to compel the mining industry to swiftly return to compliance.

As well, we expected MEM to be ensuring continuous improvement of its compliance and enforcement program through evaluation and adjustment, and to be reporting out to the Legislature and the public on the results of their activities.

DETAILED KEY FINDINGS



1. Planning

We expected MEM to have an overall compliance and enforcement program underpinned by a strategic plan. This plan would set goals, objectives and performance indicators; in addition, it would indicate how MEM was working with MoE to achieve the objective of protecting the environment. We also expected MEM's strategic plan to be supported by the resources, training, expertise and tools needed to make an effective compliance and enforcement program.

We found, however, that MEM lacks strategic direction, goals, objectives and performance indicators to provide a framework for an effective compliance and enforcement program that ensures the protection of the environment.

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MEM has not focused on developing a compliance and enforcement program. Most of MEM's efforts are devoted to supporting the development of mining through processing permits for new and existing mines. This emphasis reflects MEM's mandate to promote the development of mining in B.C. However, we found that this emphasis on mining promotion combined with a weak compliance and enforcement program creates the risk of regulatory capture for the ministry (see sidebar).

We found that MEM exhibits most of these signs which can give rise to a reasonable perception of, and increase the actual risk of, regulatory capture.

REGULATORY CAPTURE

Regulatory capture occurs when the regulator, created to act in the public interest, instead serves the interests of industry.

Possible signs of regulatory capture can include:

- The regulator is located within the agency responsible for promoting the economic interests of the industry.
- In agency publications, environmental protection is merely one goal alongside others such as economic development.
- The regulator has a low level of prosecution activity.
- The legislation applying to the regulator gives the regulator wide discretion to act.
- The regulator's budget and resources are not comparable with those in the industry.
- The regulator shows a marked preference for giving informal recommendations and advice, which are not properly recorded.
- There is a high shift of enforcement officers from the agency to the industry, where they are able to earn significantly more than they did working as enforcement officers.
- Regulatory work often takes place in isolated regional communities, and there is frequent social collaboration between industry and the regulator.

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OVERALL RECOMMENDATION

WE RECOMMEND THAT THE GOVERNMENT OF BRITISH COLUMBIA: create an integrated and independent compliance and enforcement unit for mining activities, with a mandate to ensure the protection of the environment.

Given that the Ministry of Energy and Mines (MEM) is at risk of **regulatory capture**, primarily because MEM's mandate includes a responsibility to both promote and regulate mining, our expectation is that this new unit would not reside within this ministry.

Coordination with MoE

In 2009, the provincial government introduced a policy for a coordinated and integrated approach to natural resource management in the mineral exploration and mining sectors of B.C. Because both MEM and MoE have an overlapping mandate of protecting the environment, a protocol agreement between the ministries was created in 2009 and updated in 2014. It states, "In the interests of efficiency, efforts will be made to coordinate through the inspector of mines, inspection and monitoring activities relating to tailings impoundments."

We therefore expected the ministries to be coordinating their compliance and enforcement planning work and activities. Instead, however, we found that MEM's inspection planning is not coordinated with that of MoE, nor does MEM regularly advise MoE of non-compliances, and subsequent enforcement actions that it has taken. And although the two ministries have developed a "Memorandum of Understanding for the Environmental Management of Mining Projects," this document has been in draft form since 2012.

This lack of coordination may reduce the effectiveness and efficiency of MEM's compliance and enforcement actions, and creates a risk that environmental impacts are not being addressed.

Resources, expertise, training and tools

To do their work effectively, regulatory authorities need access to the physical, technical and financial resources they require to meet their mandate and scope of work. Management should therefore aim to attract and retain qualified and experienced program staff by offering reasonable remuneration and professional development opportunities. As well, management should ensure that staff have the necessary tools to do their work effectively.

Resources

We expected MEM to have determined the resources it needs to undertake an effective compliance and enforcement program. We found this was not the case. MEM had not completed comprehensive analyses to identify its required resources.

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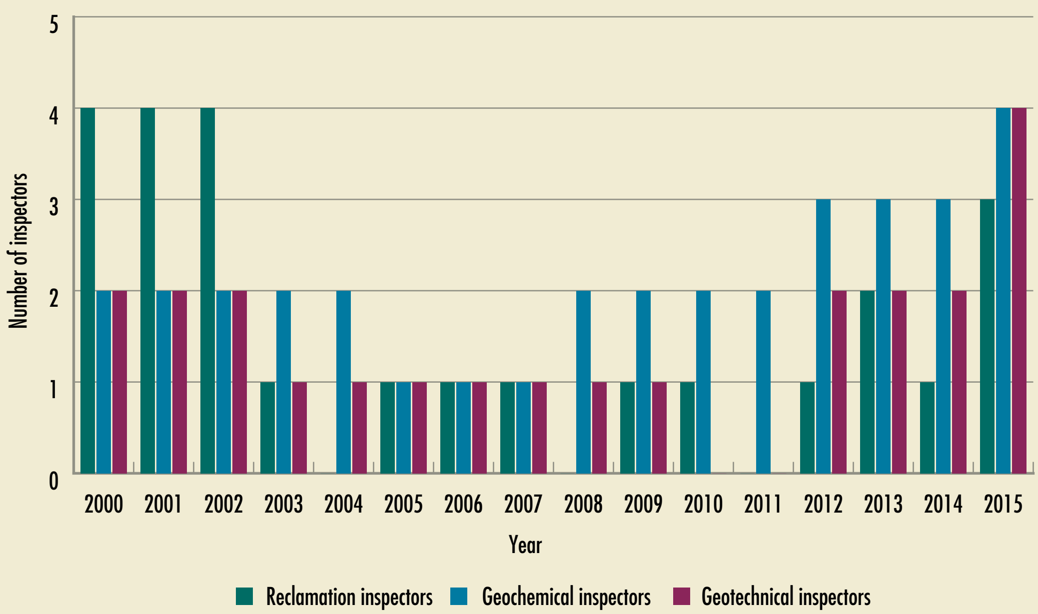
Exhibit 10: The number of inspectors in the Ministry of Energy and Mines' permitting group, 2000–2015



Source: Office of the Auditor General of British Columbia, adapted from MEM data

In the early 2000s, MEM dramatically reduced its number of inspectors,[2] by 50% – from nearly 80 in 2001 to about 40 in 2006. Specifically, in the permitting group, staffing levels dropped from eight full-time employees in 2001 to a low of two in 2011. By the end of 2015, there were 11 inspection staff in the permitting group (see Exhibit 10). The geotechnical manager position was vacant for over three years until being filled in 2011. As of Spring 2015, the position was again vacant (although, MEM had temporarily placed a senior geotechnical staff member in an acting manager position).

Throughout these years of declining full-time staff at MEM, the number and complexity of permit applications increased substantially. MEM used contractors to assist with workloads, which required significant oversight to ensure consistency of approach between projects, and consistency with provincial policy. The demand on staff time through this approach resulted in increased stress and workload.

From 2011 to 2015, MEM did not receive adequate funding for its programs and relied on **contingency funding** to supplement its budget. In 2015, MEM received a substantial increase to its budget to create a Major Mines Permitting Office and to create additional capacity.

Click on the terms that are **bold** and **blue** to go to the definition in the glossary (**Appendix B**).

[2] As stated in MEM's *Annual Chief Inspector Report* (2006), this includes Health and Safety Inspectors, in addition to specialist inspectors, such as Electrical, Mechanical, Geotechnical, Reclamation, Ergonomic and Occupational Health.

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Expertise and training

Mining is a complex and constantly changing industry that requires knowledge and expertise in many technical disciplines. We expected all MEM staff to have the necessary qualifications and experience to carry out inspections and enforcement and to review industry's self-reporting data. We found that staff in MEM's permitting group during the period of 2012–2014 were qualified for their positions and did have the required technical expertise. Nevertheless, we also noted that MEM has struggled to fill vacant positions and to retain individuals with experience in mining – a challenge the ministry has attributed to the more competitive salaries offered by industry.

We also found MEM's training in compliance and enforcement was inadequate in that the ministry does not have a formal inspector training program. Budget constraints have created limited opportunities for training in this area.

Tools

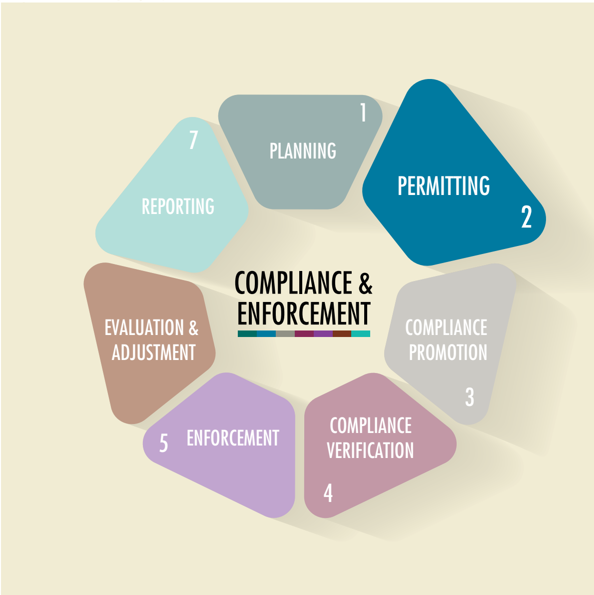
We expected MEM inspectors to have necessary and appropriate tools, such as data tracking systems, and policy and guidance, to perform their compliance and enforcement roles. The ministry's data system to track compliance and enforcement activities has been in place since 2000, but we found it was incomplete, cumbersome and does not link to other natural resource sector systems.

As well, tracking of permit requirements is difficult, because MEM's does not incorporate amendments into the overall permit, and instead, creates an addendum to the original permit. This results in a stack of documents that together make up the mine permit. The eight mines in our audit sample each had between 6 and 80 amendment documents. This practice can make it difficult to understand the permit requirements in detail, especially when the amendments can span several decades.

We also found that MEM has provided staff with little policy and guidance about its overall approach to compliance and enforcement. The ministry's inspection procedures are broad and include vague statements without clear guidance for staff or contractors. For example: "Reclamation inspectors should ***satisfy themselves*** that the company is fulfilling the requirements of their reclamation plan;" and, "closed mines should be inspected ***from time to time*** as practical."

RECOMMENDATION 1.1

Strategic planning*—We recommend that government develop a strategic plan that would detail the activities of an integrated and coordinated regulatory approach, and the necessary capacity, tools, training and expertise required to achieve its goals and objectives.*



2. Permitting

Most of MEM's efforts are devoted to supporting mine development through processing permits for new and existing mines in the province. The ministry has stated that its focus on permitting plays a crucial role in preventing and reducing environmental risk. We therefore expected MEM to ensure permits are consistently written with enforceable language.

We also expected that permits would help to ensure that taxpayers would be safeguarded from having to pay costs associated with environmental impacts.

Enforceability

We selected a sample of MEM's mine permits and reviewed the wording of the requirements. We expected to find consistent use of regulatory language and measureable criteria, such as thresholds and timing. However, for all of the permits we reviewed, we found examples of vague phrasing and inconsistent use of regulatory language that would make permit requirements difficult to implement, measure and enforce.

For some permit requirements, discretion is left to the Chief Inspector of Mines to assess the mine's performance, such as: "All drainage collection and treatment facilities shall be operated and maintained for as long as is necessary to achieve environmental protection requirements, as required by the Chief Inspector." There is no clear guidance for how the Chief Inspector makes (or delegates) decisions, nor are the decisions clearly documented. This lack of transparency may lead to inconsistencies in the enforcement of permits.

We also found that MEM does not regularly evaluate or review permits to identify areas that might create barriers to enforcement. This lack of review is concerning, especially for permits that are for older mines that may not have been designed to adequate environmental standards.

RECOMMENDATION 1.2

Permit language—*We recommend that government ensure both historical and current permit requirements are written with enforceable language.*

Safeguarding taxpayers

The polluter-pays principle states that the party responsible for environmental damage should bear the associated costs of the clean up. Consistent with this principle, MEM's policies aim to provide assurance

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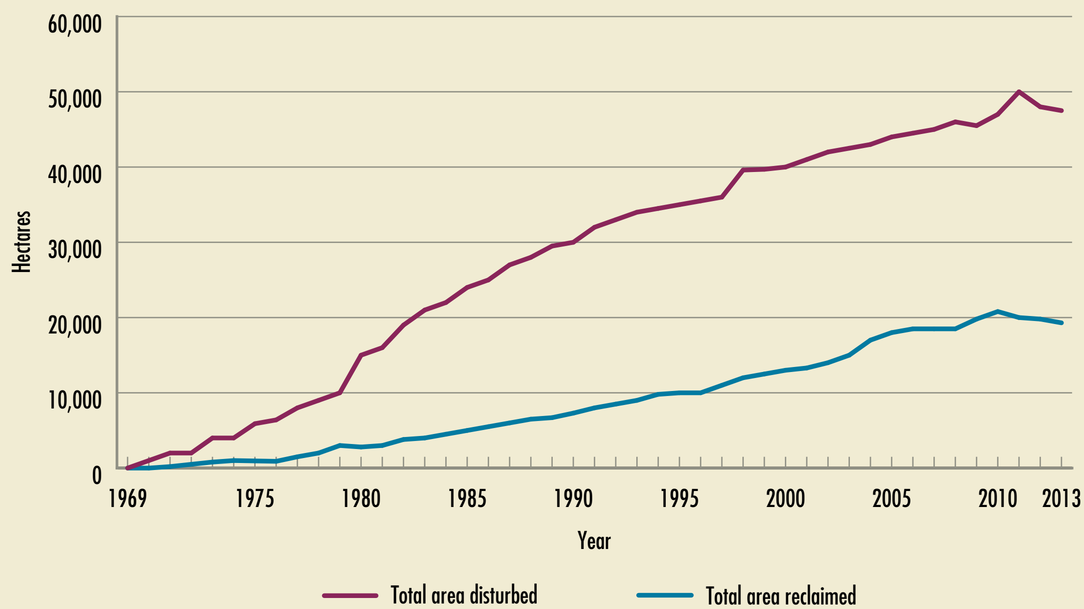
Exhibit 11: Area disturbed and area reclaimed (hectares) by metal and coal mines in B.C., 1969–2013



Source: Office of the Auditor General of British Columbia, adapted from MEM data

that certain costs will be borne by the mining company, and not the public, through the collection of a financial security deposit - a condition of a *Mines Act* permit. This security is returned only after reclamation is completed to a level deemed satisfactory by the Chief Inspector of Mines.

The security is designed to ensure that the company returns land, watercourses and cultural heritage resources to a safe and environmentally sound state after operations have ended. It is also intended to ensure that the taxpayers will not have to contribute to reclamation costs and any potential on-going monitoring costs if a company defaults on its permit obligations.

As shown in Exhibit 11, the total amount of land disturbed by mining in B.C. has been steadily growing over the past 50 years. Some of these areas will be reclaimed, but there are areas that can never be reclaimed, such as some pit mine walls and pit lakes.

The amount of the security required for each mine (including any later amendments) is set in the ministry's mine permit. Although MoE also has the power, under the *Environmental Management Act*, to set its own requirement for security, it usually relies on MEM to collect the entire security for each mine.

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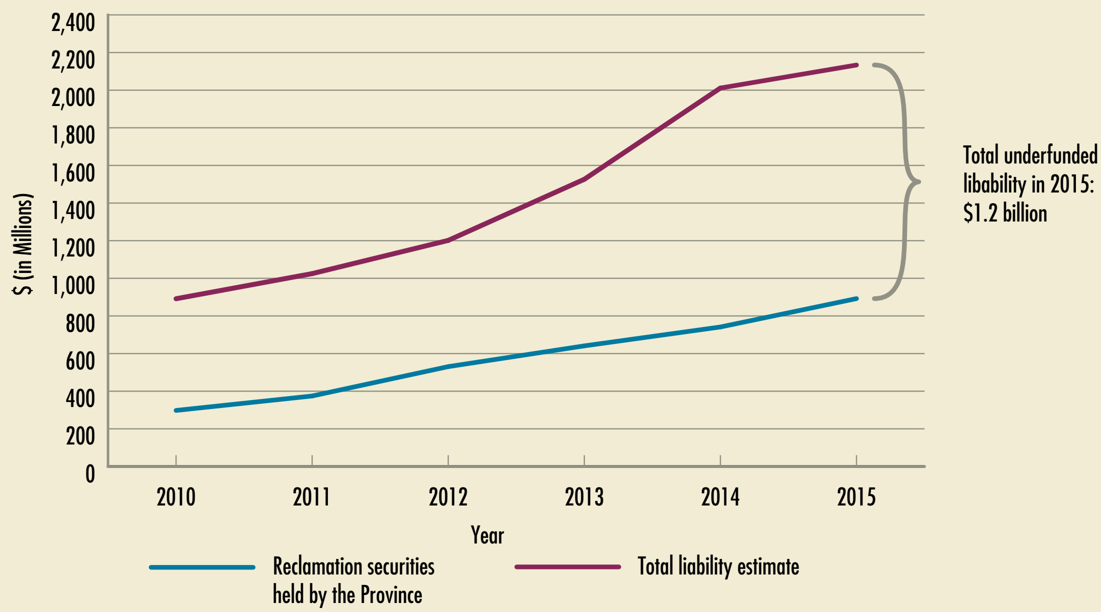
Exhibit 12: The total reclamation security deposit held by the Province compared to the total liability estimated, 2010–2015



Source: Office of the Auditor General of British Columbia, adapted from MEM data

We found that MEM could not provide evidence that government is holding an adequate amount of security to cover the reclamation costs, including any ongoing management and monitoring to achieve environmental protection. MEM has estimated the total liability (costs of outstanding reclamation) for all mines at more than $2.1 billion, yet MEM has stated that it is holding less than half that amount ($0.9 billion) in total security (see Exhibit 12).

We found that $730 million of the total under-funded liability ($1.2 billion) is for mines that will require water treatment. This is contrary to MEM's policy requiring full security on mines that require long-term water treatment.

The consequence of not collecting enough security from mining companies is that the taxpayer may be left to cover the costs, if the reclamation costs exceed the mining company's ability to pay. The Britannia Mine is an example of what can happen when the Province is left to pay remediation costs that include water treatment. In this case, taxpayers are estimated to have paid $46 million in order for the site to be remediated, including installing a water treatment plant that has an operating cost of over $3 million/year. The plant is expected to operate in perpetuity (see Exhibit 13).

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We also found that the calculation of the liability may not represent the actual risk. Specifically:

- there is uncertainty with predicting and calculating the long-term costs for perpetual water treatment.
- MEM provides limited oversight in terms of confirming the accuracy of the liability estimates that are provided by the mining company.

We found that not all mining companies reported annually their liability estimates, updated reclamation costs or an update on the total area they had reclaimed. MEM staff review these reports, but provide only limited scrutiny. The ministry does not have a designated costing specialist to assess the accuracy of the values provided by industry and the sufficiency of the security deposit.

RECOMMENDATION 1.3

Security—adequate coverage—*We recommend that government safeguard taxpayers by ensuring the reclamation liability estimate is accurate and that the security held by government is sufficient to cover potential costs.*

Exhibit 13: The Britannia Mine

Source: Office of the Auditor General of British Columbia

This closed copper mine, located 50 kilometres north of Vancouver, operated from the early 1900s to 1974. As a result of the mining activity, the surface and groundwater flowing from the mine site became acidic; and every day, for over 70 years, the mine released about 600 kilograms of metals into Howe Sound. This made the mine one of the largest sources of metal pollution, and one of the most contaminated areas, in North America.

In the mid-1990s, the Government of British Columbia pursued the former mine owners to pay for the costs of remediating the mine site. The province accepted a $30 million settlement that absolved the owners from any future liability. However, this settlement covered only a small portion of the $76 million Britannia Mine Remediation Project.

A water treatment plant constructed in 2005 has resulted in plant and animal life returning to Howe Sound. The annual operating cost of over $3 million will be borne by taxpayers in perpetuity.

Moreover, if an environmental disaster occurred and industry was unable to pay for the clean-up, MEM has no funding mechanism to cover the costs of taking action. Western Australia recently adopted a mandatory Mining Rehabilitation Fund that covers the rehabilitations of existing sites. The interest earned on the monies (paid by industry) is used to rehabilitate historical or abandoned sites. Such interest could, perhaps, also be used to offset the cost of environmental emergencies where a company does not have the ability to pay.

RECOMMENDATION 1.4

Security— catastrophic events—*We recommend that government review its security mechanisms to ensure taxpayers are safeguarded from the costs of an environmental disaster.*

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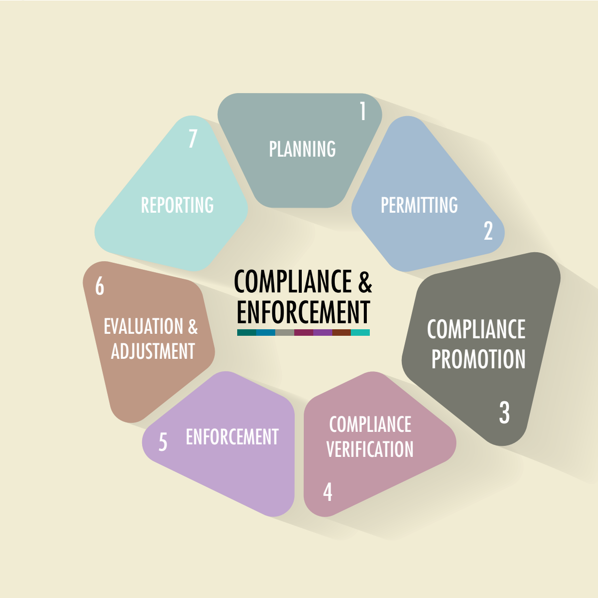

3. Compliance Promotion

Compliance promotion refers to any activity that educates and increases awareness about regulations, or that motivates or encourages voluntary changes in behaviour to comply with regulatory requirements.

It is a preventative strategy that includes both compliance assistance and compliance incentive programs.

Given the reduction in government resources, most countries recognize the growing importance of compliance promotion. We therefore expected MEM to have established an effective promotion program incorporating compliance assistance and compliance incentives.

Compliance assistance

We found that MEM organizes and actively participates in provincial and national committees that are focused on conducting research and sharing good practices with government and industry. While the ministry has created documents for industry to guide geotechnical and acid rock drainage/metal leaching work at mines, it has not established guidance for reclamation plans and activities. Guidance could provide more specific expectations to help industry meet the broad standards in the Health, Safety and Reclamation Code for Mines in British Columbia. It could also help government confirm whether industry is meeting the standards.

RECOMMENDATION 1.8

Reclamation guidance—*We recommend that government develop clear and comprehensive reclamation guidance for industry.*

Compliance incentives

In collaboration with other agencies, MEM created two annual award incentives to industry: the BC Mining and Sustainability Award and the BC Mining Reclamation Award. However, MEM has not assessed how effective these incentives have been in promoting compliance in the mining sector. We also found that, overall, the ministry could not demonstrate that its promotional activities and guidance materials were achieving voluntary compliance.

RECOMMENDATION 1.9

Incentives—*We recommend that government create effective incentives to promote environmentally responsible behavior by industry.*

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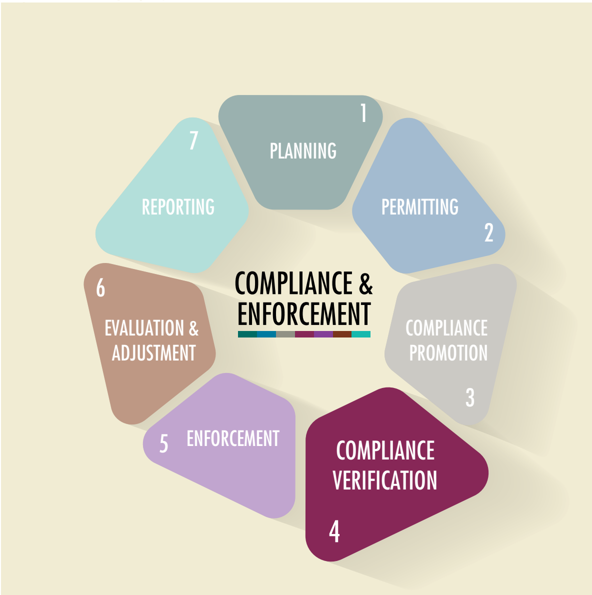


4. Compliance Verification

Compliance verification refers to monitoring and inspection to determine whether a mining company is in compliance with legislative and regulatory requirements, including the conditions of its permit. We expected MEM to be:

- applying a risk-based approach to planning its compliance verification activities,
- carrying out site inspections that meet its own policies, and
- monitoring industry reporting on compliance.

We found that MEM was deficient in all of these areas.

Risk-based planning

According to good practices, inspections should be based on a schedule that considers risk (impact to the environment and the likelihood of occurrence). Our expectation was therefore that MEM would be planning its inspections based on identified risks.

Instead, we found that the permitting group does not have a comprehensive, risk-based approach for its inspection planning and no policy that required one. The geotechnical and reclamation sections assessed risk and prioritized inspections separately and informally, based on criteria such as:

- policy to inspect all major operating mines each year
- dam risk classification
- length of time since last visit
- inputs from other staff
- complaints
- gaps in knowledge areas

Also missing was any clearly organized analysis that could be used to inform the annual planning of mine inspections based on risk to the environment. For example, MEM had ranked 45 mines as having moderate to high potential impacts on water quality; however, there was not a clearly documented rationale for these risk-ranking decisions nor a clear link between mine risk and planned annual inspections.

On several occasions in the last 10 years, ministry staff told higher-level management that inadequate monitoring and inspection, due to insufficient staffing levels, was putting the province at risk. However, we could not determine whether ministry executives fully knowingly assumed and accepted this risk, given that MEM does not have an internal risk management framework. Such a framework would include an annual process for compiling risks identified by staff, developing a plan to address key risks, and informing executive decision-makers about the remaining residual risks.

RECOMMENDATION 1.10

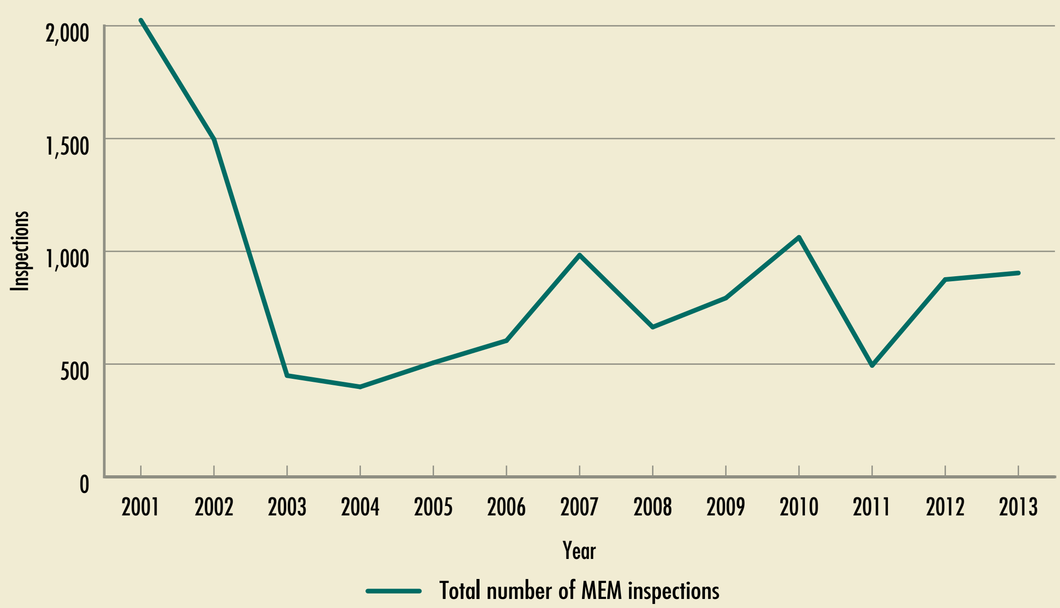
Risk-based approach*—We recommend that government develop a risk-based approach to compliance verification activities, where frequency of inspections are based on risks, such as industry's non-compliance record, industry's financial state, industry's activities (e.g., expansion), as well as risks related to seasonal variations.*

Site inspections

The ministry's reported data shows that the total number of MEM inspections across the entire Health, Safety and Permitting Branch has declined significantly since the early 2000's (see Exhibit 14).

While this graph may show a trend for the broader organization, this audit focused specifically on geotechnical and reclamation inspections. In these areas, the data MEM provided to us indicates that geotechnical and reclamation inspections at major operating mines fluctuated significantly for the years 2005-2014. Overall, inspections fluctuated from a high of nearly 20 (for both types of inspections) to a low of zero geotechnical inspections in 2010. This includes five years of single digit inspections for both types of inspections.

Exhibit 14: Total number of inspections by the Ministry of Energy and Mines, 2001–2013.
These inspections include Health and Safety inspections, in addition to specialist inspections such as Electrical, Mechanical, Geotechnical, Reclamation (includes geochemical inspections), Ergonomic and Occupational Health



Source: Office of the Auditor General of British Columbia, adapted from MEM data

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We reviewed MEM's reclamation and geotechnical inspection records for 2012, 2013 and 2014 for all major operating mines. In addition, we performed a detailed analysis of eight mines for those three years. Our sample consisted of four operating mines and four closed mines.

We found that MEM does not systematically evaluate whether a mine is compliant with its permit requirements; therefore, there is a risk that some permit conditions are not being complied with.

Below are the findings, based on our sample, for reclamation and geotechnical inspections at major operating mines and closed mines.

Reclamation inspections

MEM did not meet the minimum requirement of its policy to conduct reclamation inspections at all major mines at least annually, nor did it indicate where it had increased inspections as a result of continued non-compliance. Each of the four operating mines in our sample should have received one inspection for each of the three years sampled. Instead, we found that from 2012 to 2014, MEM conducted four reclamation inspections of the expected 12 for major operating mines in our sample. Of note:

- Gibraltar mine received an inspection in 2012, but it had not been inspected since 2008.
- Myra Falls mine has not received a reclamation inspection since 2006.

Over half the reclamation inspections that we reviewed were not completed according to the ministry's inspection procedures. For example, we were unable to determine (for any inspections) if the inspector had ensured the company was "fulfilling the requirements of their reclamation plan and complying with all the conditions of their reclamation permit in regard to stockpiling till or overburden; land use objectives; productivity; and acid mine drainage provisions."

Geotechnical inspections

In most cases, the geotechnical inspections were completed according to MEM's inspection procedures. For the three years that we reviewed (2012–2014), we found that the ministry generally met its policy of inspecting all the major mines annually. However, before this period, MEM did not consistently meet the policy. For example, the ministry performed only one geotechnical inspection in 2010 and six in 2011 (which corresponds with the absence of a geotechnical manager). The number of inspections increased in 2012 after a geotechnical manager was hired. However, in spring 2015, this manager left MEM and the ministry has not been able to permanently fill the position.

Closed mines inspections

We found that the number of inspections of closed major mines were inadequate, given the risks that are associated with these sites. In our sample of four closed mines, only one reclamation inspection and five geotechnical inspections occurred over the three year period of our review. According to its policy, MEM is responsible for ensuring that safe conditions prevail at closed or non-operating mines. This responsibility includes preventing pollution of land and water.

However, the policy states that inspection frequency at these mines should be "from time to time as practical."

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This lack of a specific timeline, coupled with the reduction of staff, has resulted in MEM inspections of closed mines being insufficient to identify significant risks.

> **RECOMMENDATION 1.11**
>
> ***Systematic compliance verification***—*We recommend that government systematically monitor and record compliance with high-risk mine permit requirements.*

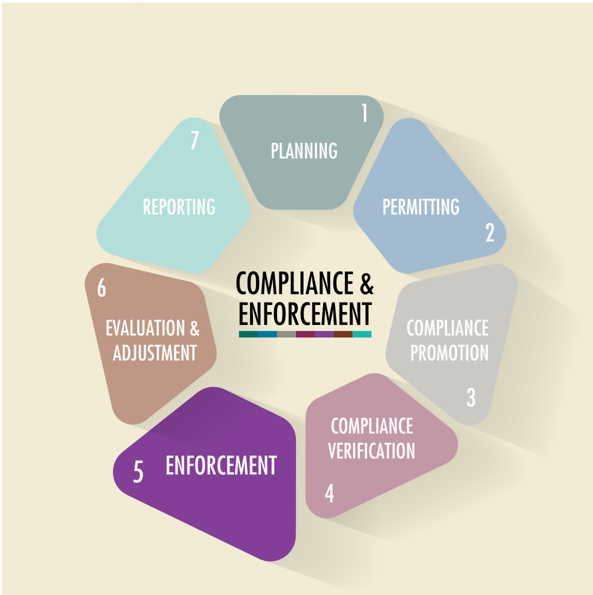
Monitoring of industry reports

Over the last decade, the government has adopted an approach to reduce the regulatory burden on industry. This approach has increased dependence on **qualified professionals** employed by industry to do the work needed to meet government's various mandates.

As *professional reliance* has grown, we expected that MEM, at a minimum, would be ensuring that reports required under permits were received and reviewed by the ministry in a timely manner, and would put into place policies and guidance about working with qualified professionals. Overall, MEM has not established any policy regarding qualified professionals. Specifically:

- MEM has not established guidance for its staff regarding what the ministry considers an appropriate level of oversight of the professionals employed by mining companies.
- MEM did not have a policy for tracking and reviewing all industry self-reported data. Staff do review some industry self-reports but, because of resourcing constraints, are unable to review every one that is submitted.
- MEM is not ensuring that mining companies submit reports – as required under the Health, Safety and Reclamation Code for Mines in British Columbia – in a timely manner, or even at all. For example, we found that only a little over half of all mining companies submitted their annual reclamation report in 2013 and 2014 (55% and 56%, respectively). Ministry staff point out that they have no enforcement tools to compel mining companies to submit reports.
- While MEM expects the mine operator to address the recommendations that qualified professionals include in their reports, there is no explicit, mandatory requirement requirement compelling all the mine operators to carry out the recommendations.

> **RECOMMENDATION 1.12**
>
> ***Qualified Professionals***—*We recommend that government establish policies and procedures for the use and oversight of qualified professionals (QP) across the natural resource sector. These policies and procedures should have the following:*
>
> - *guidance for staff that outlines the specific nature and amount of oversight expected of a QP's work*
> - *guidance for staff as to expected timeframe for review and response of QP reports*
> - *updated guidance for staff for recognizing and responding to misconduct by a QP*
> - *controls in place to ensure that there is no undue influence on the QPs by industry*
> - *controls in place to ensure that recommendations by QPs are adhered to*



5. Enforcement

Enforcement is the backbone to any compliance program. It is the final line of defence against environmental degradation. According to good practice, strategies involving education, assistance, incentives, monitoring and inspections are effective only if backed by a credible threat of enforcement sanctions.

To be effective, enforcement programs must involve:

- swift and predictable responses to violations
- responses that include appropriate sanctions

Swift responses to violations

MEM has no policy that requires its inspectors to ensure that mines return to compliance. From our sample of mines, we found that the ministry has not been systematically tracking either industry's compliance with permit requirements or industry's response to MEM's identified non-compliance. Therefore, we could not conclude whether MEM had identified all cases of non-compliance and, for those cases identified, whether there was a timely return to compliance.

We did note, however, several instances in which significant non-compliance persisted for years. For example, MEM failed to compel the mine operator to address the issue of seismic safety at the Myra Falls mine on Vancouver Island for 14 years (see Exhibit 15). Had a major earthquake (Magnitude 7 or higher) occurred before 2013, there was a risk that the dam could have failed.

Predictable responses to violations

Regulators can adopt various strategies when responding to non-compliance, ranging from strict responses to more cooperative approaches. We found that MEM has generally adopted the latter, emphasizing cooperation rather than confrontation. Its aim is to prevent environmental harm using such tools as bargaining, persuasion and negotiation. For example, we noted instances where MEM gave industry extensions to respond to non-compliance because of company claims of financial hardship.

The ministry's rationale is that a mine that is allowed to remain open and functioning will remain accountable and is more likely to follow through with undertaking environmental mitigation measures and responding to other regulatory requests. If the mine is shut down (as an enforcement response), it cannot generate revenue, and so, is likely to be less able to undertake remediation work. That increases the risk of the liability falling to the province, especially if the mine is under-secured – a common situation, as discussed earlier in this report.

We understand that this collaborative strategy is viable in some circumstances, but it assumes that the majority of mining companies are willing to comply voluntarily. As we found for most of the mines we reviewed for this report, this is not the case. For the inspections reports we reviewed, there were incidences of non-compliance in most cases.

Responses to violations varied by type of inspection. We found that when non-compliance was identified in geotechnical inspections by MEM staff, the inspectors followed a predictable response and issued a direct enforcement order (although deadlines were not always assigned to the activities in the enforcement orders). Reclamation inspections rarely met MEM's procedures for enforcement.

Most of the actions specified for non-compliance had no timelines associated with them, and the inspection reports used weak or permissive language in directives to industry (such as "should" and "it is recommended," as opposed to "must" and "shall"). MEM staff have indicated that they use this language when there is no contravention to the Act, Code or permit, but recognize that action is needed. However, the mine is not required to undertake actions that are merely suggested. A lack of clear directives can leave mining companies wondering whether action is actually warranted and it may tempt them to disregard the directive.

Exhibit 15: Fourteen-year timeline for seismic upgrades at the Myra Falls mine

Date	Activities at Myra Falls
In the early 1990s	MEM requests a seismic stability review
1996	
1997	Myra Falls recognizes the need to improve seismic stability
1998	
1999	MEM amends the permit to require seismic upgrades
2000	
2001	MEM approves the mine operator's request to extend completion of the seismic upgrade until 2005 due to financial difficulties. This extension was granted contrary to the advice provided by MEM's geotechnical staff.
2002	
2003	
2004	
2005	The mine receives an additional extension to 2007 from MEM to complete the seismic upgrades
2006	
2007	
2008	
2009	
2010	The seismic berm is near completion
2011[3]	
2012	MEM receives notification that the site is too wet to complete construction. An extension is granted until August 31, 2013
2013	**On July 31, 2013, the seismic berm is completed**

Source: Office of the Auditor General of British Columbia, adapted from MEM data

[3] In 2011 the mine was acquired by another company.

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Responses that include appropriate sanctions

The enforcement tools that MEM inspection staff have at their immediate disposal are two extremes:

- written orders that compel the mine to act
- temporary suspension or shut-down

For mine operators with a history of non-compliance, written orders are sometimes ineffective as a deterrent. MEM usually avoids issuing a temporary suspension or shut-down because of the social and economic implications. Plus, this measure has little effect if the mine is already temporarily shut down or permanently closed (see sidebar).

MEM does have other tools available to it under the *Mines Act*, such as fines, penalties, imprisonment and Supreme Court orders. However, these tools include the burden of prosecution – that is, they require investigation time, resources and expertise to produce evidence suitable for court and for a successful conviction under the *Mines Act*. Unlike MoE, which has an independent agency (the Conservation Officer Service) to enforce compliance with environmental legislation, MEM does not have an independent body to do the required investigative work. The Chief Inspector of Mines has the power under the *Mines Act* to carry out investigations, but has rarely done so.

SHASTA-BAKER MINE

Shasta-Baker mine is located 450 kilometres north of Prince George. Sable Resources Limited initiated operation there in 1989 and by 2007, had produced over 20,000 ounces of gold and 1.1 million ounces of silver. The mine has a history of repeated non-compliances and violations. MEM issued a shut-down order in 2013 as a result of dam safety concerns related to unresolved notices of non-compliance.

In a letter to Sable Resources in December 2014, MEM states that the company must meet MEM's requirements to properly manage the mine site, and that this inability has been "an increasing concern to MEM over the last several years." The letter continues, "Your inaction has increased the risk of an environmental incident." In that same month, the ministry also ordered the company to pay an additional reclamation security bond of $150,000.

In January 2015, the company responded that it would be unable to pay the bond. MEM replied that it would reconsider its decision requiring the additional bond. However, as of July 2015, the Chief Inspector of Mines had not yet provided a response to the company. In addition, MEM could not provide evidence that the company had complied with the order for more security.

The reclamation security bond for this site is currently $226,500, although MEM has estimated that the reclamation and closure costs are $1.11 million.

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Overall, we concluded that MEM's enforcement approach does not convey to non-compliant mining companies that the ministry has a strong enforcement culture. For example, the Chief Inspector of Mines recently issued letters to the Myra Falls mine operator after repeated requests by MEM staff that the operator adhere to orders. An October 2014 letter states, "The ministry is becoming increasingly concerned with Nystar's [mine owner] lack of compliance with respect to Ministry orders and geotechnical requirements for its tailings facilities" and warns that further enforcement action might be taken if the mine owner does not respond accordingly. To date, no return to compliance has resulted. This was also the case with the Shasta-Baker mine, which still remained non-compliant seven months after the ministry issued an order.

RECOMMENDATION 1.14

Policies, procedures and tools—
We recommend that government develop policies, procedures and enforcement tools for responding to non-compliances when industry does not meet government's specified timeline.

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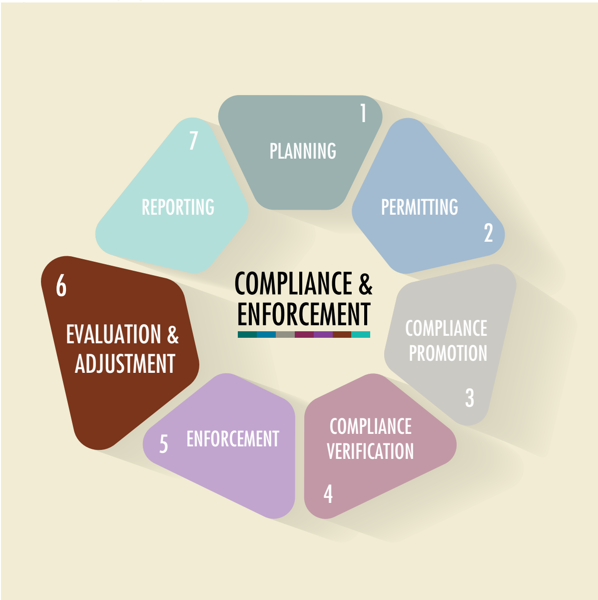

6. Evaluation & Adjustment

Evaluation is a critical yet often overlooked part of environmental management that leads to greater awareness of whether regulators are successfully achieving the desired environmental outcomes, such as preventing water contamination, improving mine reclamation results, and deterring violators.

We expected MEM to be regularly evaluating the permitting, compliance promotion, compliance verification and enforcement aspects of its program, and to be making adjustments as needed to achieve continuous improvement. We found, however, that the ministry does not have a formal process to evaluate the effectiveness of any of these activities.

MEM has not taken the steps necessary to create a meaningful evaluation program. Those steps include systematically collecting and tracking environmental performance and compliance actions, and then analyzing the data to identify trends, successes, areas of underachievement, and shifts in goals. MEM has stated that its limited resources do not allow for this work.

Without a commitment to evaluation, MEM is unable to:

- determine whether its activities are effective and aligned with government's goals, and whether improvements are necessary
- report to government or the public on the effectiveness or impact of its activities.

RECOMMENDATION 1.15

Evaluation & adjustment*—We recommend that government regularly evaluate the effectiveness of its compliance promotion, compliance verification, and enforcement activities and tools, and make changes as needed to ensure continuous improvement.*

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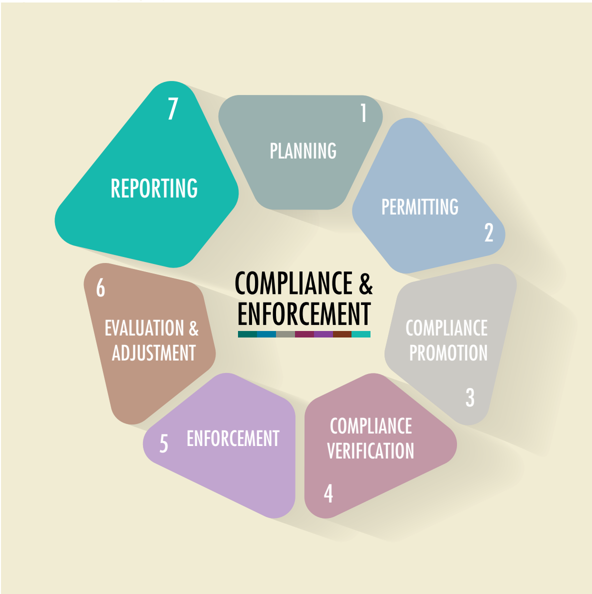

7. Reporting

Regular, timely and fair reporting of results to the Legislative Assembly and the public is important to maintaining confidence in the activities of a compliance and enforcement program. We therefore expected MEM to be reporting on its performance as a regulator and on the performance of the mining industry.

We found instead a poor record of reporting by the ministry.

A legislative requirement of MEM is that "The chief inspector must publish an annual report showing results during the previous year in achieving the purpose of this Act." However, we found that the annual reports of the Chief Inspector do not fully describe how the ministry's compliance and enforcement activities were protecting the province from significant environmental risks – a key part of MEM's mandate.

We found that MEM:

- did not include specifics on how the ministry facilitated successful reclamation and closure of mine operations, managed its environmental and reclamation liabilities, and protected and reclaimed the land and water affected by mining,
- did not inform the public of the long-term environmental risks associated with managing water contaminants,
- did not disclose the amount of liability for mining sites and the risks associated with underfunding, and
- did not include basic details of its compliance and enforcement activities and the environmental performance of regulated parties (such as inspections completed, rates of non-compliances, and enforcement actions).

MEM attributes these gaps to its lack of appropriate records management and information management systems.

However, as a result of the tailings dam breach at Mount Polley in August 2014, MEM has publicly posted all the dam safety reports for the first time. Furthermore, government has publicly committed to updating its information systems to enable this reporting to continue.

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We concluded that MEM's lack of meaningful environmental reporting may mean that the public and the Legislative Assembly do not have a complete understanding of the ministry's performance as a regulator, or of the environmental performance of B.C.'s mining sector.

RECOMMENDATION 1.16

Public reporting—*We recommend that government report publicly the:*

- *results and trends of all mining compliance and enforcement activities*
- *effectiveness of compliance and enforcement activities in reducing risks and protecting the environment*
- *estimated liability and the security held for each mine*

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COMPLIANCE AND ENFORCEMENT AT THE MOUNT POLLEY TAILINGS DAM

Summary

On August 4, 2014, a breach occurred within the Perimeter Embankment of the **tailings storage facility (or tailings dam)** at the Mount Polley copper and gold mine in south-central B.C. The breach resulted in the release of an estimated 25 million cubic metres of wastewater and tailings. The mining company has since been working on the clean-up from this event, but the full extent of the environmental repercussions from the breach are still not known.

In response to this event, government convened an independent, expert, engineering investigation and review panel (panel) to determine the mechanics of ***how*** the dam failed. Their report identified the mechanics of the failure. Their conclusion was that the primary cause of the breach was foundation failure due to a weak layer in the Perimeter Embankment foundation materials. However, the panel also concluded that, had the downstream embankment slope been flattened in recent years as proposed in the original design, failure would have been avoided.

Our examination differed from the panel's review in that we focused on ***why*** the dam failed and the Ministry of Energy and Mines' (MEM) overall compliance and enforcement activities. We found that the ministry did not ensure that the tailings dam was being built or operated according to the approved design, nor did it ensure that the mining company rectified design and operational deficiencies. MEM continued to approve permit amendments to raise and continue operating the tailings dam.

In relation to the Perimeter Embankment where the dam failed, MEM's weak regulatory oversight allowed inconsistencies with the intended dam design to persist over several years. This included: an over-steepened Perimeter Embankment slope and inadequate management of the tailings beach. At the Main Embankment, in addition to accepting a steep embankment slope and an inadequate tailings beach, MEM also did not ensure that buttressing was built to the height and extent included in the dam design.

We concluded that MEM did not enforce the design due to the following:

Over reliance on qualified professionals

It is not MEM's practice to carry out its own technical review (or to oversee an independent technical review) to confirm that tailings dams are built in accordance with the design.

Inadequate standards to guide both inspectors and industry

We expected that MEM would have ensured that their design standards were clear for both industry and inspectors to enforce. However, MEM had adopted the Canadian Dam Association's Dam Safety Guidelines for dam construction that were not specific to the

Click on the terms that are **bold** and **blue** to go to the definition in the glossary (**Appendix B**).

conditions in B.C. or specific to tailings dams. These guidelines were open to interpretation by the Engineer of Record and MEM inspectors, and this resulted in a tailings dam that was built below generally accepted standards for tailings dams.

Inspections did not meet policy

MEM performed no geotechnical inspections for a number of years, even though their policy requires a minimum of an annual inspection. Although these inspections would not have identified the weak foundation layer, staff could have identified that the operator was not actually building or operating the tailings dam to the prescribed design and was raising the dam without any long-term planning. Also, additional inspections would have provided MEM the opportunity for increased onsite vigilance.

Lack of enforcement culture

MEM has adopted a collaborative approach to compliance and enforcement that emphasizes cooperation and negotiation. In the case of Mount Polley, this approach failed to produce the desired results. MEM has the ability to compel a mining company to take corrective action when necessary, and has done so in the past using enforcement mechanisms under the Act, Code and permit. However, at Mount Polley, MEM did not use most of these enforcement mechanisms to compel the mine operator to build or operate the dam as designed and intended.

Background

The Mount Polley mine is an open-pit copper and gold mine located in south-central B.C., 56 kilometres northeast of Williams Lake (see Exhibit 16). It began operation in 1997, was temporarily closed from September 2001 to March 2005, and then reopened, continuing to operate until the failure of the tailings dam in 2014.

Exhibit 16: Location of the Mount Polley mine

Source: *Times Colonist*, August 5, 2014

On August 4, 2014, there was a breach within the Perimeter Embankment of the approximately 4 kilometre long tailings dam (see Exhibit 17).

The tailings dam at the Mount Polley **tailings storage facility** is subdivided into three sections referred to as the Main Embankment, the Perimeter Embankment and the South Embankment. The photo in Exhibit 17 was taken after the breach at the Perimeter Embankment.

Following the incident, government reported that approximately 17 million cubic metres of wastewater and 8 million cubic metres of tailings entered adjacent

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Exhibit 17: Description of Mount Polley dam embankments

The tailings dam at the Mount Polley **tailings storage facility** is subdivided into three sections referred to as the Main Embankment, the Perimeter Embankment and the South Embankment. This image was taken after the breach at the Perimeter Embankment.

Source: Terrasaurus Ltd., Photography

water systems and lakes (see Exhibit 18). The full extent of the environmental repercussions from the breach is still not known. Estimates reported in July 2015 indicate that the initial cleanup cost the company $67 million, and the Ministry of Environment, $6 million. Long-term clean-up, however, will take years.

Shortly after the incident, the provincial government convened an independent, expert, engineering investigation and review panel (panel), directing them to "investigate into and report on the cause of the failure of the tailings storage facility." On January 30, 2015, the panel released its report, titled: *Report on Mount Polley Tailings Storage Facility Breach.*

The panel's conclusion was that the primary cause of the breach was dislocation of a part of the Perimeter Embankment due to foundation failure. The specifics of the failure were triggered by the construction of the downstream rockfill zone at a steep slope. They noted

Exhibit 18: The Mount Polley mine site before the tailings pond dam breach (July 24, 2014) and after (August 5, 2014)

Source: NASA Earth Observatory images by Jesse Allen, using Landsat data from the U.S. Geological Survey that had the downstream embankment slope been flattened in recent years as proposed in the original design, failure would have been avoided.

Management and regulation of tailings storage facilities

Professional engineers – Engineers of Record (EOR), hired by mining companies – are responsible for on-going design, construction, operation and performance monitoring of the dam. The results of an EOR's monitoring are documented in the EOR's annual Dam Safety Inspection Report, which is a standard requirement for major mines. The EOR also issues recommendations to the mining company in its annual reports (and from time to time as is necessary or appropriate) for actions that, from the EOR's perspective, the company should implement to address dam safety and stability concerns. **However, EORs have no legal authority to compel mining companies to implement their recommendations. Enforcement can only be done by MEM.**

It is MEM's responsibility for *regulating* all mining-related activity in B.C., including design, construction, operation, closure, and reclamation. The Chief Inspector of Mines is given significant power and discretion during all these phases. These powers include ensuring the safety and stability of tailings storage facilities.

Our Audit

The planning work for our audit on compliance and enforcement in mining began several months before the Mount Polley breach. When the breach occurred, we considered but decided against including the mine in our original audit sample. There was already increased scrutiny from other agencies, and we did not want to overlap with the investigations underway. However, as our audit progressed and we noted gaps with how MEM addresses mining non-compliances, we became concerned that these gaps may have a relationship with the failure at Mount Polley.

We also noted that there was limited scrutiny by the panel on MEM's regulatory oversight. It therefore became evident that we could not exclude an assessment of the ministry's compliance and enforcement performance concerning the Mount Polley tailings dam.

Our audit differed from the investigation of the panel. The panel's primary mandate was to investigate and report on the cause of the failure. As a result, their report was highly technical and provided a thorough explanation of the mechanics of the failure. In terms of regulatory oversight, the panel focused mainly on one aspect – inspections – and the panel reported that overall the performance by the regulator (MEM) was "as expected."

However, our assessment included a comprehensive review of all seven components of an effective compliance and enforcement program (see Exhibit 19). In the case of MEM's oversight of the Mount Polley mine, our significant findings are in relation to MEM's enforcement.

We focussed our audit on MEM, and not MoE, as MEM has primary responsibility for the regulatory oversight of the geotechnical components of the tailings storage facility.

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Specifically, we focused on MEM's actions as they related to three significant and known dam deficiencies on the Main Embankment and the Perimeter Embankment. They were:

1. inadequate tailings beaches (both embankments)
2. over-steepened dam slopes (both embankments)
3. insufficient buttress (Main Embankment only)

Exhibit 19: Seven key elements of a comprehensive compliance and enforcement program

Source: Office of the Auditor General of British Columbia, adapted from the Organisation for Economic Co-Operation and Development's *Ensuring Environmental Compliance: Trends and Good Practices* and MOE's *Compliance Management Framework*

Audit Findings

Enforcement is the backbone to any compliance program. It is the final line of defence against environmental degradation. Good practices suggest that strategies involving education, assistance, monitoring, inspections and incentives are only effective if backed by a credible threat of enforcement sanctions.

We expected MEM to be monitoring mine compliance with permit requirements, the *Mines Act*, the Health, Safety and Reclamation Code for Mines in British Columbia and the EOR recommendations; and, to be enforcing instances of non-compliance. We also expected that MEM's enforcement response would be swift and predictable, include appropriate sanctions, and result in a timely return to compliance.

MEM made nearly 850 documents (emails, industry reports, inspections) available publicly that discuss geotechnical details related to Mt. Polley. However, these documents do not demonstrate how MEM was ensuring that all of the permit requirements were being met. It is not MEM's practice to systematically track compliance with permit conditions. As a result, the ministry did not have comprehensive and readily accessible compliance records of Mount Polley that we could review.

> *"Something had to give, and the result was over-steepened dam slopes, deferred buttressing, and the seemingly ad hoc nature of dam expansion that so often ended up constructing something different from what had originally been designed."*
>
> ~Panel report, page 75

Specifically, MEM was unable to demonstrate how the mine performed against its permit requirements for the last two decades. Over several design stages, the panel identified departures from the approved design of the tailings storage facility. These departures related to the dam slope and beach on the Main and Perimeter embankments, and the buttress on the Main Embankment. In particular, the panel concluded that, had the downstream slope on the Perimeter Embankment been flattened in recent years as proposed in the original design, failure would have been avoided.

> *"The specifics of the failure were triggered by the construction of the downstream rockfill zone at a steep slope of 1.3 horizontal to 1.0 vertical. Had the downstream slope in recent years been flattened to 2.0 horizontal to 1.0 vertical, as proposed in the original design, failure would have been avoided."* ~Panel report, page iv

MEM accepted over-steepened downstream embankment slopes

An over-steepened Perimeter Embankment slope contributed to the tailings dam failure at Mount Polley. According to the panel, had the embankment slope been consistent with the original design for the Perimeter Embankment, failure would have been avoided (see quote above).

The original design for Mount Polley's tailings storage facility specified a downstream embankment slope of 2.0 horizontal to 1.0 vertical (2H:1V) for all the embankments (see Exhibit 20).

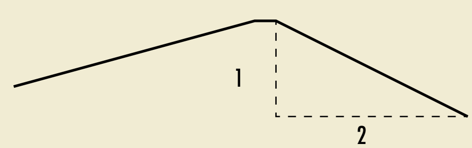
The Stage 5 design, approved by MEM in 2006, allowed the amended design to include a steeper "interim slope" of 1.4 horizontal to 1 vertical (1.4H:1V) for the Main and Perimeter embankments.

The mine operator stated that this *interim* 1.4H:1V slope would be returned to the more moderate 2H:1V slope once the stage 5 lift was completed. We expected that MEM would have ensured compliance with this permitted design – the return to a 2H:1V slope. Instead, the mine operator never flattened the slope, and MEM continued to approve subsequent dam raises.

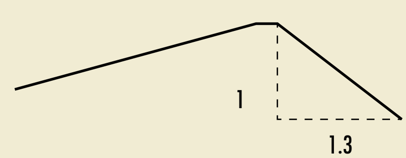
In 2011, during the stage 7 dam raise, all dam embankments were built to an even steeper slope of

Exhibit 20: Downstream dam slope[4]

A) Lower risk: Original design for Mount Polley dam slope 2.0 horizontal (H) to 1.0 vertical (V)



B) Higher risk: Over-steepened slope of Mount Polley dam at 1.3 horizontal (H) to 1.0 vertical (V)



Source: Office of the Auditor General of British Columbia

[4] This exhibit is only intended to conceptualize the Mount Polley dam slope design and construction. It is not intended to depict the actual design, construction, or scale of the Mount Polley tailings storage facility.

1.3H:1V, thus exceeding the *interim* slope. During this time when the slope became steeper across all the embankments, MEM did not provide the required oversight. MEM's inspection procedures require at least one geotechnical inspection per year; however, no such inspection were carried out for 2009, 2010 and 2011.

The result was that the steep slope was allowed to persist, reaching a level that was described by the panel as "unprecedented" (see Exhibit 21).

As the regulator, it was MEM's responsibility to ensure that the dam was being built as designed, including with the intended embankment slope. This, MEM did not do.

MEM did not enforce the development of an adequate tailings beach

An above-water tailings beach is a gently sloping surface of tailings against the upstream face of a tailings dam embankment (see Exhibit 22).

A wide beach was included as a fundamental design element for all embankments at the Mount Polley dam, deemed necessary for dam stability. The absence of a beach adjacent to the Perimeter Embankment was noted as a fundamental flaw by the panel. The panel stated, *"Had the water level been even a metre lower and the tailings beach commensurately wider, this last link might have held until dawn the next morning, allowing timely intervention and potentially turning a fatal condition into something survivable."*

Exhibit 21: Perimeter Embankment slope with area stripped for buttress, submitted by the EOR to MEM in March, 2014

Source: Tailings Storage Facility Stage 9 2013 As-Built and Annual Review Report

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We expected MEM to ensure that the tailings beaches adjacent to the dam embankments were maintained. Instead, we found a lack of oversight by MEM to adequately address what became a chronic issue along all the embankments of the facility.

The Dam Safety Review in 2006 noted a lack of adequate beach development that represented *"a deficiency that should be rectified as soon as practical."* The report further explained at length that adequate beaches along all the embankments are generally considered an integral requirement of the design. The report included a recommendation for the mine to *"aggressively create a beach."*

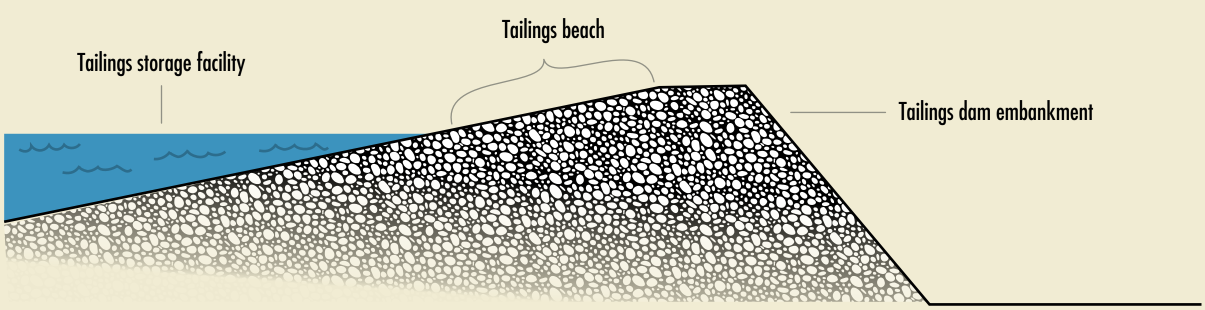
In 2008, a MEM geotechnical inspector identified the lack of tailings beach at the Main Embankment. It was noted as a deficiency that contravened the permitted design, and an enforcement order was issued, stating: *"The design requires that an above water beach be developed against the upstream face of the dam. There was no beach observed in the vicinity of the SE corner of the Main Embankment. A beach shall be re-established as soon as possible in this area to meet the design objectives."*

We did not find evidence that MEM followed up on the order from the 2008 inspection report.

Two years later, in the 2010 Annual Dam Safety Inspection Report sent to MEM, the mine operator was reminded of the beach deficiency, again, by the EOR: *"Develop a tailings deposition plan to deposit tailings around the perimeter of the facility to facilitate the development of tailings beaches and manage the location of the tailings pond. The lack of tailings beach development was a deficiency identified in a 2008 geotechnical inspection by the Ministry of Energy, Mines, and Petroleum Resources (MEMPR)."* We did not find evidence that MEM enforced the 2010 recommendation of the EOR. No further MEM inspections took place until 2012.

As the regulator, it was MEM's responsibility to ensure that the dam was being built as designed, including with the intended tailings beach. MEM did not provide adequate oversight and enforce the requirement to consistently maintain a wide tailings beach against all the embankments.

Exhibit 22: Example of a tailings beach[5]



Source: Office of the Auditor General of British Columbia

[5] This exhibit is only intended to conceptualize a beach feature. It is not intended to depict the actual design, construction, or scale of the Mount Polley tailings storage facility.

PART 1: MINISTRY OF ENERGY AND MINES

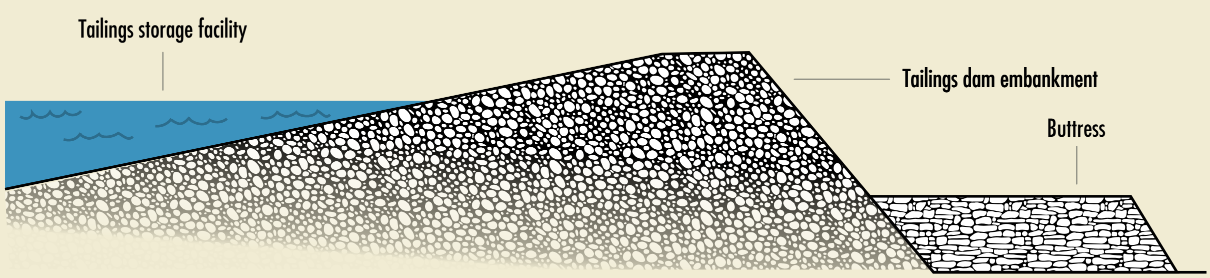
MEM did not enforce the establishment of buttressing, as designed, along the Main Embankment

A buttress is a support constructed outside of a structure (such as a tailings storage facility) to increase stability (see Exhibit 23). In the original 1995 tailings dam design, a buttress along the Main Embankment was contemplated as a possible requirement for stability at the final dam elevation. In 2007, a buttress was incorporated into the mine permit to address stability concerns. However, the buttress was never built to the height and extent of the intended design. MEM allowed the mine operator to continually defer construction of the buttress, and the buttress was never extended along the entire length of the Main Embankment.

Throughout the life of the dam, the Mount Polley dam engineers and other expert reviewers were concerned with the possibility that there may be a weak layer in the dam foundation materials. However, as noted by the panel, the site investigations by the mine operator over the years were insufficient to identify any weaknesses. This became more of a concern as the dam was built higher and steeper. Moreover, engineering reports identified greater risks with the stability of the Main Embankment due to factors such as its large height in comparison to the other two embankments.

As the dam was raised, buttressing along the Main Embankment was eventually deemed necessary and partially constructed in Stage 5. In 2007, the Stage 6 design to raise the dam included the construction of a buttress along the entire Main Embankment to account for a potentially weak layer in the dam foundation materials. MEM issued a permit on the basis of this design in 2007. Consistent with all of MEM's permits, it also stated that the company was to notify the Chief Inspector, in writing, of any intention to depart from the design plan to any substantial degree. We expected MEM to ensure that the requirements specified in the design and permit were upheld.

Exhibit 23: Example of a buttress[6]



Source: Office of the Auditor General of British Columbia

[6] This exhibit is only intended to conceptualize a buttress feature. It is not intended to depict the actual design, construction, or scale of the Mount Polley tailings storage facility.

PART 1: MINISTRY OF ENERGY AND MINES

Instead, we found that MEM did not ensure that the mine operator established a buttress along the Main Embankment in accordance with the design. The height was approximately 5m lower than the design specifications, and the buttress did not extend along the entire length of the embankment. We found no evidence that the mine operator notified the Chief Inspector in advance about the proposed departure, as required in the permit. The EOR reported the design contravention to MEM in the 2010 Annual Dam Safety Inspection Report. However, we found no evidence that MEM followed up to enforce compliance with the required buttressing. Instead, MEM continued to permit subsequent raising of the dam for Stages 7, 8 and 9.

As the regulator, it was MEM's responsibility to ensure that the dam was being built as designed and permitted, including with the intended buttress.

While the dam was out of compliance with its 2007 permit by not completing the intended buttress on the Main Embankment, the buttress that was in place at this embankment did provide some support. As the panel stated: *"the steep slopes were effectively flattened by the addition of its buttress, which explains why the failure did not occur at the highest part of the dam."* There was no buttressing on the Perimeter Embankment, and the EOR did not recommend buttressing until 2013.

> "By 2013, as the panel noted, *buttressing could no longer be deferred for either embankment."* ~Panel report, page 71

Why did MEM not enforce the tailings storage facility design at Mount Polley?

For many years before the breach happened, there were structural and operational deficiencies (beach, buttressing and slope) that contravened the permitted design, but MEM did not enforce the correction of those flaws.

We concluded that MEM did not enforce the design due to the following factors:

Over-reliance on qualified professionals

MEM relies on the EOR's confirmation (signed and sealed "as-built" report) that tailings storage facility construction is consistent with the design. It is not MEM's practice to carry out its own technical review (or to oversee an independent technical review) to confirm that tailings dams are built in accordance with the design and government standards. In the case of Mount Polley, MEM failed to carry out its own regulatory oversight resulting in a dam that was not being built as designed.

MEM relies on an EOR to design a mine that is safe and to confirm it is operating as intended. However, MEM should not delegate its regulatory responsibilities to the EOR. Furthermore, as the panel noted, the designer cannot be presumed to act correctly in every case, which is why, it is MEM's responsibility to apply appropriate regulatory oversight.

PART 1: MINISTRY OF ENERGY AND MINES

Inadequate standards to guide both inspectors and industry

We expected MEM would have ensured that their design standards were clear for both industry and inspectors to enforce. However, MEM had adopted the Canadian Dam Association's Dam Safety Guidelines for tailings dam construction that were not specific to the conditions in B.C. or specific to tailings dams. These guidelines were open to interpretation by the EOR and the inspector, and this resulted in a tailings dam that was built below generally accepted standards for tailings dams.

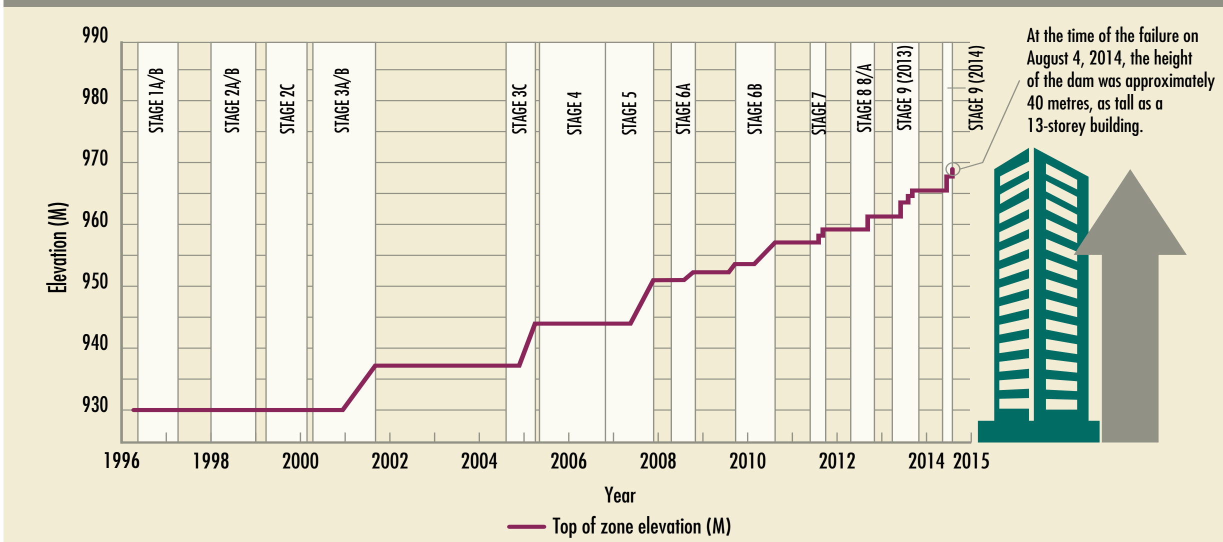
Inspections did not meet policy

According to MEM's inspection procedures, all major producing metal and coal mines must receive a geotechnical inspection at least once a year, or more often as necessary. However, we found that MEM performed no geotechnical inspections for the years 2002, 2003, 2004, 2009, 2010 and 2011, even though the tailings dam was being raised during many of these years. Construction of the Mount Polley tailings dam began in 1996. The height of the dam was later increased in nine stages, as shown in Exhibit 24, until it reached a height of approximately 40 metres - about as tall as a 13-storey building.

The panel concluded that additional inspections of the tailings storage facility would not have identified the weak foundation materials beneath the dam. However, additional inspections would have provided MEM the opportunity for increased onsite vigilance.

Furthermore, MEM's inspection procedures require that a geotechnical inspector review the current mine

Exhibit 24: Elevation increases in the Mount Polley tailings dam, 1996–2014



Source: Office of the Auditor General of British Columbia, adapted from *Independent Panel Report on Mount Polley Tailings Storage Facility Breach* plan with the mine manager, review any proposed activity related to existing or future approvals, and note any cases of non-compliance with the approval. Had MEM followed this procedure in the required annual inspections, ministry staff would have had an opportunity to formally identify that the mine operator was not actually building the dam to the prescribed design, and was raising the dam without any long-term planning.

Lack of enforcement culture

MEM has adopted a collaborative approach to compliance and enforcement that emphasizes cooperation and negotiation. This type of an enforcement culture may, in some circumstances, motivate a mining company to return to compliance, but the approach depends on the company's willingness to meet government's standards and regulatory requirements, and to implement the EOR recommendations. In the case of Mount Polley, MEM's culture of collaboration failed to produce the desired results.

MEM has the ability to compel a mining company to take corrective action when necessary. This enforcement action, typically in the form of an order, must be directly related to a requirement of the *Mines Act*, the Code or the particular mine permit. MEM must also take enforcement action if there is an imminent danger posed to workers or the environment.

We found specific enforcement mechanisms under the Act, Code and permit that MEM has used in the past for other mines. These could have been used to compel the mine operator to build and operate the Mount Polley tailings dam to the intended, and prudent, design specifications.

MEM can enforce EOR recommendations

As noted earlier, EORs have no legal authority to compel mining companies to implement their recommendations. This type of enforcement can only be done by the regulator: MEM. However, EOR recommendations are not always linked to a pre-existing regulatory requirement or a perceived imminent danger–making enforcement challenging. In these cases, MEM still has a mechanism to act. Under the *Mines Act*, the Chief Inspector and the Minister of Energy and Mines have broad, discretionary powers, including the ability to impose additional conditions in the permit at any time. As a result, EOR recommendations can be included as a condition of the permit which would make them enforceable by MEM staff. This has been done in the past for other mines.

MEM can enforce design requirements

MEM's permits have standard clauses, including "Departure from Approval." It states that the permit-holder shall notify the Chief Inspector, in writing, of any substantial departure from approval and shall not proceed to implement the proposed changes without the authorization of the Chief Inspector. This is also a requirement in the Health, Safety and Reclamation Code for Mines in British Columbia under Section 10.1.11. We found no evidence that the Chief Inspector of Mines approved departures from the intended design related to the beach, buttressing and dam slope. Had MEM noted that there was a departure from the approved design, they could have enforced this non-compliance.

MEM has broad powers to enforce dam safety

MEM staff have also made the argument to us that under the Health, Safety and Reclamation Code for Mines in British Columbia, if an inspector notes an issue that is not explicitly stated as a requirement in the permit, the inspector has broad powers to compel the company to take action. Specifically, section 1.1.2 of the Code states: "Notwithstanding the absence of a specific code requirement, all work shall be carried out without undue risk to the health or safety of any person."

To summarize:

the Mount Polley mine operator made substantial changes to the design of its tailings dam, did not build the dam to the design, and did not operate the tailings dam as was intended. In all of these instances, MEM, as the regulator, had a responsibility to require the mining company to complete the dam as designed. No other government or private actor has that ability or responsibility.

RECOMMENDATION 1.13

Mine design*—We recommend that government adopt appropriate standards, review mine designs to ensure that they meet these standards, and ensure that mines, as constructed, reflect the approved design and standards.*

PART 2: MINISTRY OF ENVIRONMENT

CONCLUSION

We concluded that the Ministry of Environment's compliance and enforcement activities of the mining sector are not protecting the province from significant environmental risks.

SUMMARY OF KEY FINDINGS

MoE has a compliance and enforcement program, but it is deficient in carrying out most of the expected regulatory activities, such as undertaking inspections, reviewing monitoring data provided by industry and enforcing where there is non-compliance. The ministry lacks the resources, expertise and training and tools necessary to pursue compliance and enforcement. Furthermore, it does not coordinate its compliance and enforcement activities with those of the Ministry of Energy and Mines (MEM), which has led to inefficiencies and a lack of overall effectiveness in protecting the environment.

MoE has not disclosed to the public and legislators the effectiveness of its regulatory oversight and the impacts that have resulted. We looked at the degradation of the water quality in the Elk Valley and MoE's response. We found that MoE was slow to regulate rising selenium levels in this area and has not publicly disclosed the ongoing risks that the ministry's recent Elk Valley Permit is posing on the environment.

MoE'S ROLES AND RESPONSIBILITIES

MoE's objective is the effective management of environmental risks through the monitoring and enforcement of environmental laws and regulations (see sidebar).

MINISTRY OF ENVIRONMENT SERVICE PLAN

Goal 2: Clean and safe water, land and air

Objective 2.4: Effective management of environmental risks

- Implement new compliance approaches that allow the Ministry to improve response to environmental risks and provide increased public accountability
- Minimize creation of future contaminated sites and manage remediation of high-risk contaminated sites
- Conduct investigations into non-compliance with regulatory requirements designed to protect the environment, human health and public safety

PART 2: MINISTRY OF ENVIRONMENT

Key among the enabling legislation is the *Environmental Management Act*, which includes requirements ensuring the protection of the environment through the monitoring and enforcement of the quantity and quality of any waste discharges from metal and coal mines.

Because both MoE and MEM have a responsibility to ensure the protection of watercourses, we expected the two ministries to be working together to achieve this objective.

Regional Operations Branch

MoE's Regional Operations Branch within the Environmental Protection Division is responsible for: reviewing *Environmental Management Act* permit applications for new and existing mines; conducting environmental assessment application reviews; conducting inspections; and, taking administrative action to enforce, or support the enforcement of, the Act.

The Regional Operations Branch includes environmental quality specialists, biologists, meteorologists, engineers, and environmental management analysts who live and work across the province. In 2014, the branch was reorganized. This resulted in Environmental Protection Officers being assigned to a number of different groups, including two that focus on mining:

- The Mining Operations Team is responsible for issuing mine permits. At the time of our audit it had 33 full-time-staff.
- The Provincial Compliance Team is responsible for planning province-wide compliance activities and inspecting all permits issued under the *Environmental Management Act* – permits that apply to about 70 types of industries or activities including mining. This team had 13 full-time staff.

Important to note in this new model is that the inspectors for mines no longer carry out dual roles of permitting and compliance work. This is one of the material differences between MoE's approach and that of MEM's. At MEM, inspectors issue permits and carry out compliance work.

Another notable difference between MoE's regulatory framework and that of MEM's, is enforcement. MoE's compliance staff may use administrative sanctions or penalties to enforce non-compliance. MoE may also use an independent investigation unit, housed in the Conservation Officer Service, to investigate suspected cases of non-compliance (by using searches, evidence seizures, surveillance, interviewing witnesses), to issue tickets or recommend formal charges to Crown counsel.

Within the Conservation Officer Service, the Major Investigations Unit specializes in investigating industrial non-compliance. This unit currently has 10 full-time staff and 6 vacancies.

PART 2: MINISTRY OF ENVIRONMENT

OUR EXPECTATIONS

A comprehensive compliance and enforcement program should have, in keeping with recognized good practices, seven key elements (see diagram on page 40).

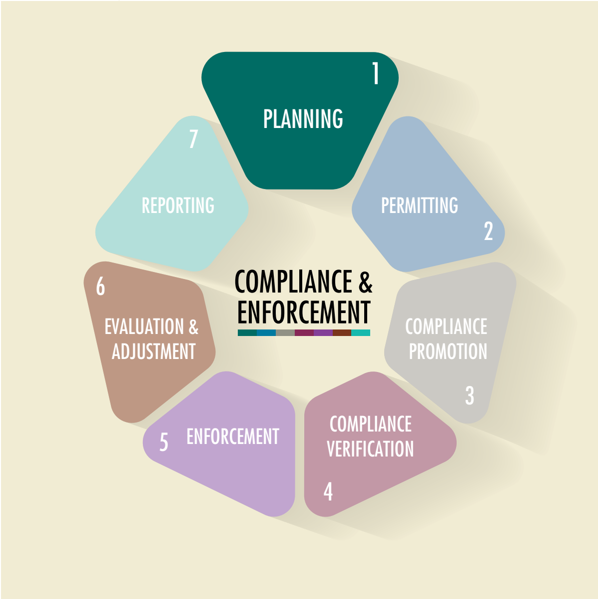
We expected MoE to have a strategic plan that would detail the activities of MoE's regulatory approach, including how the ministry intended to work with MEM. The plan would show how MoE's activities would achieve the objective of ensuring the protection of the environment. We also expected these activities to be:

- setting regulatory requirements that are enforceable,
- promoting regulatory compliance (aimed at achieving high rates of voluntary compliance),
- verifying compliance (aimed at ensuring that industry is meeting government's regulatory requirements), and
- enforcing requirements (aimed at compelling the mining industry to meet all compliance requirements).

In addition, we expected MoE to be ensuring continuous improvement of its compliance and enforcement program through evaluation and adjustment, and to be reporting the results of its activities to the Legislature and the public.

PART 2: MINISTRY OF ENVIRONMENT

KEY FINDINGS



1. Planning

We expected MoE's compliance and enforcement program to be based on a clear strategic plan that included goals, objectives and performance indicators. It would also describe how the ministry was coordinating its activities with MEM. We also expected MoE's strategic plan to be supported by appropriate resources, training, expertise and tools.

We found that MoE has developed a compliance management framework that outlines its approach to ensuring compliance. This program structure, which has been in place since 2007, includes the principles, goals and objectives that guide compliance-related work. The ministry has also established policies and objectives for setting permit requirements, promoting compliance, verifying compliance and enforcing requirements. However, we found that MoE's implementation of these activities for mining has been constrained by limited resources.

Coordination with MEM

In 2009, the provincial government introduced a policy for a coordinated and integrated approach to natural resource management in the mineral exploration and mining sectors of B.C. We expected MoE and MEM to coordinate their compliance and enforcement planning and activities because they have an overlapping mandate to protect the environment. Instead, however, we found that MoE's inspection planning is not coordinated with that of MEM, nor does MoE regularly advise MEM of the non-compliance and enforcement actions it has taken. Although MoE and MEM have developed the "Memorandum of Understanding for the Environmental Management of Mining Projects," that document has been in draft form since 2012.

This lack of coordination reduces the effectiveness and efficiency of MoE's compliance and enforcement actions and increases the likelihood of environmental risks not being addressed.

Resources, expertise, training and tools

To do their work effectively, regulatory authorities need access to the physical, technical and financial resources they require to meet their mandate and scope of work. Management should therefore aim to attract and retain qualified and experienced program staff by offering reasonable remuneration and professional development opportunities. As well, management should ensure that staff have the necessary tools to do their job.

Resources

We expected MoE to have determined the resources it needs to undertake an effective compliance and enforcement program. We found this was not the case.

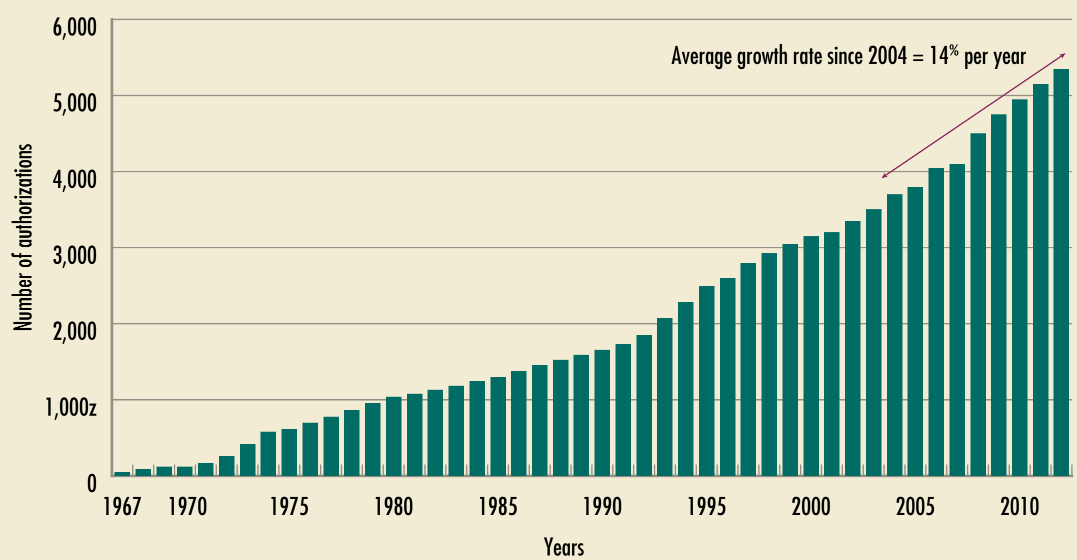
Over the past decade, workloads within the Regional Operations Branch have been increasing, and resources decreasing. According to the branch, its number of full-time employees in 2014 was a 29% drop from 2012 levels. At the same time, the number of authorizations under the *Environmental Management Act* has been increasing since 1967, by an average of 14% a year (see Exhibit 25).

We found numerous examples of declining staff morale. Many of the staff we interviewed indicated that this decline was due to increasing workloads and their inability to adequately meet the ministry's mandate of protecting the environment.

MoE reorganized the branch in 2014 to create a dedicated compliance team. The 13 members of the team are tasked with ensuring compliance in dozens of complex industries, from municipal sewage management and pulp and paper, to oil and natural gas and mining. These industries account for more than 5,500 *Environmental Management Act* authorizations, meaning each compliance team member could have around 400 authorizations to monitor and/or inspect.

We found that inspectors are not managing this workload. For instance, inspectors are not meeting

Exhibit 25: Total authorizations issued under the *Environmental Management Act*, 1967–2012*



*This includes total authorizations issued related to permit amendments, Codes of Practice and Regulations, and Operation Certificates. It also includes abandoned, cancelled, expired, suspended, and withdrawn transations.

Source: Office of the Auditor General of British Columbia, adapted from MoE data

MoE's policy to annually inspect mine sites. We concluded that MoE's resourcing levels are likely the causation.

Expertise and training

Mining is a complex and constantly changing industry that requires knowledge and expertise in many technical disciplines. We expected MoE staff to have the necessary qualifications and experience to carry out inspections and enforcement and to review industry's self-reporting data. We found that MoE's compliance team, as a whole, has an insufficient level of expertise in mining. Under the ministry's compliance and enforcement model, staff are expected to inspect a range of industries: there is no requirement for inspectors to have experience in mining.

MoE has recently seen an exiting of staff with mining experience, the result of both natural attrition (such as retirements) and in some cases, low-morale issues. As a cost-saving measure, the ministry had filled some positions with less experienced staff. This was due to the requirements of MoE's available funding and the inability to attract experienced individuals within a highly competitive mining sector.

Training for MoE staff in mining is also inadequate, and while the ministry states that it relies on mentoring, it has no formal mentorship program. According to some new staff, they are concerned that lack of training is hampering their abilities to carry out inspections.

Tools (data systems, guidance)

We expected that MoE inspectors would have necessary and appropriate tools, including data tracking systems, and policy and guidance, to perform their compliance and enforcement roles.

We learned that before 2012, MoE relied on Excel spreadsheets and hard copies of records to track its inspection and enforcement activities. A new data system was adopted in 2013, but was created on a limited budget and, as a result, had several problems:

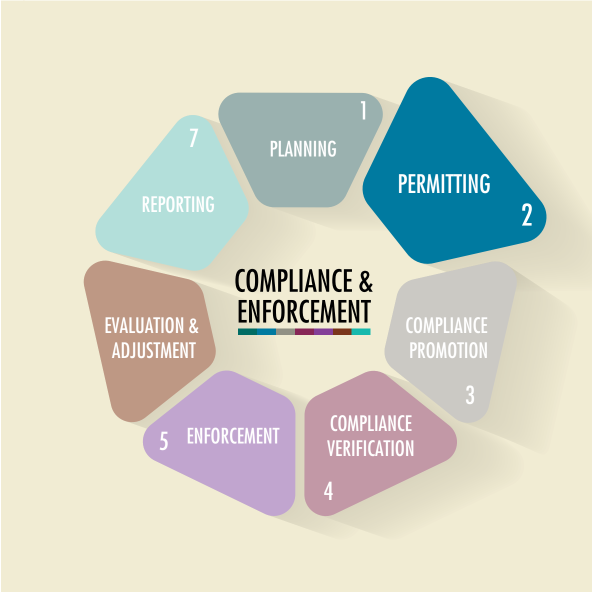
- it contained only a partial history of compliance and enforcement activities
- it was time consuming to use
- it did not connect to other data systems
- it was missing critical information, such as industry response to findings of non-compliance

MoE does provide general guidance to its compliance staff on the procedural steps necessary to complete an inspection under the *Environmental Management Act* and on the appropriate enforcement action, given prescribed circumstances. In addition, we found that MoE does have specific guidance for mine sites; however, it was developed by senior inspectors on their own initiative and has not been formally adopted as policy across all regions.

RECOMMENDATION 1.1

Strategic planning—*We recommend that government develop a strategic plan that would detail the activities of an integrated and coordinated regulatory approach, and the necessary capacity, tools, training and expertise required to achieve its goals and objectives.*

PART 2: MINISTRY OF ENVIRONMENT



2. Permitting

We expected permit requirements to reflect the purpose of the *Environmental Management Act* – namely, protection of the environment – and, for MoE to ensure permits are consistently written with enforceable language. We also expected that permits would ensure taxpayers are safeguarded from having to pay costs associated with the environmental impacts of mining activities (known as the **polluter-pays principle**).

In fact, we found the permits were not consistently written with enforceable language, and we found examples where the polluter-pays principle was not upheld.

Enforceability

We selected a sample of MoE's mine permits to review the wording of the requirements. We expected to see consistent use of regulatory language and measureable criteria such as thresholds and action timelines. We found that permit conditions relating to monitoring and reporting do generally include measureable criteria; however, we also found examples of imprecise and ambiguous language, such as, "in a timely fashion" and "appropriately qualified." Although MoE has a project underway to standardize clauses for new permits and amendments, little progress has been made and there are no plans to systematically review and update all historical permits.

Click on the terms that are **bold** and **blue** to go to the definition in the glossary (**Appendix B**).

RECOMMENDATION 1.2

Permit language—*We recommend that government ensure both historical and current permit requirements are written with enforceable language.*

Polluter-pays principle

Under the *Environmental Management Act*'s Waste Discharge Regulation, industry is charged a fee for each type of pollutant it discharges into the environment (see Exhibit 26).

This fee is intended to reflect the environmental impact of the pollutant. We found that the fee schedule has not been reviewed or revised since 2004. Thus, for some pollutants, the fees do not reflect MoE's current assessment of the environmental impacts. For example, although the element selenium can be toxic in trace amounts, MoE still classifies it as a metal and calculates the fee at the tonnage level. As a result, the fee charged to industry for discharging selenium is not proportional to the impact the element is having on the environment.

PART 2: MINISTRY OF ENVIRONMENT

Exhibit 26: Excerpt from the Waste Discharge Regulation, Table 3: Contaminant fees for effluent

Contaminant	Fee per tonne discharged		
	if payment date before March 31, 2005	if payment date between April1, 2005 - March 31, 2006	if payment date after April 1, 2006
Ammonia	$90.09	$96.50	$102.91
AOX	$239.20	$256.22	$273.24
Arsenic	$239.20	$256.22	$273.24
BOD	$18.07	$19.36	$20.64
Chlorine	$239.20	$256.22	$273.24
Cyanide	$239.20	$256.22	$273.24
Fluoride	$90.09	$96.50	$102.91
Metals	$239.20	$256.22	$273.24
Nitrogen and Nitrates	$36.01	$38.57	$41.13
Oil and Grease	$60.06	$64.33	$68.61

Source: Office of the Auditor General of British Columbia, from the *Environmental Management Act* - Waste Discharge Regulation

RECOMMENDATION 1.5

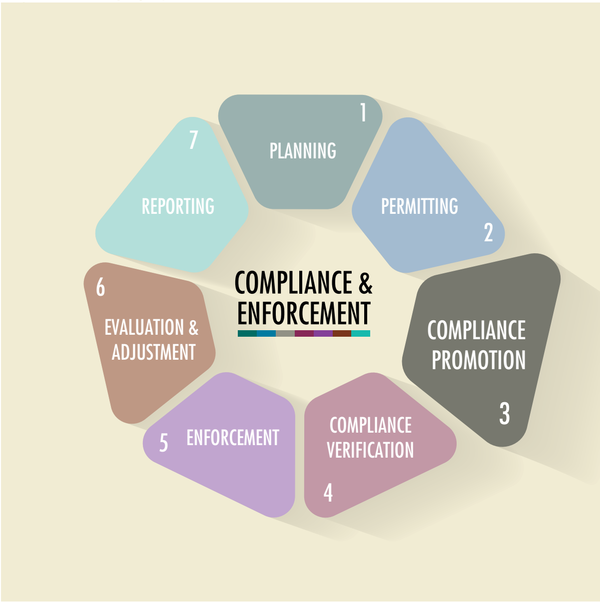
Environmental Management Act waste discharge fees—*We recommend that government review its fees under the Environmental Management Act and ensure that the fees are effective in reducing pollution at mine sites.*

The Regional Operations Branch does not recover from mine operators the cost of permitting or the cost of MoE compliance verification activities. The base fee for all *Environmental Management Act* permits is a nominal $100. This is in contrast to the province's Environmental Assessment Office, which charges a partial cost recovery for a range of services, including application assessments ($25,000–75,000), inspections ($1,700–6,500) and review of industry compliance reports ($75). The Environmental Assessment Office reports that the fees provide partial recovery of the costs incurred in delivering a high-quality program and to maintain appropriate staffing levels.

RECOMMENDATION 1.6

Cost recovery—*We recommend that government adopt a cost recovery model for permitting and compliance verification activities that is consistent across all ministries in the natural resources sector.*

PART 2: MINISTRY OF ENVIRONMENT



3. Compliance Promotion

Compliance promotion is any activity that educates and increases awareness about regulations, or that motivates or encourages voluntary changes in behaviour to comply with regulatory requirements. It is a preventative strategy that includes both compliance assistance and compliance incentive programs.

Globally, given the reduction in government resources, most countries recognize the growing importance of compliance promotion. We therefore expected MoE to have established an effective promotion program that included both compliance assistance and compliance incentives.

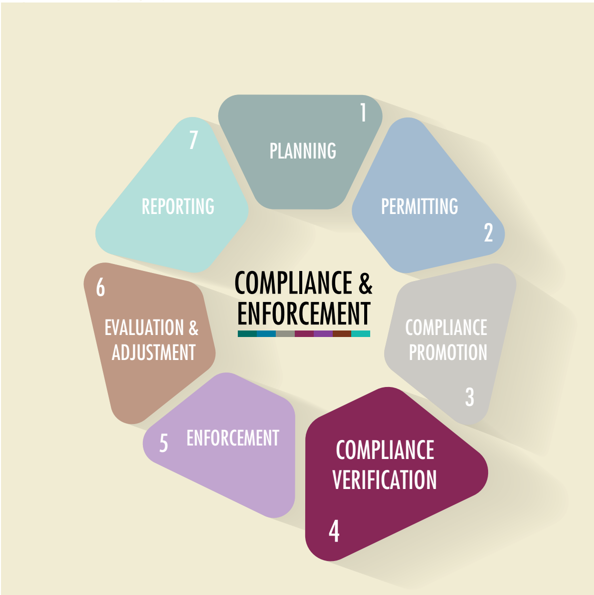
We found that, while MoE has created guidance documents to help promote industry compliance, the ministry does not know whether these materials are effectively resulting in voluntary compliance or achievement of B.C.'s environmental objectives.

We also found that MoE offers no incentives to industry, despite the *Environmental Management Act,* which allows government to create regulations "for the purpose of providing economic incentives to promote environmentally responsible behaviour."

RECOMMENDATION 1.9

Incentives*—We recommend that government create effective incentives to promote environmentally responsible behavior by industry.*

PART 2: MINISTRY OF ENVIRONMENT



4. Compliance Verification

Compliance verification refers to monitoring and inspection activities used to determine whether a mine is in compliance with legislative and regulatory requirements, including the conditions of its permit. We expected MoE to be:

- applying a risk-based approach to planning its compliance verification activities
- carrying out site inspections in keeping with its own policies
- monitoring industry reporting on compliance

We found that MoE was deficient in all these areas.

Risk-based planning

According to good practices, inspections should be based on a schedule that considers risk (weighing actual or potential impact to the environment and the likelihood of occurrence) and the need to maintain an appropriate level of contact with the regulated parties. Our expectation was that MoE would be planning its inspections based on identified risks. We recognized that MoE would be limited in addressing all the risks identified, but we expected it to identify key risks for dealing with and reporting on the residual risks.

We found that MoE used to prioritize sites based on analysis using an electronic risk-ranking tool. However, in 2014, MoE determined that staff were applying the tool inconsistently across the regions and finding it complicated and subjective to use. In the summer of 2015, MoE implemented a new risk-based planning tool to assess the risks of permits under the *Environmental Management Act*; however, it is too soon for us to conclude on the effectiveness of this new tool.

In 2014, MoE shifted its resources to assessing compliance of high risk mining operations. This focus limited MoE's ability to inspect other industries that also have *Environmental Management Act* permits – a situation that poses a risk to the ministry's overall regulatory performance.

In 2015, MoE identified this risk in its risk register, stating that there was a high risk that regulatory requirements are not adequately verified and enforced. Shifting of resources to mining has left minimal to no resources for addressing low to moderate risk activities, such as agriculture and sewage. MoE also stated that its existing mitigations to address these issues are inadequate to address this risk.

PART 2: MINISTRY OF ENVIRONMENT

Site inspections

We reviewed MoE's inspection records for 2012, 2013 and 2014 in a sample of eight mines. Among our key findings:

- MoE did not meet the minimum requirement of its policy to inspect high-priority sites annually. Only three of the eight mines we examined had received an onsite inspection by the ministry for all three years. For example, Myra Falls mine had no site inspection for 2012, 2013 or 2014 – a finding of particular concern given this site is located in a provincial park and is close to drinking water sources.
- Inspection reports were completed to the standard described in MoE's *Inspectors Manual*. However, although the manual states that such reports should be sent to the mine operator in a "timely" manner, "timely" is not defined. Some reports we reviewed were not sent to operators for months.
- An average of three different MoE inspectors conducted inspections at each of the eight mines. Given the complexity of these sites, this lack of continuity creates a risk that an inspector may not know the history of the site, and therefore may not follow up on a non-compliance issue. In addition, this situation creates the potential for inefficiencies – both for MoE staff and for mine site staff. However, this turnover of inspectors may have been the result of MoE's 2014 branch re-organization.

MoE rarely shared with MEM staff inspection plans, the findings of MoE inspections, or MoE enforcement actions taken.

We also found, from our review of four closed mines, that only one had been inspected between 2012 and 2014. For example, Shasta-Baker mine received no inspections, despite a history of significant non-compliance issues (see sidebar on page 60).

RECOMMENDATION 1.10

Risk-based approach—*We recommend that government develop a risk-based approach to compliance verification activities, where frequency of inspections are based on risks such as industry's non-compliance record, industry's financial state, and industry's activities (e.g., expansion) as well as risks related to seasonal variations.*

Monitoring of industry reports

We expected that MoE would, at a minimum, ensure that reports required under each permit were being received and reviewed in a timely manner and would have policies and guidance around Qualified Professionals (QP).

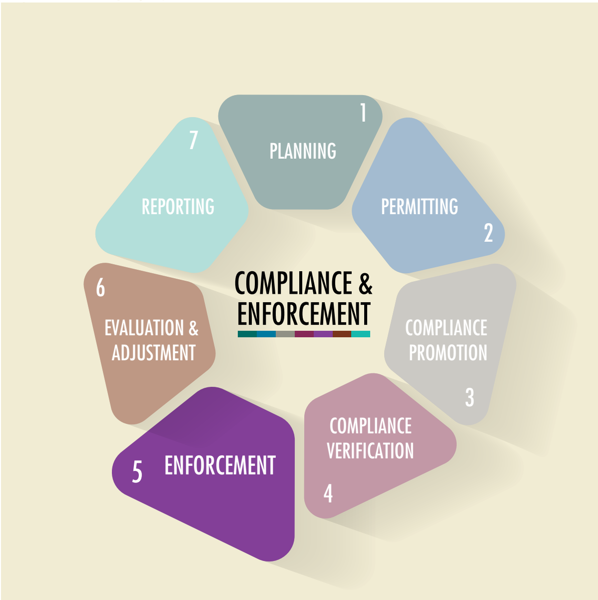
Each effluent permit for a mine has reporting requirements that include annual, quarterly and/or monthly reporting. We found that MoE does not have a clear process for MoE staff that identifies when and to what level of scrutiny a mine's self-reported data, typically prepared by QPs, is reviewed. In the sample of mines we reviewed, all were missing MoE reviews of either the annual or quarterly reports submitted by industry. We could not determine statistics for monthly reports, as they were not logged into MoE's system. The ministry was also not ensuring that all reports submitted by QPs were received according to the timeline specified in the permits. MoE told us that it does not have the resources to review all reports submitted by industry.

RECOMMENDATION 1.12

Qualified Professionals*—We recommend that government establish policies and procedures for the use and oversight of qualified professionals (QP) across the natural resource sector. These policies and procedures should have the following:*

- *guidance for staff that outlines the specific nature and amount of oversight expected of a QP's work*
- *guidance for staff as to expected timeframe for review and response to QP reports*
- *updated guidance for staff for recognizing and responding to misconduct by a QP*
- *controls in place to ensure that there is no undue influence on the QPs by industry*
- *controls in place to ensure that recommendations by QPs are adhered to*

PART 2: MINISTRY OF ENVIRONMENT



5. Enforcement

Enforcement is the backbone to any compliance program. It is the final line of defence against environmental degradation. According to good practices, strategies involving education, assistance, monitoring, inspections and incentives are effective only if backed by a credible threat of enforcement sanctions.

To be effective, enforcement programs must involve:

- swift and predictable responses to violations, and
- responses that include appropriate sanctions.

Swift responses to violations

We concluded that MoE generally does not have a swift response to non-compliance. In our sample of mines, only half of the enforcement responses specified timeframes as to when the ministry expected remedy actions to be completed. However, because MoE's inspection policy and procedures do not call for inspectors to track an industry's timely return to compliance, we cannot conclude whether even those timelines from the sample were met.

RECOMMENDATION 1.14

Policies, procedures and tools—*We recommend that government develop policies, procedures and enforcement tools for responding to non-compliances when industry does not meet the timeline specified by the ministry.*

Predictable responses to violations

MoE has a number of guidance documents that assist inspectors in applying a predictable response appropriate for a particular infraction. We noted that MoE relied heavily on notifications and warnings of future enforcement actions rather than applying a stronger tool, such as an order, that would require immediate action to remedy the non-compliance.

MoE's own review of compliance responses from 2012 to 2014 indicates that advisories and warnings in response to infractions identified during mining inspections accounted for an average of 89% of all enforcement actions.

Responses that include appropriate sanctions

MoE has a range of tools available to address non-compliance (see Exhibit 27). Until recently, this suite of tools did not include the ability to impose a financial penalty without going to court.

PART 2: MINISTRY OF ENVIRONMENT

In 2014, the ministry addressed this gap by adding administrative penalties – where penalties for contravention can range from $2,000 to $75,000 a day. Previously, MoE staff could only issue a ticket with a maximum financial penalty of $575.

Bringing these administrative penalties into effect took over 30 years: they were recommended by the Auditor General in 1981 and were also suggested by staff in MoE's *Pollution Prevention Review* in 2001.

We cannot comment on the effectiveness of this new tool as MoE had not yet used it, at the time of our audit.

In MoE's compliance model, Environmental Protection Officers who carry out the inspection of mine sites are empowered to issue only advisories or warnings. Higher levels of enforcement – such as orders, administrative sanctions and administrative monetary penalties – must be authorized by the Director (statutory decision-maker). Other actions, such as tickets or an investigation that may lead to prosecution, are directed to the Conservation Officer Service.

The Major Investigations Unit of the Conservation Officer Service may receive enforcement referrals on mining-related issues from the Environmental Protection Officers. As noted earlier, this unit currently has 10 full-time staff and six vacancies. During our audit, six of these staff members were working full time on the Mount Polley mine investigation. This level of staffing creates a risk that enforcement actions at other mine sites will not be swift and non-compliances may persist.

Exhibit 27: Ministry of Environment's tools to address non-compliance

Advisory: Written notice sent to a non-compliant party about the non-compliance and with the expected course of action often recommended.

Warning: Similar to an advisory; however, warnings differ in that they warn of the possibility of an escalating response should non-compliance continue.

Order: Written legal instruments issued by designated ministry officials. Non-compliance with an order creates an offence and may be prosecuted accordingly.

Administrative sanction: Revocation or suspension of a ministry-issued permit, licence and other administrative instrument.

Administrative monetary penalty (NEW): Discretionary financial penalty that can be imposed by designated ministry statutory decision-makers on those failing to comply with a particular provision of a statute, regulation or the terms of an authorization. These penalties can be administered with less onerous procedural and legal requirements than done by a court.

Restorative justice: Uses dispute resolution principles to create an inclusive forum designed to promote offender accountability, repair the harm caused by the offence, and restore compliance.

Ticket: A summary means of dealing effectively and quickly with the most minor offences.

Court prosecution: A legal proceeding that is recommended by the Ministry of Environment but initiated by Crown counsel to hold accountable a person or company alleged to have committed an offence.

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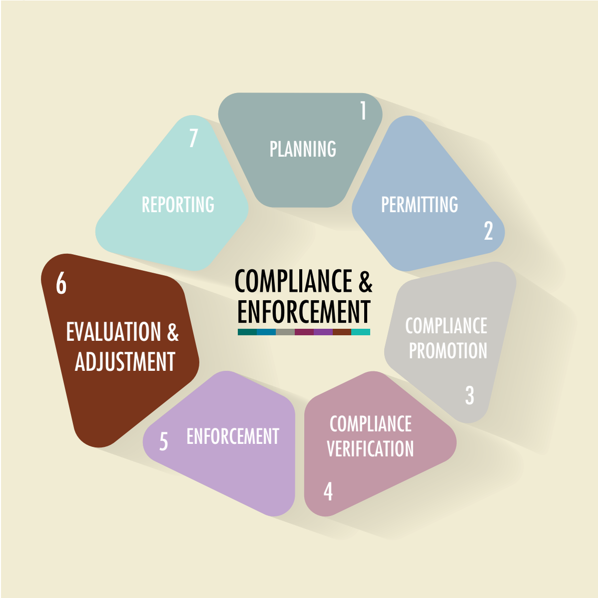

6. Evaluation & Adjustment

Evaluation is a critical, yet often overlooked part of environmental management that leads to greater awareness of whether regulators are successfully achieving the desired environmental outcomes.

We expected MoE to be regularly evaluating the permitting, compliance promotion, compliance verification and enforcement aspects of its program, and to be making adjustments as needed to achieve continuous improvement.

We found, however, that the ministry does not have a formal process to evaluate the effectiveness of any of its activities in compliance promotion, compliance verification or enforcement. While MoE does track the outputs of its compliance verification activities, it has not developed performance measures and does not track the effectiveness of those activities.

Ministry staff have indicated that because they do not have the resources for evaluation, identifying key performance indicators and evaluating performance information is not a priority.

We concluded that MoE, by not having a commitment to formal evaluation, is:

- not meeting the good practices it has set for itself (for example, MoE's 2012 *Compliance Summary* states, "Compliance activities must be linked to the effectiveness of the existing tools, the effectiveness of the preventative measures taken, and the assurance that significant pollution concerns are identified on an on-going basis"),
- unable to determine whether its activities are effective and aligned with government's goals, and whether improvements are necessary, and
- unable to report to government or the public on the effectiveness or impact of its activities.

RECOMMENDATION 1.15

Evaluation & adjustment*—We recommend that government regularly evaluate the effectiveness of its compliance promotion, compliance verification, and enforcement activities and tools, and make changes as needed to ensure continuous improvement.*

PART 2: MINISTRY OF ENVIRONMENT

7. Reporting

Regular, timely, and fair reporting of results to the Legislative Assembly and the public is important to maintaining confidence in the activities of the environmental management program. We therefore expected MoE to be reporting on its performance as a regulator and on the performance of the mining industry.

We found that MoE publicly reports the enforcement actions it takes on cases of non-compliance that meet the ministry's test of administrative fairness (orders, administrative sanctions, administrative monetary penalties, tickets, restorative justice forums, and court convictions). However, MoE does not publicly report on its annual compliance activities, or on the performance of regulated parties in a comprehensive and meaningful manner.

For example, MoE does not report on the number and type of inspections completed, rates of non-compliance, enforcement actions, or effectiveness of its activities in reducing non-compliance and in mitigating environmental impacts of non-compliance. Most importantly, MoE does not communicate the long-term environmental risks associated with managing water contamination.

All of these deficiencies in reporting are inconsistent with MoE's compliance and enforcement framework.

RECOMMENDATION 1.16

Public reporting—*We recommend that government report publicly the:*

- *results and trends of all mining compliance and enforcement activities*
- *effectiveness of compliance and enforcement activities in reducing risks and protect ting the environment*
- *estimated liability and the security held for each mine*

PART 2: MINISTRY OF ENVIRONMENT

DEGRADED WATER QUALITY IN THE ELK VALLEY

Summary

The lack of sufficient and effective regulatory oversight and action by the Ministry of Environment (MoE) to address known environmental issues has allowed degradation of water quality in the Elk Valley (located in southeastern B.C.).

Coal mining in the area for over 100 years, has resulted in high concentrations of selenium in the water system. As selenium accumulates up the food chain, it can affect the development and survival of birds and fish, and may also pose health risks to humans.

For 20 years, MoE has been monitoring selenium levels in the Elk Valley and over that time has noted dramatic annual increases of selenium in the watershed's tributaries. MoE tracked this worsening trend, but took no substantive action to change it. Only recently, has the ministry attempted to control this pollution through permits granted under the *Environmental Management Act*.

We examined the Line Creek Expansion Permit, the Area-Based Management Plan and the Area-Based Management Permit (Valley Permit)[7] to understand how they support MoE's responsibility to minimize risks to the environment. We found that these documents do not address several risks, including the following:

- MoE staff, with input from external experts, concluded that the selenium levels in the proposed Line Creek Expansion Permit were not likely protective of the environment. The statutory decision-maker could not approve the permit. Subsequently, the permit was granted by Cabinet. This was the first time that Cabinet used this approval process. The rationale for the decision was not publicly disclosed.
- The Line Creek Expansion Permit allows mining activities to be extended into an area inhabited by Westslope Cutthroat Trout, a species listed as being of "special concern" under the federal *Species at Risk Act*. This approved expansion of mining operations creates a risk of further decline of this species.
- The Area-Based Management Plan commits industry to developing six water treatment facilities in the Elk Valley. This creates a future economic liability for government to monitor these facilities in perpetuity and ensure that they are maintained.
- There is a risk that if MoE is unable to enforce the Area-Based Management Permit and the mine exceeds its permit limit for selenium at Lake Koocanusa, the outcome could be a violation of the 1909 *Treaty relating to boundary Waters and Questions arising along the Boundary between Canada and the United States* (the Treaty). The Treaty forbids the pollution of water bodies on either side of the border.
- The levels for selenium in the Area-Based Management Permit are inconsistent with the **precautionary principle**.a

[7] Line Creek mine is one of 5 coal mines that Teck is operating in the Elk Valley.

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The ministry has not disclosed these risks to legislators and the public.

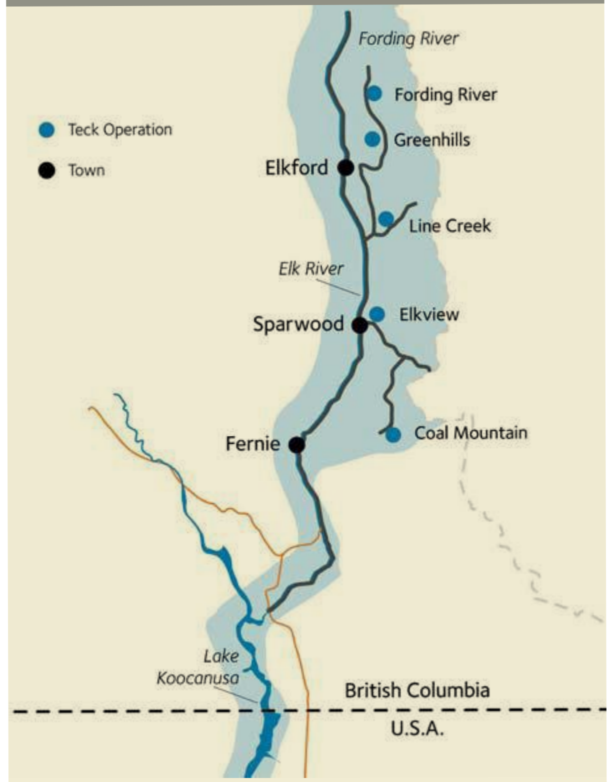
Ultimately, despite the addition of water treatment facilities, the current permit levels of selenium are above the water quality guidelines set by B.C. to protect aquatic life, and for human health and safety. Selenium from both historical mining activities and the ongoing expansion is likely to continue to impact the environment far into the future.

Background

The Elk Valley is located in the southeastern corner of B.C. and includes the communities of Elkford, Sparwood and Fernie. Within the valley's watershed is Lake Koocanusa, which extends south, crossing the Canada–U.S. border into Montana and feeding into the Columbia River system. Some of the river systems in the valley support the Westslope Cutthroat Trout, a species officially listed under the federal *Species at Risk Act* as being of "special concern."

Coal has been mined in the Elk Valley for over 100 years, but only in the past four decades has large-scale extraction resulted in open pits and massive waste dump sites. Currently, there are five major coal mines operating in the valley (see Exhibit 28). In 2008, Teck, which owned a minor stake in the Elk Valley Coal Partnership, purchased all of these coal mines. Several of these mines were operating for many years before Teck's purchase. Both past and recent mine operations and expansions have resulted in a significant increase in the concentration of selenium in river and tributaries in the Elk Valley.

Exhibit 28: Location of the five operating coal mines in the Elk Valley



Source: Office of the Auditor General of British Columbia, based on Teck Coal Ltd.'s Elk Valley Area-Based Management Plan

While selenium is naturally occurring and trace amounts are necessary for the health of many organisms, including humans, it is toxic in excess amounts.

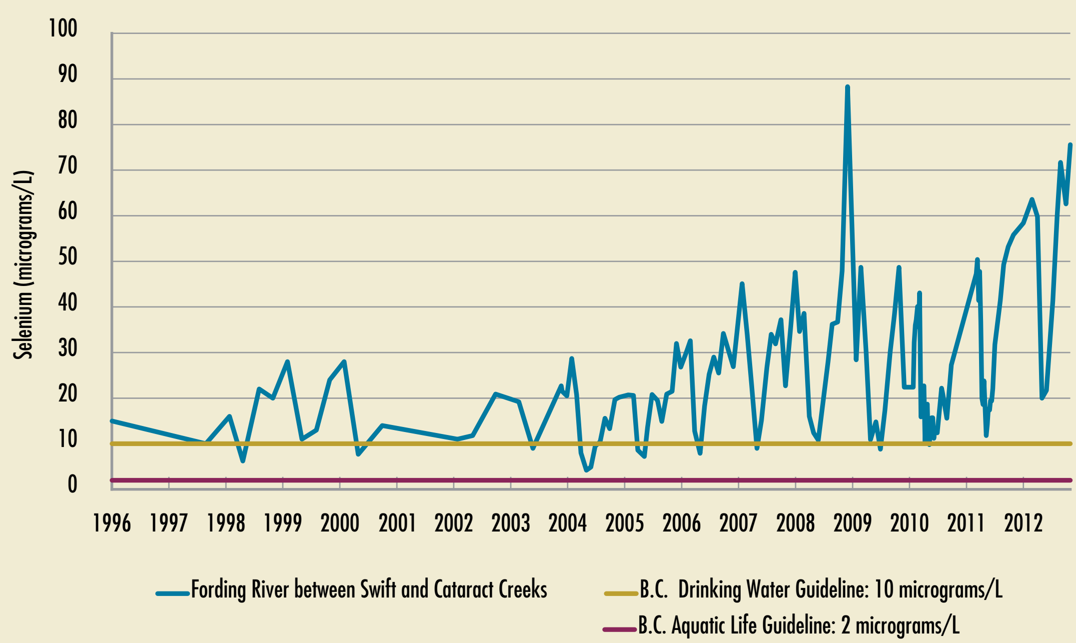
The accumulation of selenium occurs over time as water leaches the element from the waste rock generated by mining activities. Once selenium gets into streams, lakes and other waterways, it is carried up the food chain, becoming more concentrated in the process. The result in fish is reduced growth, behavioural changes, greater incidence of deformity and increased rates of mortality. For birds, the result is reduced egg hatchability and greater incidence of deformity in the chicks that do hatch.

Selenium was not identified by MoE as an environmental issue in the Elk Valley until 1995, even though studies from the U.S. were citing it as a concern as early as the 1970s. In 1996, MoE began a selenium monitoring program and in 1998 established the Elk Valley Selenium Task Force (EVSTF) - a group consisting of representatives from MoE, MEM, Environment Canada and the mine company.

The EVSTF commissioned an independent group to monitor selenium levels in the valley and conduct research over the next 10 years. In 2008, the EVSTF held a workshop to determine regulatory limits for selenium in the Elk Valley. It then recommended, as its highest priority, site-specific water quality objectives. None of these objectives were put into the permits until 2014.

MoE monitoring data from 1996 to 2012 shows that selenium levels in the Fording River are increasing annually at a rate of approximately 13% within the Fording River, and 8% within the Elk River. These levels are well above B.C.'s guidelines for drinking water and aquatic life (see Exhibit 29).

Exhibit 29: Selenium levels in the Fording River, Elk Valley, 1996–2012



Source: Office of the Auditor General of British Columbia, adapted from MoE data

PART 2: MINISTRY OF ENVIRONMENT

In 2009, Teck proposed to expand its mine at Line Creek. This expansion, on top of growing MoE and public concern about pollution in the area, prompted the Minister of Environment to issue a ministerial order in April 2013, calling for the mine company to develop an Elk Valley Area-Based Management Plan. This plan (and associated management permit) was to apply to all of the company's mines in the valley.

The plan was approved by the Minister of Environment and the permit was approved by the Director in 2014. The permit directs the mine company to:

- immediately take action to stabilize water quality concentrations of selenium
- in the medium term, set targets for the progressive reduction in water quality concentrations of selenium
- in the longer term, take action to reduce concentrations of selenium further
- sets timelines for the establishment of water treatment plants
- set out monitoring and reporting requirements

The desired outcomes of the plan and permit include protection of the health of aquatic ecosystems, groundwater and humans.

Our Audit

Permit requirements are the means through which outcomes, such as the protection of the environment, are expected to be achieved.

The Line Creek mine in the Elk Valley was one of the mines our Office selected to sample for this audit. Early in our review, we learned that Line Creek was part of a larger government initiative to better manage the selenium issue in the entire Elk Valley region. That initiative, the creation of an Area-Based Management Plan and resulting Valley Permit, was a new undertaking for MoE.

We therefore reviewed the permits and the Area-Based Management Plan to determine whether the regulatory requirements would enable the ministry, through its compliance and enforcement of these permits, to achieve its objective of protecting the environment.

We expected MoE to be proactive in setting **precautionary** limits in the permits, and to be writing the permits in a way that supports enforceability and reflects the polluter-pays principle.

Line Creek Expansion Permit

The Line Creek operation is located about 25 kilometres north of Sparwood. It has been in production for the past 33 years and produces 3.5 million tonnes of coal annually. The permit would allow an extension of the current operation and would extend the life of the mine for an estimated additional 18 years (see Exhibit 30).

The Line Creek Expansion Permit allows mine development into an area that is currently not affected by selenium accumulation. This area also provides habitat to Westslope Cutthroat Trout, a fish species listed under the federal *Species at Risk Act* as being

Click on the terms that are **bold** and **blue** to go to the definition in the glossary (**Appendix B**).

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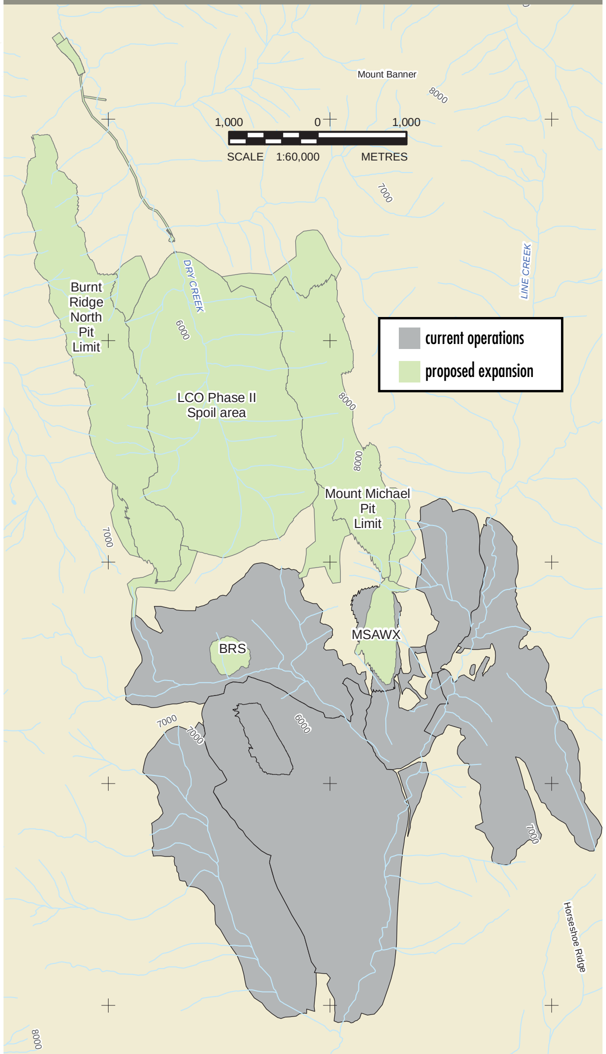
Exhibit 30: Map of Line Creek Expansion

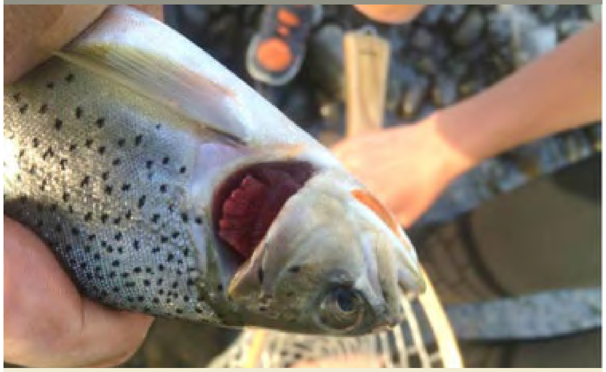


Source: Office of the Auditor General of British Columbia, adapted from Teck's Environmental Assessment Office Application in 2011

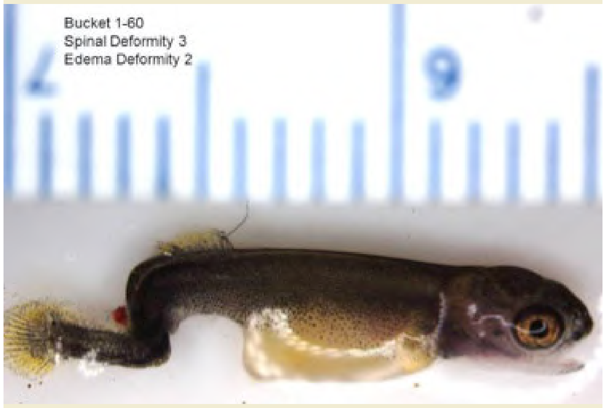
of "**special concern**." Both MoE and Environment Canada have identified other areas of the Elk Valley where the trout are impacted by selenium (see Exhibit 31).

When MoE scientists reviewed the selenium levels proposed for the Line Creek expansion, they concluded that the levels "are not likely protective of environmental resources in the Elk Valley." These concerns were echoed by the U.S. Environmental Protection Agency and other scientific experts.

Exhibit 31: The impact of selenium on Westslope Cutthroat Trout in the Elk Valley



Missing gill cover in Westslope Cutthroat Trout



Spinal skeletal deformity in Westslope Cutthroat Trout fry

Source: Environment Canada, *Environmental Sampling in Areas Affected by Coal Mining in the Elk and Fording River Watersheds of South Eastern British Columbia, 2012–2014*

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The "statutory decision-maker" (see sidebar) could not approve the permit under section 14 of the *Environmental Management Act* (EMA) which states that the statutory decision-makers may authorize a permit only if it includes *requirements for the protection of the environment.*

ROLE OF THE STATUTORY DECISION-MAKER

> "*Statutory Decision-Makers must be impartial and independent. They are required to make decisions fairly and in accordance with the applicable legislation. They cannot be fettered in the exercise of their statutory powers; they must make decisions independently, free from undue influence of any party within or external to the Ministry.*" ~ Source: Ministry of Environment, Statutory Decision-Making Handbook, 2013

Subsequently, a decision was made by government to approve the permit under section 137 of EMA. This clause, which allows Cabinet to approve a permit where it is in the public interest to do so, had never been used before. There is no definition in the *Environmental Management Act* as what defines "public interest," but the Act states that Cabinet may consider factors outside the scope or mandate of the Act. Cabinet did not provide the public or legislature with the rationale for why the permit was in the public interest. This creates a risk that the public or legislature will not be informed about what factors (economic, environmental, social) were considered in decision-making.

We also found that the Line Creek Expansion Permit has a site performance objective for selenium that allows five times the amount set in B.C.'s water quality guidelines for aquatic fish. We concluded that government, in granting the permit, did not publicly disclose the implications these permit levels will have in this area where the expansion will extend the life of this mine for an additional 18 years and produce an additional 3.5 million tonnes of coal annually.

As well, we expected MoE's permits to reflect the polluter-pays principle. We found, however, that under the Line Creek Expansion Permit, the mine company is charged only about $5,000 a year for emitting selenium pollution. This is not reflective of the known environmental impact of selenium.

The Area-Based Management Plan

Under the ministerial order, Teck was directed to create an Area-Based Management Plan. The plan commits the mine company to building six water treatment facilities in the Elk Valley, one of which has already been constructed at the cost of $105 million to the company. Teck and the Province anticipate that these water treatment facilities will operate in perpetuity, resulting in long-term obligations for both parties. The mine company must maintain these facilities, and the province must monitor the facilities to ensure that permit conditions are met. In addition, the provincial government has oversight of these activities and would accept additional responsibilities if the mine operator was to default on its obligations.

PART 2: MINISTRY OF ENVIRONMENT

The Area-Based Management Permit

The Area-Based Management Permit was meant to reflect the ministerial order of stabilizing and reducing selenium. We therefore expected the levels of selenium set in the permit to reflect the order. Instead, we found that the permit levels of selenium for most areas exceed the known historical levels in the Elk Valley (see Exhibit 32).

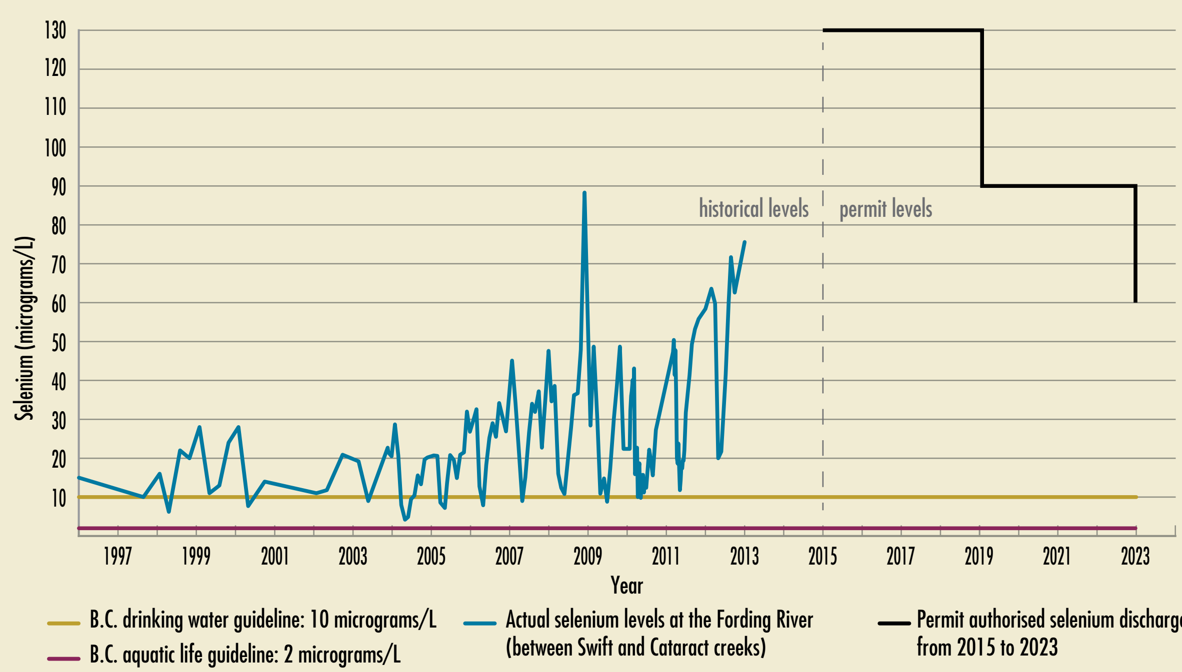
MoE has stated that this increase in permitted level is necessary because of greater leaching of selenium from old waste rock. However, this permitted level was modelled based on data not only for historic sites – but also for the planned expansion, which will see a doubling, by the year 2034, of the waste rock in the Elk Valley from 2012 levels.

Once water treatment facilities are in place there will be a reduction in the permitted selenium; however, the selenium levels allowed in the permit for 2023 still range from being 10 to 30 times the ministry's aquatic guidelines of 2 micrograms of selenium per litre of water (see Exhibit 33).

It is not clear how these high selenium levels will meet government's objective to protect the health of aquatic ecosystems, groundwater and humans in the Elk Valley.

The Area-Based Management Permit sets out the amount of selenium that the mine company is permitted to discharge into the Elk Valley. Rivers in the valley drain into Lake Koocanusa, which spans the

Exhibit 32: Historical levels and permitted levels of selenium in the Fording River[8]



Source: Office of the Auditor General of British Columbia, adapted from the MoE data and the Elk Valley Permit

[8] The historical and permit levels are not from the exact same site on the Fording River.

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Canada–U.S. border. The Area-Based Management Permit creates a risk that if MoE is unable to enforce the permit and the mine company exceeds its permit limit for selenium at Lake Koocanusa, the outcome could be a violation of the 1909 Treaty relating to boundary Waters and Questions arising along the Boundary between Canada and the United States (the Treaty) that forbids the pollution of water bodies on either side of the border.

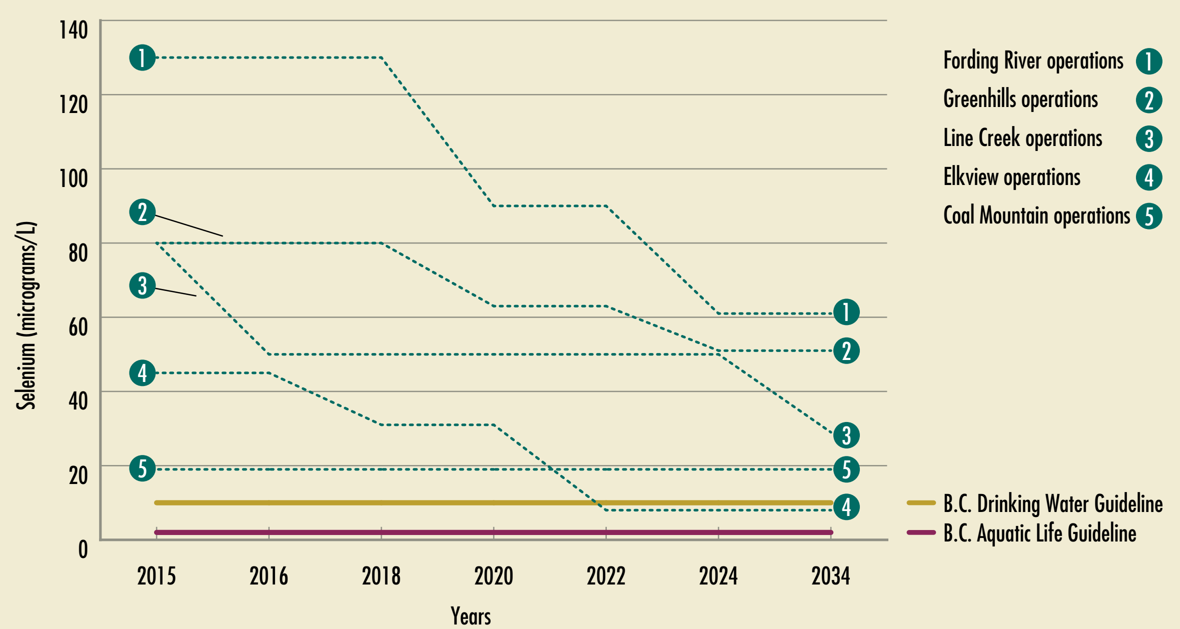
Over the past three years, the U.S. Environmental Protection Agency (EPA) has written to MoE with concerns about the cumulative effect of contaminants from the coal mines in the Elk Valley on Lake Koocanusa and the Kootenai River in Montana. The EPA has stated that the current limit for selenium of 2 micrograms per litre (in freshwater) specified in the valley-wide permit is higher than the current average selenium concentrations in the lake. According to the EPA, the selenium levels contemplated by the B.C. government will result in an increase in selenium in the area, not a stabilization or reversal of levels, as was promised in the ministerial order issued in 2013.

These risks have not been clearly reported to legislators or the public.

RECOMMENDATION 1.7

Decision-making—Use of section 137 of the Environmental Management Act—
We recommend that government publicly disclose its rationale for granting a permit under section 137 of the Environmental Management Act. Specifically, information should include how factors such as economic, environmental, and social attributes were considered in the determination of public interest.

Exhibit 33: Permitted selenium (monthly averages) for all Teck mines in the Elk Valley



Source: Office of the Auditor General of British Columbia, based on MoE's Permit 107517 (for Teck)

APPENDIX A: AUDIT EXPECTATIONS AND SCOPE

Exhibit A1: Seven key elements of a comprehensive compliance and enforcement program

Source: Office of the Auditor General of British Columbia, adapted from the Organisation for Economic Co-Operation and Development's *Ensuring Environmental Compliance: Trends and Good Practices* and MoE's *Compliance Management Framework*

OUR EXPECTATIONS

In this audit, we expected the Ministry of Energy and Mines (MEM) and Ministry of Environment (MoE) to have strategic plans that would detail the activities of their compliance and enforcement programs, including how the two ministries intended to work together. We also expected the plans to demonstrate how the ministries were achieving their objectives of ensuring the protection of the environment. We looked for activities that would include all the elements of what good practice states are crucial to ensure compliance (see Exhibit A1). Such practices include:

- setting regulatory requirements that are enforceable
- promoting compliance (to achieve high rates of voluntary compliance)
- verifying compliance (to ensure that industry is meeting government's regulatory requirements)
- enforcing requirements (to compel the mining industry to swiftly return to compliance)

As well, we expected MEM and MoE to be ensuring continuous improvement of their compliance and enforcement program through evaluation and adjustment, and to be reporting out to the Legislative Assembly and the public on the results of their activities.

We based our audit expectations on:

- regulatory requirements of the *Ministry of Energy and Mines Act*, the *Mines Act*, the Health, Safety and Reclamation Code for Mines in British Columbia, the *Environmental Management Act*, and the *Waste Discharge Regulation*
- MEM's and MoE's policies and guidance
- advice of subject matter experts
- international good practice, including that of the International Network for Environmental Compliance and Enforcement

APPENDIX A: AUDIT EXPECTATIONS AND SCOPE

AUDIT SCOPE

We conducted this audit in accordance with the standards for assurance engagements set out by the Chartered Professional Accountants of Canada (CPA) in the CPA Handbook – *Assurance and Value-for-Money Auditing in the Public Sector*, Section PS 5400, and under the authority of section 11(8) of the *Auditor General Act*.

We carried out our work between November 2014 and July 2015. This included a detailed examination of compliance and enforcement activities that took place at a sample of mines from 2012 to 2014. However, the long and complex history of mining meant that we reviewed documentation outside this timeframe.

Our work involved:

- interviewing:
  - MEM and MoE executives and program area staff
  - Natural Resources Canada staff
  - First Nations Energy and Mining Council staff
  - mining company employees
  - qualified environmental professional contractors
  - mining engineers
- verifying MEM and MoE policies, business practices and processes
- reviewing mine permits, inspection reports, enforcement actions and other documentation
- making site visits to a selection of regional MEM and MoE offices, and operating and closed mines in B.C.

APPENDIX A: AUDIT EXPECTATIONS AND SCOPE

The scope of our audit work is summarized below:

	In Scope	Out of Scope
Entities	MoE (mainly the Environmental Protection Division) and MEM (Permitting Branch)	• The Ministry of Forests, Lands and Natural Resource Operations • Environmental Assessment Office
Program area	Provisions in the *Mines Act*, the Health, Safety and Reclamation Code for Mines in British Columbia, and the *Environmental Management Act* related to the protection of the environment	• Health and safety of mine workers • Cultural heritage resources
Mine phases	operation/production and closure	• exploration, development/construction • abandoned mines (i.e. permit obligations have been satisfied and the mineral claims have reverted to the government) • closed mines that predated 1969 (when reclamation was added to the *Mining Act*)
Mine type	Major mines (metal and coal)	• Small mines (Gravel pits, quarries, industrial, and placer mines)

APPENDIX B: GLOSSARY

Abandoned mines: As defined under the *Mines Act*, mines are classified as abandoned when all permit obligations have been satisfied and mineral claims have reverted to government.

Acid rock drainage: Acid rock drainage is formed by the natural oxidation of sulfide minerals when they are exposed to air and water. Activities that involve the excavation of rock with sulfide minerals, such as metal and coal mining, accelerate the process.

Beach: A gently sloping surface of tailings against the upstream face of a tailings dam embankment. Beaches can serve as a buffer to maintain separation between water in the tailings pond and the embankment structure.

Buttress: An external support built to reinforce a structure (such as a tailings storage facility) by increasing stability.

Closed mine: As defined under the *Mines Act*, mines are classified as closed when all mining activities have ceased; however, the permit holder remains responsible for compliance with the legislated requirements and the permit.

Contingency fund: Funding that government sets aside to accommodate the financial consequences of unanticipated events.

Financial security deposit: The Government of British Columbia collects a financial security deposit from mining companies that can be used if a company defaults on its reclamation obligations. This security is only returned once the mine site has been reclaimed to a satisfactory level and there are no ongoing monitoring or maintenance requirements. The intent of the government's reclamation legislation is to help ensure that modern mine sites in B.C. do not leave an ongoing legacy or require public funds for clean-up activities.

Heavy metal and non-metal leaching: Leaching can occur when minerals containing heavy metals and non-metals (such as arsenic, copper, cadmium, lead, zinc and selenium) in excavated rock or exposed mine walls come into contact with water and then seep from the rock into the environment. Metal and non-metal dissolving and transportation may be accelerated in the acidic conditions created by acid rock drainage.

Mine operator: The mining company, under Section 21 of the *Mines Act*, appoints a mine operator to be responsible for the management and operation of mine

Ore: Mineralized rock containing a valued metal (such as gold or copper) or other mineral substances (such as coal).

Open pit mining: A method of surface mining that can be utilized when valued substances are found near the surface—it involves extracting rock or minerals from open pits.

APPENDIX B: GLOSSARY

Pollution: The presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment.

Polluter-pays principle: States that the party responsible for environmental damage should bear the associated costs of the clean up.

Placer mining: A type of mining that involves mining stream bed deposits for minerals. Placer mining is frequently used for precious metal deposits, particularly gold and gemstones.

Precautionary principle: When human activities may lead to unacceptable harm that is scientifically plausible but uncertain, the precautionary principle states that actions should be taken to avoid or diminish the harm.

Reclamation: The process of restoring land, watercourses and cultural heritage resources that have been mined to a safe and environmentally sound state and to an acceptable, productive end use. For successful site reclamation, activities must be carried out concurrently with mining activities, rather than being left until mine closure; this is referred to as progressive reclamation. Since 1969 in British Columbia, mining companies have been required by law to reclaim all lands disturbed by mining and related activities. There are broad reclamation standards within the Health, Safety and Reclamation Code (Part 10.7) for revegetation, growth media, metal uptake, landforms, watercourses, water quality, disposal of chemicals and re-agents, and monitoring and post-closure land use.

Regulatory Capture: This is the process by which regulatory agencies eventually come to be dominated by the very industries they were charged with regulating. Regulatory capture happens when a regulatory agency, formed to act in the public's interest, eventually acts in ways that benefit the industry it is supposed to be regulating, rather than the public.

Qualified professional: For the purposes of this report, qualified professionals are individuals employed or contracted by a mining company that are qualified to practice in B.C. in their relevant professional discipline (engineers, biologists, etc…).

Species of "special concern:" Under the federal *Species at Risk Act*, a species of special concern is wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.

Tailings: A by-product of the mining process that is left over after separating the valuable materials from the uneconomic portion of ore. Tailings are typically a mixture of sandy silt with a trace of clay particles.

Tailings Storage Facility: A structure built for the purpose of storing tailings. Conventional facilities typically consist of one or more embankments.

Underground mining: A mining method that is used when minerals occur deep below the Earth's surface and require tunneling.

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CPAWS 496

APPENDIX E

Environment and Parks and the Alberta Energy Regulator—Systems to Ensure Sufficient Financial Security for Land Disturbances from Mining

SUMMARY

What we examined

We followed up our recommendation, originally made to the former Department of Environment in 1999, to implement a system for obtaining sufficient financial security to ensure that the conservation and reclamation of mine sites is completed. We have repeated the recommendation three times.

Since the time of our last follow-up audit, the Department of Environment and Parks developed and implemented the Mine Financial Security Program (MFSP). The focus of our current audit was on this program, and whether it constitutes an approach that provides for sufficient financial security. Our audit approach included assessing whether the methodology is logical and in agreement with the stated objectives of the MFSP and whether adequate ongoing monitoring of the security being provided is taking place. The design of the MFSP resides with the department and the administration was transferred to the Alberta Energy Regulator, effective March 2014. Therefore, our audit was conducted at both organizations.

As of December 31, 2014, $1.57 billion of security is currently being held in comparison to estimated reclamation liabilities of $20.8 billion. Because the MFSP applies an "asset to liability approach," both the security held and the value of the resource in the ground are considered assets in the program, which is designed to offset liabilities. As the resources are depleted, the security requirements increase to reflect greater liability exposure. The security required is reduced as reclamation takes place and the liability is reduced.

Overall conclusion

Implementing the MFSP was an important step towards a system that obtains sufficient financial security for mining related land disturbances. However, for the design and operation of the MFSP to fully reflect the intended objectives of the program, improvements are needed to both how security is calculated and how security amounts are monitored.

What we found

There is a significant risk that asset values calculated by the department are overstated within the MFSP asset calculation, which could result in security amounts inconsistent with the MFSP objectives. The MFSP asset calculations do not incorporate a discount factor to reflect risk, use a forward price factor that underestimates the impact of future price declines, and treat proven and probable reserves as equally valuable.

The extent of the department’s and AER’s audit verification activity since 2011 has been limited. There is no documented risk-based plan to outline the extent of activities necessary to provide the necessary assurance that security amounts are appropriate.

What needs to be done

We are assessing the recommendation as implemented because the deployment of the MFSP satisfies the intent of what was originally recommended. However, we are making a new recommendation as the department needs to analyze and decide upon the various factors overstating asset values in the MFSP calculation. Additionally, the department should consider the impact of factors that may inappropriately extend the mine life within MFSP security calculations.

We are also making a new recommendation to the AER as the administrator of the MFSP. The AER needs to develop a plan, informed by external and operator risks, to decide when and how many audits of operator submitted information it will complete. Additionally, the AER could cost-effectively enhance its monitoring activities by keeping a closer eye on current events that may signal risks to the operating and financial condition of mining operators.

Why this is important to Albertans

In the event that a mine operator cannot fulfill its reclamation obligations, and no other private operator assumes the liability, the province may have to pay a potentially substantial cost for this work to be completed. Thus, a robust and responsive system to calculate and collect security from mine operators is essential.

AUDIT OBJECTIVE AND SCOPE

Our audit objective was to determine if the department and the AER implemented our recommendation to implement a system for obtaining sufficient financial security to ensure that conservation and reclamation of mine sites is completed.

We conducted our field work from October 2014 to March 2015. We substantially completed our audit on June 11, 2015. Our audit was conducted in accordance with the *Auditor General Act* and the standards for assurance engagements set by the Chartered Professional Accountants of Canada.

BACKGROUND

By law, coal and oil sands mine operations are responsible for reclaiming land that is disturbed by mining and the operation of related plants. Standards for reclamation are set by the Government of Alberta.

Audit history

In 1998, we performed an audit of the systems used by the Department of Environment to collect financial security for land disturbances in the oil sands and coal mining sectors. We determined that financial security was usually in the form of a letter of credit from a bank, intended to cover the costs related to eventual site reclamation by industry operators. However, we found that the department did not have a consistent process to determine the amount of financial security required from the operators and there were varying practices being followed by different operators and industries. Our original recommendation was reported in our 1998–1999 report, and we repeated the recommendation in our follow-up reports in 2000–2001, 2004–2005 and 2009.

Developments since our 2009 follow-up audit

The government has moved forward with a number of reclamation initiatives to improve clarity, security, and environmental performance within the oil sands and coal mining sectors. These new reclamation initiatives include the MFSP, enhanced reclamation reporting, and a strategy to encourage quicker reclamation.

The Mine Financial Security Program

The fundamental principle of the MFSP is that the *Environmental Protection and Enhancement Act* approval holder is responsible for carrying out suspension, abandonment, remediation and surface reclamation (going forward, referred to as reclamation in this report) work to the standards established by the province and to maintain care and custody of the land until a reclamation certificate has been issued.

The MFSP was initiated by the department in 2011 to ensure that financial resources will be available to reclaim disturbed lands if an operator is unable to complete the reclamation. The MFSP intends to strike a balance between protecting Albertans from incurring costs associated with reclamation work and maximizing opportunities for responsible and sustainable resource development. The amount of security and when it needs to be provided are key elements that factor into that balance.

By June 30, mine operators are required to provide annual reporting for the previous year ended December 31. This annual reporting includes the information necessary to calculate the required security deposit. Responsibility for the administration of the program was transferred from the department to the AER in March 2014. The department continues to be responsible for establishing the overall MFSP policy and design.

The program requires a base amount of security for each mine project, which is intended to provide the funds necessary to safely secure the mine site and place the project in a care and custody state.

The MFSP uses an asset-to-liability approach to managing financial risks relating to reclamation liabilities. This approach recognizes that the resource value associated with an approved project is an asset in terms of its ability to generate cash flow through operations. When a project has MFSP assets at least three times larger than its MFSP liability, is 15 years or more from the end of its reserves and is keeping current with its reclamation plans, additional security above the base amount is not required. When a project has MFSP assets less than three times its MFSP liability, is nearing the end of its productive mine life, or is not meeting its targeted reclamation plans, additional financial security is required. (See appendix for base and other types of security deposits.)

Because the MFSP has been designed using an asset-to-liability approach rather than a full security approach, Albertans bear a degree of risk that reclamation will not be completed by the mine operator. The MFSP attempts to manage this risk by requiring these various deposits.

The MFSP is not designed to respond quickly to sudden fluctuations in the price of oil. This was a deliberate decision made by the department to avoid potentially widely fluctuating security amounts from year to year. If an abrupt financial and operational decline were to occur in the oil sands sector it would likely be difficult for an oil sands mine operator to provide this security even if the need for the security was identified through the program. It is important to recognize that the department has accepted the risk of not protecting against a broad based and rapid structural decline in the oil sands sector, having designed the program with the intent of capturing what they believe are a reasonable range of economic conditions.

FINDINGS AND RECOMMENDATIONS

Improvements needed to the design of the mine financial security program

Background

Asset safety factor deposit

The MFSP incorporates an asset safety factor deposit which is only required if a mine's resource assets are worth less than three times the total anticipated costs for conserving and reclaiming the mine site. The asset safety factor calculation was created to ensure that a mine will have assets of sufficient value in place to ensure that a new operator will be motivated to take over the mine and complete the required reclamation activities if the existing operator is not able to do so.

Under the MFSP, the value of an oil sands mine's resource assets is based on the income that those assets are likely to generate over the life of the mine. The assets are calculated as:

MFSP Assets = N * R * F

Where N = 3-Year Average of Annual Netbacks[1]
R = Gross Proven and Probable Reserves
F = Forward Price[2] Factor

Outstanding reclamation deposit

The outstanding reclamation deposit is intended to encourage the prompt reclamation of disturbed lands. The operator posts security when they do not complete planned reclamation according to the reclamation schedule approved by the department within the operator's mine reclamation plan. The amount of security is $75,000 per hectare of work planned but not performed.

Operating life deposit

An operator is required to start posting financial security when there are less than 15 years of reserves left. Security gradually increases so that all outstanding reclamation costs are fully financially secured by the time there are less than six years of reserves left.

Presently, no oil sands mining operator has posted more than the base amount of security. In other words, no security is currently required under the various other forms of deposit based on data submitted by oil sands mine operators.

1 Netback is a term used in oil and gas extraction that is calculated by taking revenue from oil and gas production and deducting all the costs associated with bringing oil and gas to market. It is typically presented on a "per barrel" basis.
2 A forward price is the predetermined delivery price for an underlying commodity, currency, or financial asset decided upon by the buyer and the seller to be paid at a predetermined date in the future.

RECOMMENDATION 2: IMPROVE PROGRAM DESIGN

We recommend that the Department of Environment and Parks, as part of its regular review of the Mine Financial Security Program:

- analyze and conclude on whether changes to the asset calculation are necessary due to overestimation of asset values in the methodology
- demonstrate that it has appropriately analyzed and concluded on the potential impacts of inappropriately extended mine life in the calculation

Criteria: the standards for our audit

The department should demonstrate that the Mine Financial Security Program:

- is designed consistently with its principles
- is operating as intended
- mitigates the risk of taxpayers having to assume costs of reclamation work in case of operators' possible non-compliance with legislation

Our audit findings

KEY FINDINGS

- The MFSP asset calculation overstates the economic value of mining assets.
- The department needs to review and resolve opportunities it identified within the MFSP to inappropriately extend an oil sands mine's life.
- The department reviews and approves planned yearly reclamations.

Asset calculation methodology results in overstated estimated asset values

We have identified three significant inconsistencies between the MFSP objectives and the approach to the asset calculation that is likely to result in overvaluation of mine assets:

- The reserve estimate used under the program includes both proven and probable reserves. Probable reserves, defined as a 50 per cent likelihood of commercial extraction, are less likely to be productive than proven reserves, defined as a 90 per cent likelihood of commercial extraction. Treating both proven and probable reserves as equally valuable on a per barrel basis increases the risk that the department is overestimating the value of these assets. Furthermore, there is no consideration in the calculation of the development costs necessary to bring undeveloped proven reserves and probable reserves into production.
- The resource asset valuation calculation applies a forward price factor to the average netback for the last three years. This methodology is intended to adjust past earnings to reflect expected future declines in oil prices. Using this approach implies that commodity price declines will have an equally proportional impact on revenues as they do on operating costs, which is not consistent with the reality of oil sands operations. Applying the forward price factor to the average netback instead of applying it only to average revenues and then deducting average operating expenses underestimates the impact of future price declines on the valuation of a mine's resource assets.
- The resource asset valuation calculation does not reflect any risks associated with the future economic value of the reserves. Oil sands mines are long-term operations and it takes many years to completely extract a site's reserves. Over that long time frame, there are numerous risks to the profitability of a mine operation. These include oil price fluctuations, foreign exchange rate changes, technological change and regulatory change. These risks are typically reflected by applying a discount rate to the expected future income stream when valuing a long-term asset. No discount rate, or risk-based adjustment, is applied in determining the asset value under the program, which overstates the value of a mine's resource assets.

While correcting for these overstatements may not immediately result in any change to the security required, it could result in additional required security earlier than presently anticipated or in the event of prolonged oil price weakness.

Possible inappropriate extension of mine life

The department has identified two circumstances that could result in unnecessary deferrals in the collection of security under the program:

- Some oil sands mine operators are using in situ techniques to extract oil reserves and augment their open pit mine reserves. These in situ techniques involve the drilling of wells and the injection of heat into the reservoir to extract bitumen as opposed to extracting it through open pit mining. This technique creates less land disturbance than does an open pit mine. However, the inclusion of the oil reserves made available through this process in the calculations under the program serves to increase the mine's resource assets and extend the life of the mine. This delays the collection of security for the open pit mining operation as it reaches the end of its life.
- Oil sands mine operators may be able to amend the areas covered by their mine approvals or combine multiple mines into one approval. The effect of this may combine an old mine operation with a new one and thus increase the resource assets associated with the approval. This delays the collection of security for the older mining operation as it reaches the end of its life.

We understand that the department is currently analyzing the first of these issues as part of its MFSP review process. The second issue will not be part of the MFSP review process.

Planned yearly reclamation is being reviewed and approved

One of the stated principles that guided the development of the MFSP is that "lands available for reclamation should be reclaimed and returned to the province or landowner as soon as possible."

If operators do not complete their planned yearly reclamation, any shortfall translates into higher security at a rate of $75,000 per hectare. Operator mine reclamation plans are reviewed and approved by the department, and now by the AER, and we were provided evidence of detailed technical questions and challenges to operators' mine reclamation plans. This review is completed outside the context of the MFSP as it has broader implications to other areas within the department. Within this review, we found evidence that the yearly reclamation planned had been assessed for adequacy. This assessment is important as the amount of security posted is impacted if planned reclamation is not completed.

The review of planned reclamation is a key control for the MFSP. The more optimistic an operator's yearly reclamation forecast is, the more likely an operator will have to post security; thus, there is a potential disincentive for operator's to plan to reclaim more disturbances earlier.

Implications and risks if recommendation not implemented

If there isn't an adequate program in place to ensure that financial security is provided by mine operators to fund the conservation and reclamation costs associated with their mine operations, mine sites may either not be reclaimed as intended or Albertans could be forced to pay the reclamation costs.

If incentives are not in place to reclaim lands as soon as reclamation is possible, mine sites may remain disturbed for longer than necessary and Albertans face a larger risk that they will end up having to pay the eventual reclamation costs.

Monitoring of the security provided can be improved

Background

The AER assumed responsibility for monitoring the program in March 2014. The program was previously monitored by the department.

Under the program, operators are required to file a brief annual report that discloses their conservation and reclamation liability, their resource assets and the components of the resource asset calculation, and the amounts required for each security deposit under the program. This report is certified by the operator's chief executive officer or chief financial officer. No supporting documentation is required with the report.

The AER is able to "audit" the information provided in the annual report and there are four levels of audit under the program.

- Level 1 audit—Phone or in-person discussions with the operator seeking clarification of information in the annual report.
- Level 2 audit—Written questions and responses confirming scope and methodology used in preparing the annual report.
- Level 3 audit—Detailed audits performed by AER staff, with possible involvement of the Department of Environment and Parks or Department of Energy staff, on all or a portion of the data and assumptions in the annual report. These audits are typically performed at the operator's offices.
- Level 4 audit—Detailed audits performed by a third party auditor. These audits are typically performed at the operator's offices.

The MFSP guidance document indicates that audits may be conducted; however, it doesn't prescribe the number and type of audits to be completed.

RECOMMENDATION 3: IMPROVE PROGRAM MONITORING

We recommend that the Alberta Energy Regulator, as part of its enterprise risk assessment process, develop and execute on a risk-based plan for its Mine Financial Security Program monitoring activities to ensure it is carrying out the appropriate amount of verification.

Criteria: the standards for our audit

Environment and Parks and the Alberta Energy Regulator should demonstrate that the Mine Financial Security Program is implemented, is being followed and is being monitored adequately.

Our audit findings

KEY FINDINGS

- A risk-based plan has not been developed to direct the nature and extent of monitoring activity.
- The level of audit verification is not sufficient to mitigate risk.
- Monitoring activities to mitigate risk could be enhanced.

Risk-based plan has not been developed

When the MFSP was initiated, the department intended to complete two level 4 audits per year, one in the coal sector and one in the oil sands sector. The department was responsible for conducting audits of submissions prior to AER taking over the monitoring of the program.

The AER has not established an audit plan that identifies the level 3 and level 4 audits that should be completed over a given timeframe. A risk assessment has been recently developed to help identify which operators should be monitored more closely. However, there presently is no evidence that the level of audit activity is commensurate with the risks that exist.

Insufficient level of audit verification

The previous program for collecting security for the reclamation of mine operations required operators to provide detailed support for the calculations used to support the amount of security provided. When the MFSP was developed by the department, this requirement was removed. The MFSP only requires a certified annual report and allows for the AER to request additional information to review, or conduct more detailed audits of the calculations. The self-reporting nature of the MFSP enhances the importance of the level 3 and level 4 audits, which verify the information being submitted by operators.

There are 19 coal mines that provide financial security under the program. Since the inception of the program, only two of these mines have been subject to level 3 audits. One level 4 audit had begun at the time of our audit. There is a high degree of financial risk associated with coal mine operations due to the decline in coal prices. As a result, the entire coal sector elected to provide full financial security for the reclamation of their mines. However, very little audit activity has been undertaken in the coal sector to ensure that the amount of financial security provided by the operators is adequate.

Since the program was implemented in 2011, only two level 4 audits have been completed in the oil sands sector and three level 3 audits have been completed.

Given that $1.57 billion of financial security was provided under the program in 2014 and a significantly greater liability exists in relation to unsecured reclamation costs for existing mine operations, the level of verification activity has been insufficient.

AUDITS COMPLETED

	LEVEL 3		LEVEL 4	
	Oil Sands	Coal	Oil Sands	Coal
2012	1	1	0	0
2013	2	1	1	0
2014	0	0	1	1

Note: There are 8 oil sands mines and 19 coal mines

Since 2011, the department and the AER have completed a total of 32 level 2 audits, which entails requesting additional information based on areas of risk or potential concern with an annual submission. The level 2 audit is an important part of the monitoring process as it can identify potential issues. However, they don’t involve verifying supporting information from company records. As such, they provide less assurance on the accuracy of amounts used to calculate security.

Monitoring activities to mitigate risk could be enhanced

The MFSP is designed for an annual review, driven by an annual report that mine operators are required to submit due at the end of June following the reporting year ended December 31. However, significant changes in the intervening period can erode an operator’s financial situation. The AER presently does not have a process to monitor information that might identify material changes to an operator’s continuing operations and financial condition. For example, keeping apprised of significant corporate press releases, interim financial statements and share prices.

The AER does receive information from its field staff that have a more direct line of sight to the operators. This information may alert the AER to changing circumstances that may warrant further review in the context of the MFSP.

Implications and risks if recommendation not implemented

Without an effective and timely monitoring program, necessary adjustments to security amounts may not be promptly identified, which increases the risk that Albertans will end up having to pay for the conservation and reclamation of mine sites.

TYPES OF FINANCIAL SECURITY DEPOSITS UNDER THE MINE FINANCIAL SECURITY PROGRAM

The Mine Financial Security Program includes four types of financial security deposits, focusing on various potential risks during the lifecycle of a mine:

Base Security Deposit—Existing and new projects are required to provide a base amount of security. Among other things, this security will be used for suspension care and custody to maintain security and safety at the site until a new operator takes over or the site is closed. For existing projects, the base security deposit will be the amount of security each project had posted with the government effective December 31, 2010. For existing projects, the security amount as of December 31, 2010 that is being held is:

APPROVAL HOLDER, PROJECT NAME AND EPEA APPROVAL NUMBER	BASE SECURITY DEPOSIT
Canadian Natural, Horizon, 149968	$61,200,000.00
Imperial, Kearl, 46586	$64,655,000.00
Shell Albian, Jackpine, 153125	$72,361,895.00
Shell Albian, Muskeg River, 20809	$111,277,441.29
Suncor, Base Mine, 94	$359,096,654.00
Suncor, Fort Hills, 151469	$38,958,605.00
Syncrude, Mildred Lake and Aurora North, 26	$205,303,024.00

For new projects, the base security will be:

MINE TYPE	BASE SECURITY DEPOSIT
Mine-mouth coal mine	$2,000,000
Export coal mine	$7,000,000
Oil sands mine	$30,000,000
Oil sands mine with upgrader	$60,000,000

Operating Life Deposit—to mitigate the risks at the end of mine life. An operator is required to start posting financial security when there are less than 15 years of reserves left so that all outstanding abandonment, remediation and surface reclamation costs are fully financially secured by the time there are less than six years of reserves left.

Asset Safety Factor Deposit—to mitigate the risks if an operator's cash flow falls below a level deemed adequate to ensure that all MFSP liabilities can be fully funded. The operator posts financial security when the MFSP asset to MFSP liability ratio falls below 3.00. Sufficient financial security must be posted to bring the ratio to 3.00.

Outstanding Reclamation Deposit—to mitigate the risks posed by an operator deferring reclamation. The operator posts security when they do not complete planned reclamation according to the reclamation schedule approved by the government.

Approval holders can elect to place full security at any time in the life of the project based on the MFSP liability calculation. In this case, the approval holder would no longer be subject to the four security deposits described above. The entire coal sector has elected to provide full financial security.

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EXPERT REPORTS OF CPAWS

WYNDHAM ENVIRONMENTAL LTD.

<contact information removed>

September 15th, 2020

Canadian Parks and Wilderness Society
Southern Alberta Chapter
Via email

Attention: Mr. Brad Clute
Executive Director

Re: Evaluation of the Suitability and Likely Efficacy of Proposed Selenium Mitigation Measures – Proposed Grassy Mountain Coal Mine

1. Introduction and Background

Wyndham Environmental Ltd. (WEL) was retained by the Canadian Parks and Wilderness Society, Southern Alberta Chapter (Exhibit A) to review and comment on the proposed selenium attenuation mechanism for the planned Grassy Mountain Coal Mine (the Site). The proposed attenuation mechanism relies on reductively precipitating selenium out of solution by artificially manipulating pH and Eh (i.e., acidity and reduction/oxidation [redox] potential) conditions within Saturated Backfill Zones (SBZs) utilizing injection of organic liquids (e.g., methanol).

2. Personal Information

This letter of opinion was prepared by:

Marc W. Bowles
<contact information removed>

and

Sarah Dougherty
<contact information removed>

3. Author Credentials

3.1 Marc Bowles

Mr. Bowles has worked as an environmental consultant since 1992. He holds a Bachelor's degree in Geology and Master of Science degrees in Applied Mineral Exploration and Hydrogeology. He is a professional geologist registered in Alberta. He was also formerly a rostered Contaminated Sites Approved Professional and professional geoscientist registered in British Columbia. His technical experience spans site characterization, contaminant hydrogeology, liability assessment, and remediation. Marc is also the inventor of the Trench and Gate Remediation System, a proven methodology for in-situ treatment of groundwater contaminant plumes hosted in low permeability sediments. Mr. Bowles has been qualified as an expert witness in the field of contaminant hydrogeology by the Alberta Court of Queen's Bench, and has appeared before the Alberta Environmental Appeals Board to provide an expert opinion. Marc's résumé is included in Exhibit B.

3.2 Sarah Dougherty

Ms. Dougherty has worked as an environmental consultant since 2012. She holds a Bachelor's degree in Environmental Chemistry and a Master of Applied Science degree in Environmental Science. She is a professional chemist registered in Alberta. Her technical experience spans environmental monitoring, contaminated site characterization, analytical chemistry, and in-situ remediation of petroleum hydrocarbon contamination. Sarah's résumé is included in Exhibit B.

4. Instructions

As detailed in the letter of retention (Exhibit A), WEL was retained by counsel for CPAWS to provide an expert opinion related to the following two questions regarding the proposed mine and mitigation measures designed to reduce off-Site selenium migration:

1. What is the likely effectiveness of the Saturated Backfill Zones Benga proposes to build for selenium attenuation?
2. What is the risk of malfunction related to the proposed Saturated Backfill Zone, and what would be the likely consequences of such a malfunction?

In order to evaluate the proposed attenuation methodology, WEL was directed to review key documents prepared as part of the Environmental Impact Assessment (EIA) process (Geosyntec 2020; Riversdale 2016a/b/c, 2019, 2020), documents listed in the retainer letter, documents referenced therein and other applicable literature as detailed in the References section.

5. Problem Formulation

With regard to evaluating the potential efficacy of utilizing the SBZ concept to attenuate off-Site selenium migration, there are several factors to consider. Key amongst these are:

- is there a potential for selenium migration during initial establishment of reducing conditions within the SBZ;
- can the appropriate ph/Eh conditions to keep selenium in a stable state be maintained during mine operation and the post-closure period; and,
- can the SBZ cells be constructed in a manner that contains impacted water and prevents off-Site migration of contaminated groundwater?

To answer these questions, the proposed system was evaluated from both a hydrogeological and geochemical point of view as further discussed below.

6. Hydrogeological Setting, Preferential Migration and Post-Closure Monitoring

The hydrogeological setting, conceptual site model and stratigraphy have all been well defined by others as detailed in the EIA and related documents. With respect to potential off-Site migration of selenium (or other contaminants of concern), one of the key requirements will be to ensure the preferential migration pathways that could facilitate or expedite off-Site migration are eliminated or controlled. Preferential migration pathways may develop due to biofouling or already exist on-Site (e.g., fractures and old mine workings) as discussed below.

6.1 Biofouling

The proposed methodology for selenium attenuation utilizes methanol injection to create reducing (i.e., low or negative Eh) conditions, thus facilitating the reduction of selenium to less mobile forms (as further discussed in Section 7). This is a microbially-mediated reaction, and has been used to remediate nitrogenous groundwater plumes. Injection of organic liquids stimulates the growth of these organisms, particularly in the immediate area of the injection well where the microbes use this carbon source and, if conditions are favourable, reproduce. With time, microbial growth can result in a significant loss of permeability due to a build up of these organisms, a term referred to as biofouling. Loss of permeability can either result in the inability to distribute injected fluids homogenously throughout the SBZ, or creation of preferential flow paths along unfouled migration pathways. Benga has identified this as a potential problem and has proposed to rehabilitate biofouled wells as follows (Riversdale 2020).

> *Periodic rehabilitation of the treatment unit using physical or chemical measures may be required. This typically involves surging and purging injection points or application of a compressed air shock to physically dislodge and recover excess biomass, and in some cases requires addition of an acid such as glycolic acid to destabilize biofilms to improve their removal.*

Potential challenges to using these proposed methodologies include:

- the inability to observe subsurface conditions and evaluate methodology effectiveness;
- that physical remediation methods (e.g., surging) only generally work within the immediate area of the injection well;
- the difficulty of circulating acid through areas with significant permeability loss; and
- potential remobilization of contaminants due to changed pH/Eh conditions brought about by the addition of acid.

Personal experience gained by Mr. Bowles for a project undertaken in Calgary has shown that injection of acetic acidic (vinegar) to promote denitrification in some instances resulted in extreme biofouling that could not be remedied by acid injection, chlorination, or physical remediation techniques. Accordingly, maintaining injection wells over the long-term, including potentially through the post-closure period may prove difficult. As a result, it is suggested that contingency plans be implemented to replace potentially biofouled injections wells on a regular basis, including during the post-closure period.

6.2 Fracture- and Mine Workings-Controlled Migration

6.2.1 Fracture Zones

The geology of the Site and surrounding area is characterized by several thrust faults including the nearby Mutz Thrust (Norris 1993) and numerous associated unnamed smaller thrust faults (Riversdale 2019). Fracturing associated with these thrusts is well documented and may comprise extensive subparallel and subvertical fracture zones which can act as preferential flow paths for groundwater which could speed subsurface migration and result in off-Site contamination.

Fracture zones are discussed in (Riversdale 2019) as follows:

> *While Benga indicates that major thrust faults are expected to be a control mechanism for lateral groundwater flow and local fractures appear to enhance flow within geological units, rather than across bedding planes, ultimately the consultant report states "the actual behavior of each fault is uncertain, as some may act as barriers, while others may act as conduits likely depending in part on the rock type at a particular location". The complex geology, and potentially groundwater flow system, is further confounded by the presence of historical mine workings.*

Benga has discussed options for mitigating transport through bedrock fractures which include (Riversdale 2020) "where necessary selective sealing of fissures in the underlying rock"; and "Benga has proposed to monitor ground water and if necessary, implement a ground water capture strategy to reduce selenium loading to the environment through this route." However, identifying bedrock fractures and capturing fracture-borne groundwater can be very challenging.

Even under ideal conditions, visually identifying fractures in the base of an open pit can be very difficult due to the presence of rock debris, sediment, etc. Geophysical techniques could potentially be used as one tool to help identify fracture zones, but may not be able to differentiate active fractures. As key fractures will likely be subvertical, identifying them will necessitate drilling angled boreholes followed by downhole logging using a variety of techniques. This is a difficult and expensive process, especially when key active fractures do not necessarily follow the same orientation. Additionally, targeting individual fractures for "sealing" activities (e.g., in-situ grouting) is very difficult. Accordingly, sealing of bedrock fracture zones is often accomplished using grout walls. Grout walls are emplaced by drilling close-spaced wells across fracture zones and injecting grout slurries downhole to close off open fractures. In areas with vertical or subvertical fractures this will likely necessitate drilling angled boreholes to intersect multiple fractures. In practice, this sometimes requires installing multiple grout walls in parallel to fully capture contaminated groundwater, also a difficult and expensive option. Pumping wells for capturing contaminated groundwater are then installed up-gradient of the grout wall, and captured water must be treated. As both contaminated and non-contaminated groundwater may be captured, volumes for treatment could potentially be significant.

6.2.2 Mine Workings

Benga has identified the challenges associated with controlling groundwater flow conveyed in old mine workings (Riversdale 2019).

> *With regards to the complete identification and 3D modeling of the groundwater pathways, including the historical mine tunnels, attempts have been made to locate and*

> *identify the historical mines without success. In 2014, Benga conducted a drilling program to locate one of the historical mine tunnels and install a potential water supply well into the underground workings. The program consisted in the drilling and completion of one water supply well to a maximum depth of 159 meters below ground level (mbgl). The drilling program did not encounter the historical mine. Underground investigation for historical mines is difficult and uncertain despite the use of available maps. Information regarding the locations of chambers, pillars and walls are not georeferenced and therefore the locations can only be approximated by measurement from known features.*

Groundwater from "legacy underground workings is currently seeping out a mine portal at the 1,468 m elevation (Riversdale 2016a).

Based on the above, there is obviously potential for off-Site migration of impacted groundwater migrating through old unidentified mine workings. Contingencies for identifying these areas of concern, and (if necessary) sealing them, should be included in any development plan. As with intercepting groundwater in fractures, mitigating contaminated groundwater transport though mine workings can prove challenging.

6.3 Post-Closure Monitoring

The need for post-closure groundwater monitoring has been clearly identified (Riversdale 2016b).

> *At closure, the groundwater quality and quantity on the reclaimed lands is expected to be similar to the natural groundwater conditions. Groundwater monitoring will be implemented to validate these predictions and monitor change.*

However, there are limited details presented regarding how long this might have to be undertaken or the breadth of the proposed program. This could constitute a significant long-term investment to ensure that conditions in the SBZ remain stable and reducing to prevent selenium remobilization. As discussed above, if monitoring programs do not show that conditions are stable, installing complex groundwater capture and remediation systems will be required.

7. Review of Proposed Reductive Chemistry Mechanism

The proposed chemical selenium fixation mechanism involves (ideally) reducing selenate and selenite to elemental selenium as shown in the Eh/pH diagram (Figure 1; National Institute of Advanced Science and Technology 2005). For this to occur, the SBZs must be turned to, and kept at, anoxic conditions to promote a reducing environment (i.e., low or negative Eh). Methanol will be added to the system to promote reduction of the selenium species. Figure 1 shows (generally) the expected initial selenium species in Area 1 (selenate, hydrogenselenite, and selenite). Under anoxic conditions with an electron donor such as methanol, these selenium species may be reduced to elemental selenium via a microbially-mediated reaction. It is hoped that selenium will precipitate or sorb and remain in the SBZs (approximate extent of Area 2 of Figure 1). The efficiency of this reductive precipitation mechanism will depend on Eh/pH conditions, the availability of electron donors, the availability of microbes to mediate the reaction mechanism, temperature, and lack of oxygen in the SBZs. There might be other variables to consider, though these were not discussed in any reviewed documents.

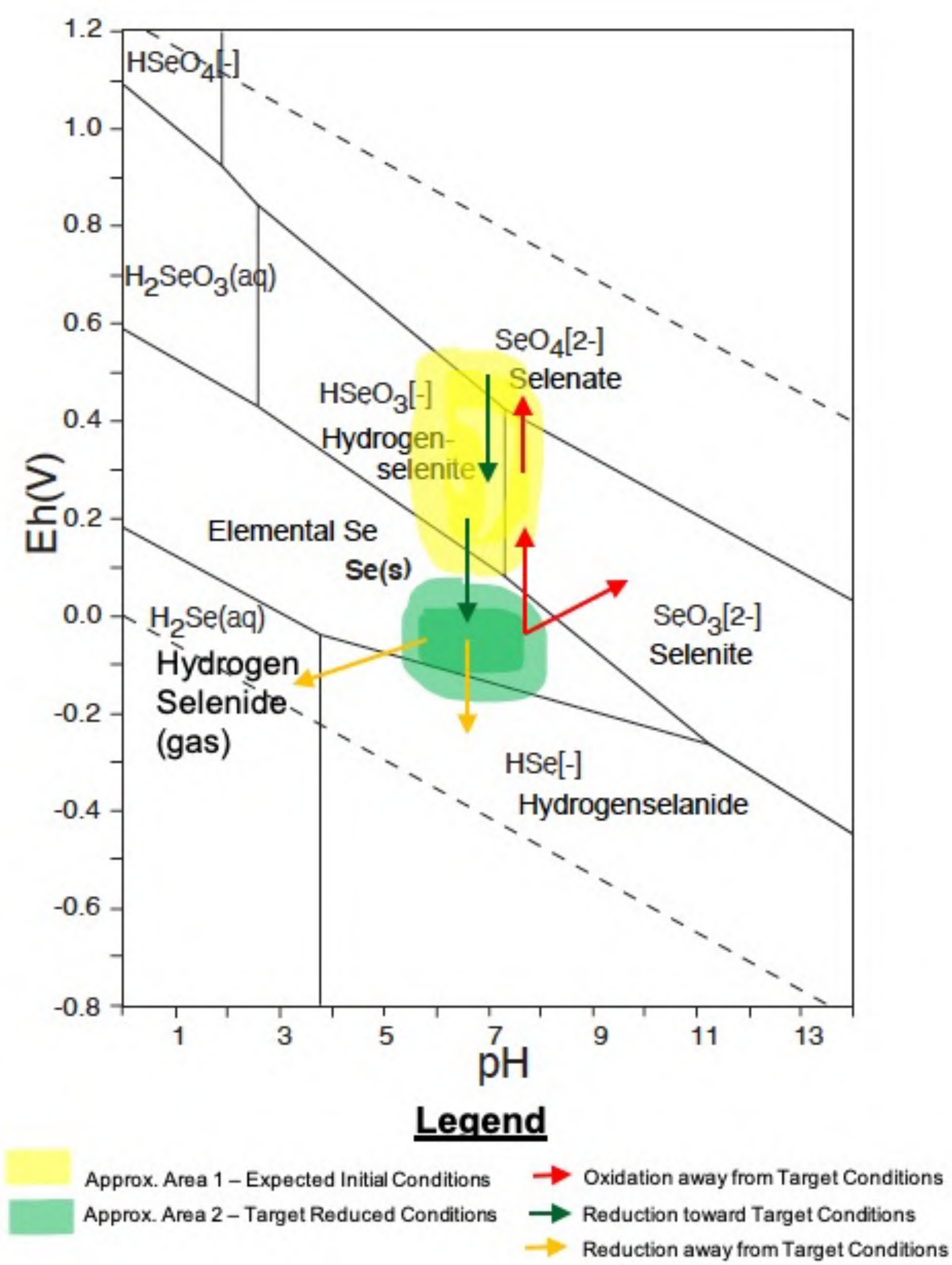

Figure 1 Eh/pH diagram of selenium species for the system Se-O-H

If conditions within the SBZ are not managed correctly (e.g., oxygen is allowed in, the temperature changes significantly or the pH/Eh shifts) different selenium species may come to dominate and selenium could be dissolved into more mobile forms.

Riversdale indicated in a response to the Joint Review Panel that Benga will consider the use of an oxygenation step during water treatment to convert any selenite that might exit the SBZs to selenate as has been done at the Line Creek Facility for Teck (Riversdale 2020). This would reduce the overall toxicity of any released selenium. However, implementation of such a remedial step would require the construction and maintenance of a long-term (and likely above-ground) treatment system that might have to be operated for an extended time in the post-closure period.

7.1 Effectiveness of Saturated Backfill Zones

A lab-scale selenium attenuation bench test was conducted using materials from the Grassy Mountain Site (Geosyntec 2020). Different scenarios were tested, including scenarios where the column was being underdosed with methanol, overdosed with methanol, and dosed with an optimal methanol volume. Concentrations of nitrate and selenium in the influent were also modified for different scenarios, and temperature was varied for different phases of the study.

The bench test showed that for optimal carbon dosing at a typical groundwater temperature and at concentrations of nitrate and selenium that are likely average for the Site, approximately 90% of selenium was removed from the influent water. When the column was underdosed with carbon, selenium was partially removed from the influent, but not with the same efficiency as the optimally dosed phases of the test. Also, when higher concentrations of nitrate were introduced, the efficiency of selenium removal was reduced.

Problems with the column arose near the end of the test during Phase 6, which might be an indication of possible faults with the system, though the cause of failure was not clear. It was hypothesized that the column selenium loading had reached maximum capacity for the microbial population, thus selenium was not being reduced at expected rates. Another hypothesis was that the microbial population had died off from a lack of volatile fatty acids (VFAs; there had been a drop in VFAs in the influent prior to poor selenium removal results). It is unclear from the Geosyntec report if the VFAs were added to the influent similarly to methanol or if the VFAs are expected to be naturally-occurring. If the VFAs are an additive similar to methanol, concentrations of VFAs will likely need to be carefully monitored to ensure enough are available for the microbial population. Both hypotheses regarding the failure of Phase 6 indicate the need for further study, which could include a Site-specific pilot test. Regardless, the variability in results suggests that chemical conditions will have to be carefully managed for the system to be effective.

SBZs are currently in use at a nearby coal mining facility (Elk Valley, which is run by Teck Resources). The SBZs have been effective for selenium removal from water at that facility thus far, which provides some case study evidence that this system will work under controlled conditions (Teck 2019a). These results are limited, since the SBZs have only been in operation since 2018 (Teck 2019b).

7.2 Long-Term Modelling Results

The EIA indicated it is assumed that 99% of selenium will be removed from water that is treated in the SBZs. Appendix 10 of the EIA includes geochemical modelling that showed different scenarios based on various parameters, including selenium attenuation factors of 90%, 99%, and 99.5% (Riversdale 2016c). Both scenarios with 99 and 99.5% removal resulted in surface water concentrations in nearby creeks that met criteria after many years (though eventually, concentrations exceed criteria). The 90% removal scenario resulted in surface water concentrations in nearby creeks that do not meet proposed criteria for surface water within 10 years of operation. The model does not evaluate the specifics of carbon dosing, but does serve as an indication that a high level of selenium removal efficiency will be required to prevent toxic concentrations of selenium from escaping the Site.

Given that the lab-scale bench test was showing an average removal at optimal conditions of 90%, modelling would indicate that it is possible that surface water concentrations might not meet criteria in a few years, depending on the concentrations of selenium entering the SBZs and how effectively the zones operate under real world (non-laboratory) heterogenic conditions. The models might not reflect reality given that some unknown variables might affect selenium removal efficiency. Also, how selenium might reach surface water bodies may affect concentrations. Modelling results might under- or over-estimate selenium concentrations down-gradient, depending on how unknown variables affect the system.

7.3 Closure Planning

The reclamation plan in the EIA does not include any discussion of the long-term reclamation plan for the SBZs (Riversdale 2016b). No reviewed literature contained any discussion of controlling redox conditions in the long-term in zones with elemental selenium. The reclamation plan does have some discussion around selenium management for the surge ponds and above-ground infrastructure, but no discussion of the SBZs.

It is possible that elemental selenium might get oxidized back to selenite and/or selenate over time if redox conditions in the SBZs are not controlled, though it is not known how quickly this might occur or if it might result in toxic concentrations of selenium in nearby surface water bodies.

8. Conclusions

Give the above discussion, answers to the two questions posed are present below.

8.1 What is the likely effectiveness of the Saturated Backfill Zones Benga proposes to build for selenium attenuation?

The proposed attenuation mechanism could prove effective in mitigating off-Site selenium releases. However, the reasons why some laboratory trials failed are not fully understood; such failures in the field might result in selenium releases should the reductive mechanism efficiency drop. It is therefore possible that surface water in nearby creeks might receive enough selenium over time to exceed criteria based on modelling completed for the EIA, depending on the actual efficiency of the SBZs and on how well the modeled selenium removal reflects reality in the SBZs. A Site-specific pilot test would provide better information concerning the risk of failure with respect to selenium removal efficiency.

No provision for post-closure management of the SBZs appears to have been presented. With no engineered controls (e.g. engineered caps, etc.), oxygenated atmospheric water may percolate downwards into the SBZs, potentially reversing the reductive precipitation mechanism and liberating selenium. It is also possible that while conditions are initially being manipulated in the SBZ to achieve the desired reducing environment, selenium could escape the system. Finally, there are no long-term studies of the proposed methodology that can provide confidence in it as a stable and enduring post-closure solution.

8.2 What is the risk of malfunction related to the proposed Saturated Backfill Zone, and what would be the likely consequences of such a malfunction?

Given the scope of the current engagement, it is not possible to calculate a failure risk. However, based on the above discussion there are several factors and conditions that could cause a failure including:

- the presence of potential preferential migration pathways (e.g., fracture zones and old mine workings) and short-circuiting of treatment zones resulting from biofouling;
- the overall efficiency of selenium removal might not be high enough to prevent increasing selenium concentrations in nearby surface water bodies;
- if preferential pathways are not detected, or conditions are not maintained at optimal, this could result in the off-Site release of selenium or other potential contaminants of concern, with resulting impacts to the local watershed; and
- should the maximum reduction capacity of the microbial population be reached, the efficiency of selenium removal might decline.

9. Closure

We trust this letter provides you with the information you require. Please do no hesitate to contact the undersigned should you have any questions.

Respectfully,

<Original signed by>

Sep. 15, 2020

Marc W. Bowles, M.Sc.[2], P.Geol.
Hydrogeologist

ASSOCIATION OF THE CHEMICAL PROFESSION OF ALBERTA
M0790
<Original signed by>
Sarah Dougherty
Professional Chemist

Sarah Dougherty, M.A.Sc., P.Chem.
Environmental Chemist

PERMIT TO PRACTICE
WYNDHAM ENVIRONMENTAL LTD.
<Signature removed>
RM SIGNATURE:
RM APEGA ID #: M48931
DATE: Sep. 15, 2020
PERMIT NUMBER: P011359
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Attachments

Exhibit A	Retainer Letter
Exhibit B	Résumés

10. References

Geosyntec (Geosyntec Consultants) 2020. Laboratory Study Report, Column Study to Evaluate Treatment of Nitrate and Selenium in Mine Water Using Gravel Bed Reactor, Grassy Mountain Project, Alberta. Report prepared for Benga Mining Ltd. May 2020.

National Institute of Advanced Industrial Science and Technology 2005. Atlas of Eh-pH diagrams: Intercomparison of thermodynamic databases. Geological Survey of Japan Open File Report No. 419. Research Center for Deep Geological Environments Naoto TAKENO. May 2005. Page 231.

Norris, D.K. 1993. Geology and Structure cross-sections. Blairmore (West Half), Alberta Geological Survey of Canada Map 1829A, scale 1:50,000.

Riversdale (Riversdale Resources) 2016a. Updated Environmental Impact Assessment, Benga Mining Ltd., Grassy Mountain Coal Project, Section C: Project Description. August 2016.

Riversdale (Riversdale Resources) 2016b. Updated Environmental Impact Assessment, Benga Mining Ltd., Grassy Mountain Coal Project, Section F: Conservation and Reclamation Plan. June 2016.

Riversdale (Riversdale Resources) 2016c. Updated Environmental Impact Assessment, Benga Mining Ltd., Grassy Mountain Coal Project, Appendix 10: Geochemistry Reports. August 2016.

Riversdale (Riversdale Resources) 2019. Joint Review Panel Request for Additional Information Response Package Addendum 10. Package 5: Surface Water Quality, Hydrology, Hydrogeology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology. Benga Mining Limited, Grassy Mountain Coal Project. August 2019.

Riversdale (Riversdale Resources) 2020. Coal Conservation Act Application Nos. 1844520, 1902073, Environmental Protection and Enhancement Act Application No. 001-00403427, and Water Act Application Nos. 001-00403428, 001-00403429, 001-00403430, 001-00403431, Public Lands Act Application Nos. MSL160757, MSL160758, LOC160841, LOC160842 and LOC970943. Joint Review Panel Impact Assessment Agency of Canada Reference No. 80101, Hearing Submission. Benga Mining Limited, Grassy Mountain Coal Project. August 2020.

Teck (Teck Resources) 2019a. Permit 107517 Environmental Monitoring Committee 2019 Public Report. How Teck Manages Water Quality in the Elk Valley.

Teck (Teck Resources) 2019b. Elk Valley Water Quality Plan – Five Year Update. September 2019.

11. Limitations

This report has been prepared for the exclusive use of the Canadian Parks and Wilderness Society Southern Alberta Chapter with the understanding it may be submitted to the Grassy Mountain Joint Review Panel.

The information, interpretations, comments, and recommendations contained herein are specific to the property described in this report and do not apply to any other project or site. This report should be read in its entirety.

Unless otherwise specified, the interpretations, comments, and recommendations presented in this report have been formulated following an assessment of site conditions, as per the scope of work and the general limitations described below and in light of current site knowledge and/or planned use of the site, the applicable regulations, orders, standards, and criteria.

The content of this report is based on information reviewed, our present understanding of the site conditions, information provided by third parties, and our professional judgment in light of such information at the time of this report. This report provides a professional opinion and no warranty is expressed, implied, or made as to the conclusions, advice, and recommendations offered in this report. This report does not provide a legal opinion regarding compliance with applicable laws. With respect to regulatory compliance issues, it should be noted that regulatory statutes and the interpretation of regulatory statutes are subject to change.

The services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the science professions currently practicing under similar conditions, subject to the time limits and financial constraints applicable to the services.

Any use which a third party makes of this report, or any reliance on, or decisions made based on it, are the responsibilities of such third parties. Wyndham Environmental Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. The findings and conclusions of this report are valid only as of the date of this report.

https://hydrogeo-my.sharepoint.com/marc_hydrogeo_pro/documents/wel/cpaws/report/wel_cpaws_se_review_sep_15_2020.docx

Exhibit A

Retainer Letter

PUBLIC INTEREST LAW CLINIC
FACULTY OF LAW

MURRAY FRASER HALL
2500 University Drive NW
Calgary, AB, Canada T2N 1N4

September 8, 2020

Marc Bowles and Sarah Dougherty,

Re: Expert Retainer
Grassy Mountain Coal Project
IAA Reference No. 80101

Dear Marc Bowles and Sarah Dougherty,

We are counsel to the Canadian Parks and Wilderness Society Southern Alberta Chapter (CPAWS) in the above referenced hearing for the Grassy Mountain Coal project before the Joint Review Panel for the Grassy Mountain Coal Project.

We confirm that you have agreed to provide an affidavit containing your expert opinion for this proceeding. We are writing to set out the questions that we would like you to address in your affidavit.

Material Facts

1. Benga Mining Limited ("Benga") has applied for licenses to construct and operate the Grassy Mountain Coal Project ("The Project"), an open-pit metallurgical coal mine near the Crowsnest Pass. The Project is located near the Crowsnest Pass, approximately seven kilometres north of the community of Blairmore, in southwest Alberta.

2. The Joint Review Panel under the *Responsible Energy Development Act*, *CEAA 2012*, and the *Impact Assessment Act*, is the responsible authority in regards to the approval of the Project.

Relevant Documents

1. Updated Environmental Impact Assessment, Part C – Project Description,

2. Updated Environmental Impact Assessment, Eighth Addendum, Responses to questions on Hydrology.

3. Updated Environmental Impact Assessment, Tenth Addendum, Package 5: "Surface Water Quality, Hydrology, Hydrogeology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology".

4. Updated Environmental Impact Assessment, Eleventh Addendum, Information Requests 6.16-6.22.

5. Updated Environmental Impact Assessment, Twelfth Addendum, Response to Information Request 7.1

6. Updated Environmental Impact Assessment, Twelfth Addendum: the material relating to Selenium listed in Tables 1-5, 1-6, and 1-9 of the reference lists for valued components

7. The Column Study to Evaluate Treatment of Nitrate and Selenium in Mine Water Using Gravel Bed Reactor.

8. Such other parts of the Updated Environmental Impact Assessment and Addenda for the project as you may identify as important.

Questions

Based on the facts set out above, your own research, your review of the Relevant Documents described above, your review of any other relevant material on the Project on the *CEAA* public registry, and any other materials you deem relevant, please provide your professional opinion on the following:

1. What is the likely effectiveness of the Saturated Backfill Zones Benga proposes to build for selenium attenuation?

2. What is the risk of malfunction related to the proposed Saturated Backfill Zone, and what would be the likely consequences of such an malfunction?

In preparing your expert opinion, you should rely on any source that you consider reliable in support of your opinion and on your own knowledge and experience. Please feel free to offer any additional expert opinion beyond answers to the above questions that you believe is necessary to provide a full and comprehensive expert opinion.

Form of Affidavit

In your affidavit, please:

1. State your full names and addresses;
2. Describe your areas of expertise and qualifications in relation to the issues addressed in your affidavit;
3. State the facts and assumptions on which your opinions are based;
4. Provide your answers and opinions to the questions set out above, and your reasons for those answers and opinions;
5. List any literature or other materials specifically relied on in support of your answers and opinions;
6. If applicable, describe the methodology that you used in providing your answers and opinions, including any research, tests, or other investigations on which you have relied, including (if applicable) details of the qualifications of the person who carried them out, and whether a representative of any other party was present;
7. State any caveats or qualifications necessary to render your expert opinions complete and accurate, including those relating to any insufficiency of data or research and an indication of any matters that fall outside your field of expertise;
8. State, if applicable, the particulars of any aspect of your relationship with a party to the proceeding or the subject matter of your proposed evidence that might affect your duty to the Joint Review Panel;
9. Attach, as Exhibit A to your affidavit, this retainer letter;
10. Attach, as Exhibit B to your report, your most up-to-date *curriculum vitae*; and,
11. Attach, in successive Exhibits to your affidavit as needed, any other material you deem relevant or necessary to render your expert opinion complete and accurate.

Timeline

You must complete your report by September 16, 2020.

Privilege and Confidentiality

Please be advised that all communications between us, including this letter, are confidential and privileged. However, if we introduce into evidence any report that you prepare, that privilege is waived. At that time, all correspondence between us, and any drafts of reports and related notes may become available to other parties in the proceedings.

You understand that your work product may, at our discretion on the instructions of our client, be shared with common interest parties, any other intervenors, and their legal representatives who may ultimately be granted standing to join in these proceedings.

Sincerely,

<Original signed by>

Drew Yewchuk
Staff Lawyer
Public Interest Law Clinic
3310, 2500 University Drive NW
Calgary, Alberta, T2N 1N4
<contact information removed>

Exhibit B

Résumés

Résumé	Marc Bowles, M.Sc.², P.Geol.

Education

M.Sc. Hydrogeology, University of Calgary, Calgary, Alberta, 1998

Applied Environmental Management Certificate, Southern Alberta Institute of Technology (SAIT), Calgary, Alberta, 1992

M.Sc. Applied Mineral Exploration MINEX, McGill University, Montreal, Quebec, 1988

Diploma Geology, McGill University, Montreal, Quebec, 1987

B.Sc. Geology, University of Western Ontario, London, Ontario, 1982

Bilingual Program Certificate, Government of Québec, 1977

Technical Director and Hydrogeologist

Mr. Bowles has worked as an environmental consultant since 1992. He holds a Bachelor's degree in Geology and Master of Science degrees in Applied Mineral Exploration and Hydrogeology. He is a professional geologist registered in Alberta. He was also formerly a rostered Contaminated Sites Approved Professional and professional geoscientist registered in British Columbia. His technical experience spans site characterization, contaminant hydrogeology, liability assessment, and remediation. Marc is also the inventor of the Trench and Gate Remediation system, a proven methodology for in-situ treatment of groundwater contaminant plumes hosted in low permeability sediments. Prior to becoming an environmental consultant, Marc spent 14 years in the mining industry supervising exploration, claim staking, delineation drilling, and geophysical programs. Marc also has significant strategic planning and business management experience from his time spent working in management roles.

Marc's special fields of competence include:

► Project management and logistics.
► Design and supervision of contaminated site assessments, environmental monitoring programs, hydrogeological characterization and remediation projects.
► Liability assessment and environmental insurance claim review.
► Specialized QA/QC program design and chemical data interpretation.
► Design of remediation systems for capturing and treating contaminated groundwater.
► Coordinating and managing multi-discipline teams for large and comprehensive environmental investigation and remediation projects.
► Design, supervision and interpretation of electromagnetic, magnetic, induced polarization, and scintillometer geophysical surveys used to define geological structure and delineate contamination or mineralization.
► Management and minimization of environmental liabilities.
► Litigation support for high liability and high profile contamination cases.
► Mineral exploration and mine remediation.

Employment History

Wyndham Environmental Ltd. – Calgary, Alberta

Senior Hydrogeologist (2011 to Present)

Responsible for providing senior technical review and program design/ implementation advice for clients as well as advising and mentoring on professional development to client staff.

Golder Associates Ltd. – Calgary, Alberta

Senior Hydrogeologist (2008 to 2011)

Responsible for senior technical review of Phase II/III delineation programs, remediation programs, project management, and mentoring of junior and intermediate staff. Developed courses and provided staff training for: site investigation protocols; selection of appropriate drilling technologies; optimizing monitoring well installation; auditing of upstream oil and gas facilities; groundwater trench interception technologies; and application of Alberta Environment Tier 1 and 2 criteria.

WorleyParsons Komex – Calgary, Alberta

Technical Director; Principal Hydrogeologist (2007 to 2008)

Responsible for providing technical oversight and training to contaminated sites personnel including, soils scientists, engineers and hdyrogeologists with respect to site investigations protocols. Oversaw the compilation of preferred operating procedures. Developed and delivered courses for annual employee training seminars. Aided project managers with client relationships and provided strategic planning for managing client liabilities. Provided senior review for Alberta Directive 001 Site-specific Liability Assessments. Managed contaminated sites portfolios and prioritized spending for key clients including approximately 50 sites for BP Canada.

WorleyParsons Komex (Komex International Ltd.) – Calgary, Alberta

Vice President, Hydrogeology; Group Manager, Contaminated Sites (2004 to 2007)

Responsible for directing contaminated sites investigation programs, determining remedial options, and overseeing remediation programs for numerous upstream oil and gas clients. Determined and implemented strategic initiatives for the hydrogeology division of the company. Managed a mixed group of engineers and environmental scientists.

Komex International Ltd. – Calgary, Alberta

President, Canadian Operations (1999 to 2004)

As President, Marc was responsible for company profitability, strategic planning, human resources, health and safety, manpower management, policy design and implementation. He led the management team through a period of refocusing on core principles followed by five successive years of growth, averaging greater than 10% increases in both earnings and staff annually. Marc was also extensively involved in creating an employee share ownership program. During each of his five years at the helm, Komex was named one of Canada's 50 Best Managed Companies.

Komex International Ltd. – Calgary, Alberta

Vice President Operations (1998 to 1999)

As Vice President, Marc was responsible for ensuring a consistent management approach was applied within Canadian operations. Responsibilities included making a reality the plans of the Canadian Management Team as well as reporting to the President and Board of Directors. Changes initiated during this period included the implementation of a formalized mentoring program and hiring controls. He was one of a small group of people elected by senior co-workers and shareholders to the then newly formed Canadian Management Team which was put in place to ensure successful succession planning.

Komex International Ltd. – Calgary, Alberta

Senior Geologist/Hydrogeologist (1992 to 1998)

Responsible for planning, coordinating and conducting hydrogeological exploration and contaminated site characterization programs. Responsibilities included budgeting, contractor supervision, well installation, sampling, developing analytical schedules, QA/QC, client liaison, and logistical planning.

PROJECT EXPERIENCE – LIABILITY EVALUATION / LITIGATION SUPPORT

Various Confidential Clients
Calgary, Alberta

Marc has supervised the completion of several large liability assessments completed in contemplation of asset purchases or as part of Energy Resources Conservation Board Directive 001 Site-specific Liability Assessments. He has evaluated assets with retirement obligations totalling billions of dollars and advised companies with respect to significant liabilities they might be taking on as a result of contemplated purchases. He has provided oversight to multi-disciplinary teams undertaking historical site reviews. Marc has also been responsible for providing, and validating, input variables used for Monte Carlo simulations to estimate total liability ranges. Clients have included intermediate Alberta-based oil companies as well as large international companies. As well, he has acquired the ability to effectively communicate team findings to professionals lacking applicable environmental training.

Marc has served as an expert witness for the Court of Queen's Bench of Alberta and has provided litigation support as an expert witness for a variety of environmental cases to multiple law firms.

PROJECT EXPERIENCE – CONTAMINATED SITES REMEDIATION

BP Canada Energy Company Ltd.
Canada

Managed a dedicated team of hydrogeologists, engineers and safety professionals overseeing the remediation, routine monitoring and regulatory reporting for more than 50 BP Canada sites located in Alberta, British Columbia, the Northwest Territories, and Saskatchewan. Under his direction, the BP team supervised the remediation and decommissioning of three large gas plants. As lead contact for BP project work in Western Canada from 1994 to 2008, Marc supervised projects related to, risk assessment; liability evaluations; regulatory compliance guidance; best practices compilation; Environmental Impact Assessments; remediation of soils and groundwater; independent incident investigations; site characterization; water supply evaluation; and, litigation. Special projects undertaken on behalf of BP included designing and supervising the construction of specialized monitoring and drinking water wells completed in potable aquifers underlying contaminated sites. These wells included a nested casing and displacement grouting design to ensure isolation of the contaminated zone and to prevent annular cross-contamination. Conceptualized and installed the Trench and Gate in-situ groundwater remediation system at the East Garrington Gas Plant, Alberta. Principal researcher responsible for the development of the Trench and Gate system, a modification of the Funnel and Gate concept redesigned to treat hydrocarbon contaminated groundwater hosted by fine grained, low hydraulic conductivity sediments such as glacial tills. Designed a chloride/sulfolane contaminated groundwater plume capture and downhole injection system installed at the Bigstone Sour Gas Plant.

TAQA North (formerly PrimeWest Energy Inc.)
Calgary, Alberta, Canada

Principal manager for PrimeWest projects related to site characterization, remediation planning and liability assessment for two large gas plants located in Southern Alberta as well as supervising routine work at a number of smaller facilities. Responsibilities included client liaison, technical education, stakeholder communication as well as regulatory negotiation and reporting. Designed and supervised the installation of a large-scale groundwater capture and treatment system which included a 350 m long interception trench installed using specialized one-pass trenching equipment within an active process area of a sour gas plant.

City of Calgary
Calgary, Alberta, Canada

Managed a comprehensive program of Phase II site investigations for the East Village Area of Calgary undertaken to determine remedial options and estimate costs associated with redeveloping the area. The program included several components and challenges including: choosing an optimal investigation methodology; working with other consultants to standardize procedures and reporting; interpretation of groundwater hydrochemical results influenced by leaking water mains; providing regulatory guidance; and, managing a unique and challenging health, safety and security program.

Oversight of multiple multi-media landfill monitoring programs and annual regulatory reporting. Managed landfill decommissioning programs and oversaw preparation of a remediation certificate submission for closure of an urban landfill. Provided hydrogeological planning and supervision for landfill leachate removal and dewatering programs.

Various Companies
Calgary, Alberta, Canada

As a hydrogeologist and geologist Marc has been responsible for all facets of contaminated sites management from proposal and budgeting through to remediation and site closure. Particular responsibilities have included: installation of groundwater monitoring networks; piezometer development; hydraulic conductivity testing at facilities to establish local groundwater quality and flow regimes; geological borehole logging; supervising drilling operations; collection of groundwater/soil samples; quality assurance/quality control program design and implementation; measuring field hydrochemical parameters; interpretation of soil and groundwater chemistry to determine the presence and extent of contamination; developing remediation approaches; advising on liability minimization and detailed report preparation. Projects undertaken in England and Canada include: evaluating liability for property transactions; preparation of annual environmental monitoring reports and license renewal applications for Alberta Environment and Parks; design of specialized analytical schedules and QA/QC programs for non-routine environmental groundwater investigation programs targeting low level contaminants; completion of annual reports summarizing the use of groundwater and surface water for waterflood projects; interpretation of historical monitoring well data to determine local effects of groundwater withdrawal; and, preparing license applications for water wells and groundwater diversion projects.

Mr. Bowles advises companies regarding whether they have undertaken appropriate due diligence, as well as whether the remediation methods chosen for their sites are appropriate, efficient, effective, in accordance with regulations and meet accepted standards of professional practice.

PROJECT EXPERIENCE – MINING

Newmont Mining Corporation
Cajamarca, Peru

Headed up a multi-discipline team comprising engineers, industrial hygienists, hydrologists, hydrogeologists, and social impact specialists who undertook a World Bank audit and review of the environmental and social impact management systems for the Yanacocha heap leach gold mine in Peru.

Confidential Client
Calgary, Alberta, Canada

Supervised a team of engineers, environmental/remediation professionals and liability assessment specialists who completed a methodology and costing evaluation for long-term remediation and reclamation of numerous base/precious metals, underground and open pit mines in Canada and the United States.

Multiple Clients
Canada & Austria

Mr. Bowles was active in the mineral exploration industry as a prospector, geological assistant, geologist, project geologist, or independent geological consultant. He conducted targeted exploration programs for gold, uranium, base metals, and oil sands. Marc supervised all facets of the exploration programs from grass roots prospecting up through delineation diamond drilling. Programs were undertaken in Austria and across Canada for several employers and clients.

TEACHING EXPERIENCE

University of Calgary
Calgary, Alberta, Canada

Guest lecturer for environmental courses at the University of Calgary.

Komex International
Calgary, Alberta, Canada

Former in-house instructor for Transportation of Dangerous Goods and Workplace Hazardous Materials Information System (TDG and WHMIS Accreditation from SAIT, Calgary, Alberta, 1992).

PROFESSIONAL AFFILIATIONS

Association of Professional Engineers and Geoscientists of Alberta (APEGA), Professional Geologist

Former Contaminated Sites Approved Professional (Roster of Approved Professionals, British Columbia until 2010)

Former Professional Geoscientist registered with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC)

Former Fellow of the Geological Association of Canada

CEO Advisory Council to Premier Ralph Klein (2003-2004)

PUBLICATIONS AND PRESENTATIONS

Bentley, L.R. and M.W. Bowles. 1995. Estimating Bulk Hydraulic Conductivity Using a Trench Pumping Test. In Proceedings of Scientific Meeting of the Canadian Geophysical Union, May, Banff, Alberta.

Bentley, L.R., J. Barker, M.W. Bowles and J. Rathgeber. 1995. In-Situ Remediation of Hydrocarbon Contaminated Groundwater In Low Hydraulic Conductivity Media Using Trench and Gate Technology. In Proceedings of the 5th Symposium on Groundwater and Soil Remediation, GASRep Conference, October, Toronto, Ontario.

Bentley, L.R. and M.W. Bowles. 1996. A Prototype Trench and Gate Groundwater Mitigation System. In Proceedings of the Canadian Society of Petroleum Geologists Conference, June, Calgary, Alberta.

Barker, J., L.R. Bentley, M.W. Bowles, D. Granger, B. Hoyne, H. Jacobs, S. Rimbey and D. Thomas. 1997. The East Garrington Trench and Gate System: It Works. In Proceedings of the 6th Symposium on Groundwater and Soil Remediation, GASReP Conference, Montreal, Quebec.

Bentley, L.R., M.W. Bowles, B. Hoyne, and D.A. Thomas. 2000. In Situ Ground Water Remediation Using the Trench and Gate System. Ground Water, Vol. 38, No. 2, March-April.

Sarah Dougherty, M.A.Sc., P.Chem.
<contact information removed>

Overview

I am a professional chemist currently working as an intermediate environmental scientist for Advisian in Calgary, Alberta.

My current role involves organizing and executing groundwater, surface water, soil, and soil vapour monitoring programs for regulatory approvals of midstream gas facilities, well sites, and municipal landfills; supporting remediation activities involving *in situ* chemical oxidation; providing support for data quality assurance programs; auditing and liaising with analytical laboratories; helping clients use conceptual site modelling and statistics to target remediation programs; applying Alberta Tier 1 and Tier 2 guidelines to groundwater and soils data; managing Alberta and CCME guidelines in a database for use by my group; and assisting in risk assessments for contaminated sites in Alberta.

Work Experience

Environmental Scientist with Advisian, a Worley Group (Jul 2012 to present):

- Leading soil vapour, groundwater, surface water, waste, leachate, and soil sample collection programs on operating and inactive sites for regulatory approvals or remediation activities, including Phase 2 site assessments.
- Analyzing site data to assist in risk assessments and conceptual site modelling for contaminated sites.
- Assisting in developing a methodology for *in situ* chemical oxidation of hydrocarbons for a contaminated site.
- Managing regulatory and non-regulatory groundwater monitoring programs in Alberta and Saskatchewan, including staffing field projects, and ensuring reports are complete on budget and on schedule, and managing client relations.
- Applying risk-based regulatory guidelines for Alberta (provincial jurisdiction) and for Canada (federal jurisdiction, including Health Canada Guidelines and Canadian Council for Ministers of the Environment Guidelines).
- Developing tools to facilitate verification of data quality for laboratory analytical reports and training staff to use these tools.
- Liaising with laboratories to ensure good data quality is achieved.
- Auditing analytical laboratories to ensure compliance with accrediting entities and contracts.
- Meeting with clients to discuss issues identified through monitoring programs and solutions to those issues.
- Updating and generation standard operating procedures for sample collection and interpretation.
- Developing and implementing health and safety plans for field work and participating in health and safety audits.

Consulting Scientist for Wyndham Environmental (2020)

- Reviewing technical information to assist in various contaminated sites assessments to provide chemistry expertise.

Student Intern and Consultant with Health Canada Air Health Exposure Assessment Group (May to Dec 2008; May to Aug 2009; May to Jul 2010; and Jan to Feb 2012):

- Compiled air pollutant, daily report, and daily food intake data for multiple epidemiological air quality studies.
- Designed data entry databases and data dictionaries for air quality studies.

Professional Memberships

- Association of the Chemical Profession of Alberta (Professional Chemist)—2016 to present.
- Canadian Society for Chemistry—2012 to present.

Education

- **University of Sydney—**Master of Applied Science (Environmental Science) 2011.
- **Queen's University—**Bachelor of Science Honours (Subject of Specialization, Environmental Chemistry) 2010.
- **Woodroffe High School—**Ontario Secondary School Diploma with French Immersion, 2005.

Certifications

- Standard First Aid – C Certificate—completed September 2017.
- Prime Contractor Training—completed May 2016.
- Ground Disturbance Level II—completed February 2018.
- H_2S Alive—completed February 2018.
- Transportation of Dangerous Goods—completed in July 2018.
- UTV Training—completed June 2019.

Academic Projects

- Research project under the supervision of Dr. J. Webster studying sediment dynamics of One Tree Reef on the Great Barrier Reef in Queensland.
- Honours project in Sustainability under Dr. G. Whitelaw and Dr. R. Danby compiling a state of the environment report for the Frontenac Arch Biosphere Reserve in Ontario.
- Honours project in Organic Chemistry under Dr. E. Buncel studying hydrolysis of organophosphate pesticides.

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EXPERT REPORTS OF CPAWS

EXPERT REPORT COAL QUALITY AND VALUE ASSESSMENT

GRASSY MOUNTAIN PROJECT

September 16, 2020

Prepared for:
The Canadian Park and Wilderness Society Southern Alberta Chapter (CPAWS)

Prepared by:
C. J. Kolijn, Mining Engineer, MSc.

INTRODUCTION AND EXECTIVE SUMMARY

Introduction

Benga Mining Limited, a wholly owned subsidiary of Riversdale Resources Limited, is proposing to construct and operate an open-pit metallurgical coal mine near the Crowsnest Pass, approximately seven kilometres north of the community of Blairmore, in southwest Alberta. As proposed, the production capacity of the project would be a maximum of 4.5 million tonnes of clean coal per year, over a mine-life of about 25 years.

The Canadian Parks and Wilderness Society Southern Alberta Chapter (CPAWS), through their counsel, requested this Expert Report for presentation before the Joint Review Panel for the Grassy Mountain Project. This report is based on public information, made public by Benga/Riversdale and the Government of Canada on their respective websites, utilizing my extensive experience as a Mining Engineer in the international Mining and Integrated Coke and Ironmaking industry, over a 37-year period, after completing my Masters' of Science degree at the University of Technology in Delft, The Netherlands in 1983. Starting in Mine Production and quality planning in Australia, my career progressed to the Integrated Steel Industry, Process Engineering and Coking Coal Blend Design to optimize Coke Quality and applied R&D for Coke and Ironmaking, including international consulting. In 2001 I joined Fording Coal, now Teck Coal, for Business Development, and as Manager Technical Services responsible for Coking Coal Product Development and applied R&D, working with the mines, the marketing department and the international customers. I retired end of March 2019, registering as a consultant, CJK MetCoal Consulting. At present, I consult for Hatch Ltd in the capacity of Senior Consultant – Cokemaking, assigned to Metals, Pyrometallurgy Sector Practice.

This Expert Report entails the following topics:

- A Review of Metallurgical Coal Markets and Value;
- Blast Furnace Ironmaking, Cokemaking and Metallurgical Coal Value in Use Concepts;
- Metallurgical Coal Quality Attributes and Coke Quality Overview;
- Metallurgical Coal Specifications and Benchmarking and International Coal Indexing;
- Mine Project Reserve Quality and Project Viability – Also Applicable to Producing Mining Operations;
- The Grassy Mountain Mining Project – Resource and Product Quality and Value Assessment;
- Grassy Mountain's Clean Coal Product Market Value.

Grassy Mountain's coal product is compared to the International Benchmarks and competition in Canada's Elk Valley and Australia, plus the proposed ELAN project in Alberta.

Executive Summary

Riversdale / Benga's documentation focusses on production of a single Hard Coking Coal Product to achieve a Coke Strength after Reaction of 65. This product's quality and value is below the Prime Hard Coking Coal products of The Elk Valley and Queensland's Bowen Basin, Australia. Analysis of the information made available by Riversdale reveals a number of inconsistencies and conflicting quality information. Furthermore, the composition of the Measured Reserves, based on material differences in the three seams' quality attributes and variability within the seams make it unlikely a single product will be produced, given normal mine planning, operational and marketing challenges over the course of the mine's productive life, when the optimal blend of all three seams will not be available to consistently hit the product's quality and market value target.

This is all the more critical, given the fact that only 16% of the Measured Resources can be considered of high quality Hard Coking Coal. In industry it is very common for mines to produce their "flagship" product plus a lower quality, less costly product, adding product diversity for marketing purposes. This will safeguard consistent "flagship" product quality and value when the production timing of the mine's differing seam qualities is not optimal. The results of a study to optimize market value when producing two products versus production cost was not located. Advanced customers, such as Japan, S-Korea, Taiwan, Europe and increasingly China and India expect consistent product quality to drive their advanced and optimized coke, iron and steelmaking processes. It is common practice to send potential customers representative samples to research for their assessment and feedback.

The Seaborn Coking Coal Market is driven by the world's economy and related Iron Production via the Blast Furnace route in particular. Historically, the Supply/Demand balance can shift rapidly for Metallurgical Coal and Iron Ore. The consequences are highly volatile Metallurgical Coal and Iron Ore pricing, creating highly competitive commodity markets.

Throughout the Grassy Mines' productive life, adequate cashflow needs to be generated to cover capital and operational cost, plus the cost of ongoing environmental mitigation and reclamation, including restoration at the end of the mine's life. This could be potentially challenging in practice, given the market's high price volatility and uncertainties pertaining to the Grassy Mine project with regard to its product quality, more precisely the split between Hard Coking Coal and lower value product Tonnage's revenues.

C. J. Kolijn, Mining Engineer, MSc. September 16, 2020

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Attachment ER2: IHS Markit Coking Coal marker price Methodology and Specifications, effective December 2019

Attachment ER3: S&P Global Platts, Global Metallurgical Coal, Specifications Guide of June 2020

Attachment ER4: Riversdale Resources, Grassy Mountain Coal Project – Updated Environmental Impact Assessment, Section B Geology and Geotechnical, Seam Wash Quality Maps August 2016

Attachment ER5: Clean Coal Product Seam Blends During Mine Life (CJK August 19, 2020)

Attachment ER6: Grassy Mountain Seam and Product Quality Calculation Sheet (CJK August 6, 2020)

REFERENCE LISTING

1. The Changing Global Market for Australian Coal Bulletin September 2019 Reserve Bank of Australia.

2. Australian Economy and Financial Markets Chart Pack May 2020, Reserve Bank of Australia.

3. Metal Bulletin Fastmarkets Coking Coal Daily.

4. Australian Coking Coal (Platts) Low Vol Futures.

5. Development of a BF Model with Thermodynamic Process Depiction by Means of the Rist Operating Diagram. A. Spanlang.

6. S&P Global Platts, Code List – Coal Trader International July 2019

7. S&P Global Platts June 2020 Specifications Guide Global Metallurgical Coal.

8. IHS Markit Coking Coal Methodology and Specifications December 2019.

9. Riversdale Resources, Grassy Mountain Coal Project - Updated Environmental Impact Assessment, Project Description Section C, Page C-22, dated August 2016.

10. Riversdale Resources, Grassy Mountain Coal Project - Updated Environmental Impact Assessment, Project Description Section C, Page C-22, dated August 2016.

11. Kick off Meeting Benga Mining Ltd (Riversdale Resources) – Grassy Mountain Coal Project, 2-3 December 2015. Grassy Mountain Coal Project Technical Overview, Section 2 Geology of December 2nd, 2015.

12. RPM's Grassy Mountain Technical Report page 16 of March 26, 2019 and Grant Thornton's Independent Expert's.

13. Report and Financial Services Guide of 26 March 2019, both under Riversdale's Target's Statement of 29th March 2019.

14. Atrum Coal, Elan Scoping Study, Investor Presentation, slide 27, dated April 2020.

1. A REVIEW OF METALLURGICAL COAL MARKETS AND VALUE

1a The main customer for Metallurgical Coal is the integrated steel industry:

- Metallurgical coking coal is used to make coke in coke ovens at approx. 1100°C, where the coal releases volatile matter (gas, light oils & tar) and solidifies into coke in the absence of oxygen. Coke supplies the reducing agent (Carbon) and energy to “drive” the Blast Furnace process; low Ash and high Carbon Content are desirable.

  Coke is used in the Blast Furnace process to reduce iron ore (mostly pelletized and sintered, some lump ore) to produce liquid iron (Hot Metal), which is refined to remove impurities such as Sulphur, Phosphor and Silicium in the Basic Oxygen Furnace (BOF) to produce steel to meet the mill’s product requirements.

  Sulphur and Phosphor are contained in both coal and Iron Ore; lower Sulphur and Phos adds to their value, since higher Sulphur and Phos content adds to the cost of their removal from the liquid Hot Metal in the BOF (Part of the Sulphur is removed with the Blast Furnace Slag at a cost). Coal Ash is contained in the Coke; low levels are desirable, since ash adds to the Blast Furnace’s energy (Coke) requirement and is tapped from the bottom of the Blast Furnace as liquid slag.

- Metallurgical coal with inadequate coking properties, but desirable purity (Low Ash, low S & P and high Carbon), can be injected directly into the Blast Furnace. This coal is referred to as PCI (Pulverized Coal Injection) coal.

- Metallurgical Coal pricing on the International Market is determined by coal quality and the supply/demand balance. The Steel Industry is very sensitive to swings in the world’s economy. Swings in the demand for steel, iron ore and Met-Coal are a result, triggering sharp pricing responses.

1b The main markets for Canadian Metallurgical Coal will be:

- Asia: The main seaborne competition is from Australia. China also produces its own Metallurgical Coal. China also imports Coking Coal from Russia and Mongolia, although most modern coastal steel plants focus on seaborne coal supply;

- Europe: Competition from the USA and Australia;

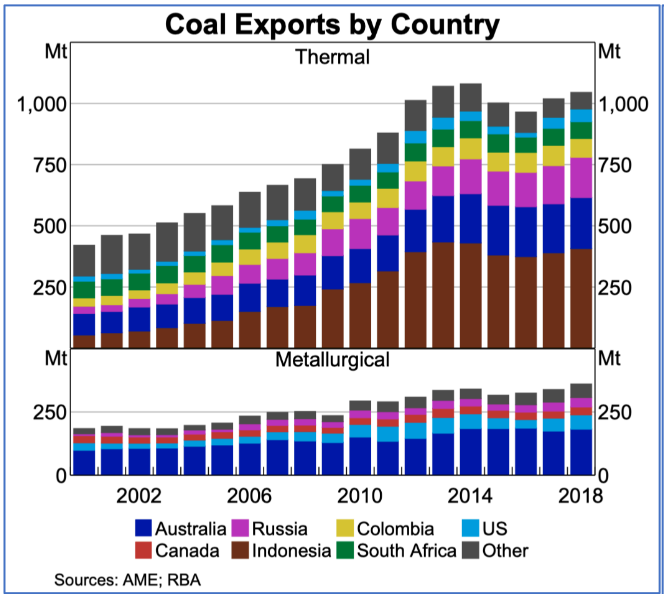
- N-America: Competition from USA;

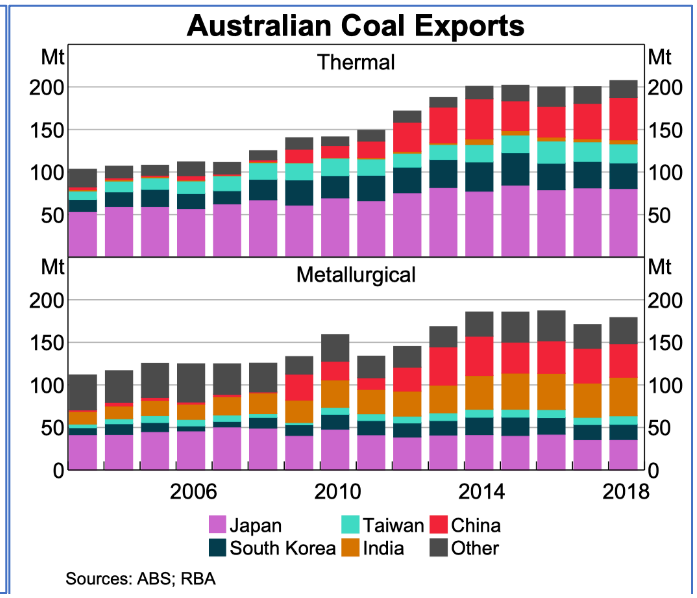
- S-America: Competition from Australia and the USA;

- Africa is not a large market, some of it supplied by Mozambique.

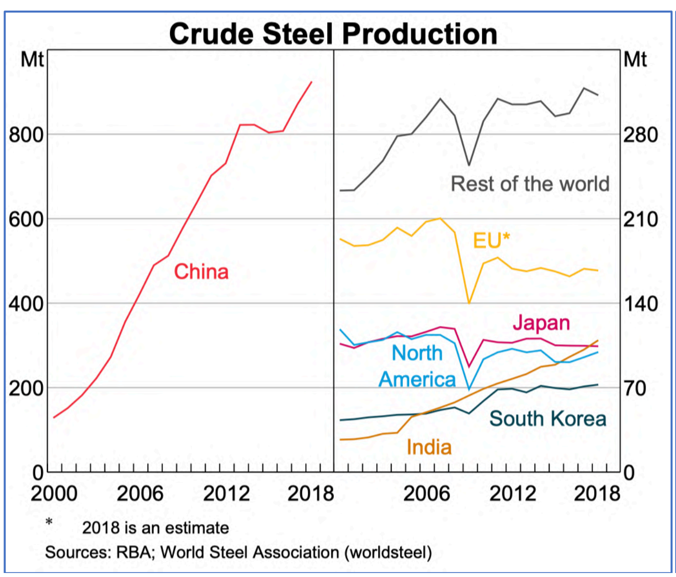
1c International Metallurgical Coal Exports and Pricing:

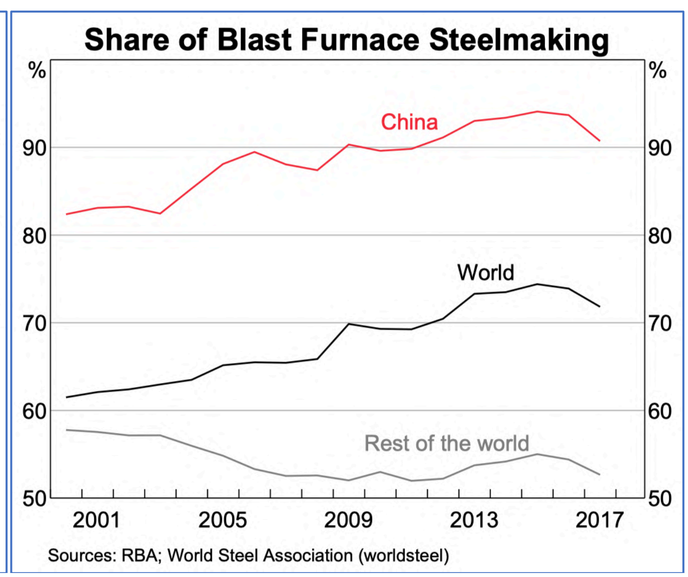
Australia is the world's main seaborne Metallurgical coal supplier of approx. 180mlnTonnes/Y, followed by Canada 31mlnTonnes/Y (2018 data). Most of Canada's Met-Coal is exported. The world's total Metallurgical coal exports was approx. 415mlnTonnes/Y in 2018. The US' mostly Appalachian producers are swing-suppliers when the price is high enough; they benefitted significantly over the past decade form the relaxation of environmental and operational practices. See the seaborne coal export graphs below (Source: AME, RBA, published by Reserve Bank of Australia, September 2019)[1]:





World Crude Steel production and the Blast Furnace's share are shown in the two graphs below. Blast Furnace steelmaking drives demand for Metallurgical coal (Source: AME, RBA, published by Reserve Bank of Australia, September 2019):

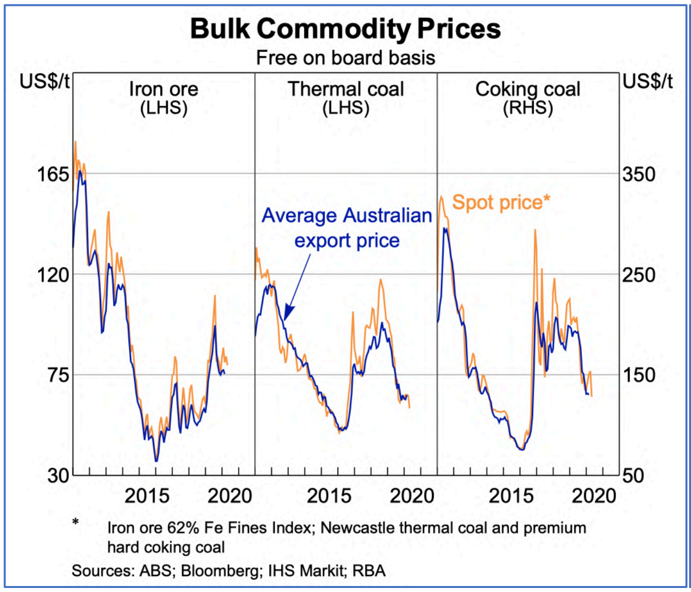


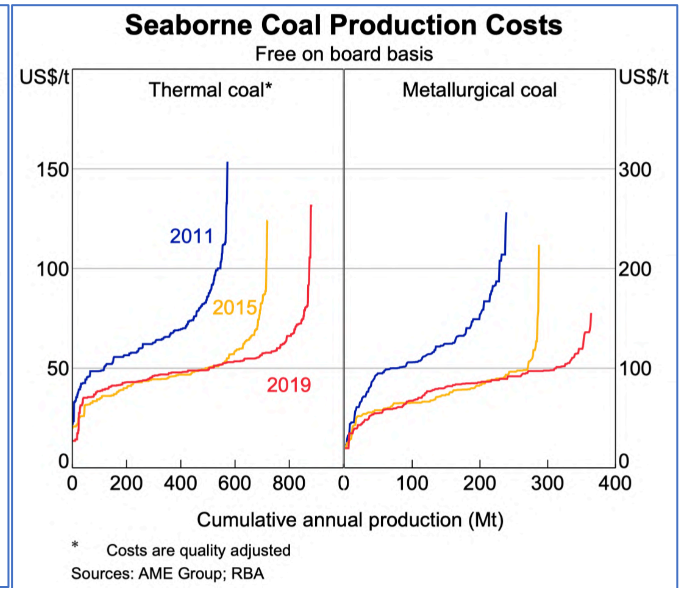


In the above graphs, the impact of the 2008 recession on world steel consumption is clearly visible. The Blast-Furnace route is the most important source of hot metal, especially to refine high quality and purity steel for high-tensile steel required in modern cars.

[1] The Changing Global Market for Australian Coal Bulletin September 2019 Reserve Bank of Australia
https://www.rba.gov.au/publications/bulletin/2019/sep/the-changing-global-market-for-australian-coal.html

World Steel production is an important driver for metallurgical Hard Coking Coal (HCC) and iron ore Spot and Free on Board (FOB) pricing, referring to the graphs below (Source: AME, RBA, ABS, Bloomberg and HIS, published by Reserve Bank of Australia, September 2019 and May 2020)[2]:





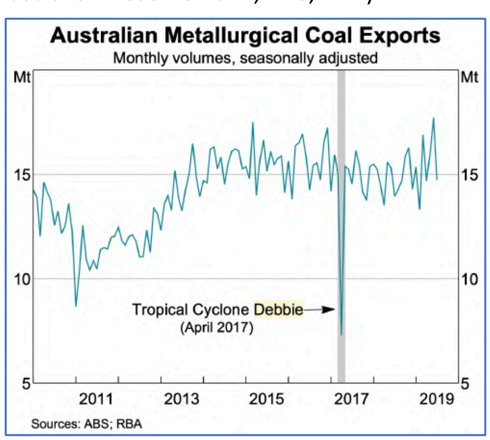
The above-right graph shows competition increased as lower-cost supply entered the market and costs of existing mines have declined. Reflecting this the global production curves have moved outwards and became flatter over the past decade.

1d <u>The value and pricing of Metallurgical Coal is driven by:</u>

- Iron & Steel Producer's demand, their specific processes, plant & equipment and the value of their products in their markets. Transportation mode, distance and cost are also important factors.

- The characteristics of the coal deposit and the attributes of the coal product. Coal pricing is very volatile. During periods of high demand, prices can significantly increase, but can slump in a downturn. Mines with higher production cost and/or lower value products will cut down production or shut down.

- **Coal Availability versus demand:** During periods of shortages of Metallurgical Coal or shortage of specific types of Metallurgical coal, the market price will increase. In 2017 the tropical cyclone "Debbie", flooded large parts of the Queensland Bowen Coal Basin and many mine pits. It devastated rail infrastructure and seaports, triggered a 50% decline in exports from the world's largest seaborne Metallurgical Coal producing area. **International Met-Coal spot prices rose sharply from less than US$150 to temporarily US$275 FOB, eventually dropping back below US$150.** Conversely, during an economic crisis or a COVID-type crises prices can decline sharply, when demand slumps. See the graph below for Debbie's impact (Australian Reserve Bank, ABS, RBA):



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[2] Australian Economy and Financial Markets Chart Pack May 2020, Reserve Bank of Australia. https://www.rba.gov.au/chart-pack/

1e Hard Coking Coal Pricing January 2020, the impact of the COVID epidemic and Forecast to 2023:

Over the past twelve months leading up to May'20 coal prices came down, due to reduced demand and sufficient supply. Pricing declined further due to the COVID-19 pandemic. The Table E1 below shows publicly available pricing from The Metal Bulletin's Fastmarket's website published the following pricing for Seaborne coking coal prices, using Platts Globex Coal Specifications Guide as published for June 2020. Price is US$/Tonne shipped from **Dalrymple Bay Coal Terminal, Queensland, Australia, Free on Board (FOB). Prime Hard Coking Coal (PHCC) and Hard Coking Coal (HCC) pricing are quoted in Table E1:**

Table E1 **Date**	**Premium Hard Coking Coal PHCC US$ FOB Platts TSI CSR 71-74**	**Hard Coking Coal HCC US$ FOB Platts TSI CSR 62**	**Price Relativity HCC/PHCC**	**Source / Comments**
January'20 Pre-COVID	135.00			Reserve Bank of Australia
22 May 2020	118.27	90.81	77%	Metal Bulletin Fast Markets[3]
28 May 2020	112.23	90.38	81%	
04 June 2020	107.75	87.08	81%	
11 June 2020	107.59	88.58	82%	
30 July 2020	108.49	89.09	82%	
August – December'20	126.00	103.32	82%	Platts Globex Projection PHCC[4] Price relativity HCC/PHCC estimated at 82% to calculate HCC pricing.
Year 2021	138.54	113.60	82%	
Year 2022	139.00	113.98	82%	
Year 2023	135.00	110.70	82%	

Note the steep price PHCC decline from US$135 in January 2020 to US$108 July 2020 and the projected slow recovery to the US$135 – US$139 range in the following 2 – 3 years.

Coal Specification, type classification and Benchmarking will be further explained in Section 4.

1f Hard Coking Coal Pricing Long-Term Projections from 2023 forward (FOB Dalrymple Bay Coal Terminal Qld)

As of the end of July, 2020, expert consensus (including Wood Mackenzie) for the long term ranged from:

- **Platts TSI PHCC CSR 71 – 74: US$130 to US$150 FOB maximum for the upside.**

Referring to Table E1 above, and using the relativity HCC/PHCC pricing of 82% for the long term:

- **Platts TSI HCC CSR 62: US$107 to US$123 FOB maximum for the upside.**

Historically, Canadian Coking Coal at times sells at a 3% discount to comparable Australian Coking Coal, mainly due to the cost of longer Seaborne transportation distances to some of the key markets. During shortages, price parity will be achieved.

Please refer to Attachment ER1: Australian Coking Coal (Platts) Low Vol Futures Quote Globex years 2020 – 2023.

[3] Metal Bulletin Fastmarkets Coking Coal Daily
https://www.metalbulletin.com/Article/3943913/Search-results/COKING-COAL-DAILY-Seaborne-prices

[4] Australian Coking Coal (Platts) Low Vol Futures
https://www.cmegroup.com/trading/energy/coal/australian-coking-coal-platts-low-vol-swap.html

2. BLAST FURNACE IRONMAKING, COKEMAKING AND METALLURGICAL COAL VALUE IN USE CONCEPTS

The Blast Furnace is the Coke Maker's task-master for it drives Coke Quality requirements and therefore Metallurgical (coking coal) value and pricing (as delivered to the specific steel plant). The Blast Furnaces (BF) ironmaker strives to produce Hot Metal (in the past referred to as Pig Iron) as efficiently and cost-effectively as possible. For this, high quality burden materials (Coke, Iron ore, mostly pelletized or Sintered, injection fuels and fluxes) are required.

Since there is a trade-off between quality and pricing, the Ironmaker is constantly evaluating the BF's performance versus burden materials quality. This search for the most optimal cost-benefit balance drives both Coal and Iron Ore prices and selection (under given market conditions). The higher Blast Furnace productivity, the higher quality materials are required.

The "Value in Use" assessment for supplier's products is calculated to guide the steel plants' purchasing decisions for price, quality and Tonnage. A typical coking coal blend consists of approx. eight different coals, selected and optimized for their complementary attributes and cost. The value of a specific coal can differ from plant to plant, depending on its processes (type of coke plant), Blast Furnace Coke quality requirements and location (transportation cost). A Cokemaker will use a coal blend of different sources, not only for economic and coke quality reasons but also to spread the risk of supply disruptions.

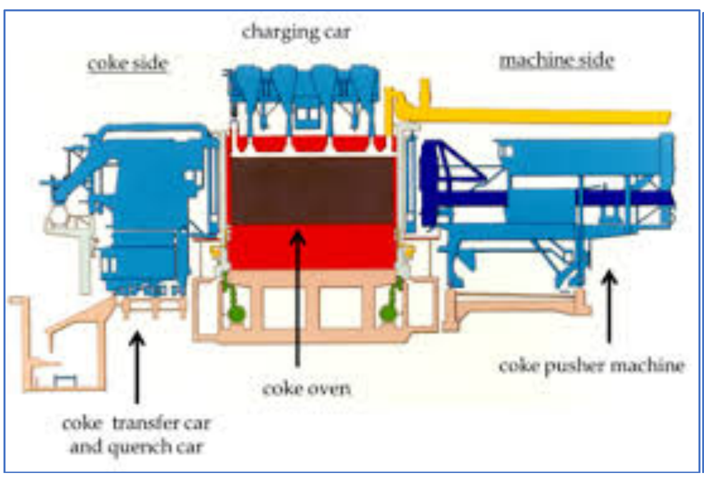
Industry operates two types of Coke Batteries:

- Slot Ovens typically charge 30Tonnes coal/oven, coking time 16-20 hours, where by-products are produced and part of the coke oven gas is burnt to heat the battery.

- Non-Recovery Ovens (NRO) typically charge 50Tonnes/oven, no by-products are produced since all coke oven gas is combusted to heat the battery and generate steam for electricity generation. Coking time is typically up to 48 hours.

- Both slot-ovens and non-recovery ovens are arranged in "Batteries" containing up to 30 ovens each. Generally speaking, non-recovery coke ovens with their longer coking times can utilize lower quality, cheaper coking coals. Which coke plant design is selected is ultimately determined by economics, driven by the available metallurgical coal and the value of by-products versus electricity. For considerable time, China favoured non-recovery ovens. However, the past decade some countries (China and Brazil) encouraged slot-oven plants for their by-product revenue (gas, tar, chemicals for paints, fertilizers, etc.).

Below are typical Slot-oven coke plant (left) and Non-recovery coke plant diagrams (Right). (Open Sources: Slot Oven diagram Environmental Control and Emission Reduction for Coking Plants INTECH Open Science 2012. NRO Ovens, advanced design: SuncokeEnergy website):



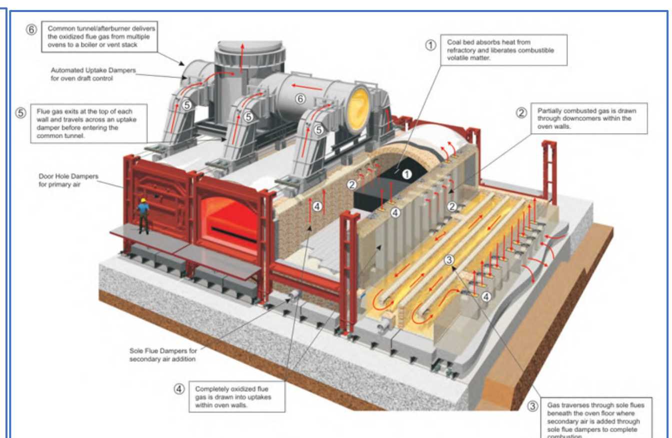


Figure 2-1, Sun Coke Heat Recovery Oven - Illustration of Gas Flows

High strength coke is essential to the Blast Furnace process, for it enables the flow of process gasses and drainage of liquid Iron and Slag. Weak coke that breaks down will reduce burden permeability and process efficiency and productivity, ultimately leading to blockage; if left unchecked the burden can start to "hang", no longer descending, potentially leading to a rapid release "slippage" and violent destruction of the Blast Furnace.

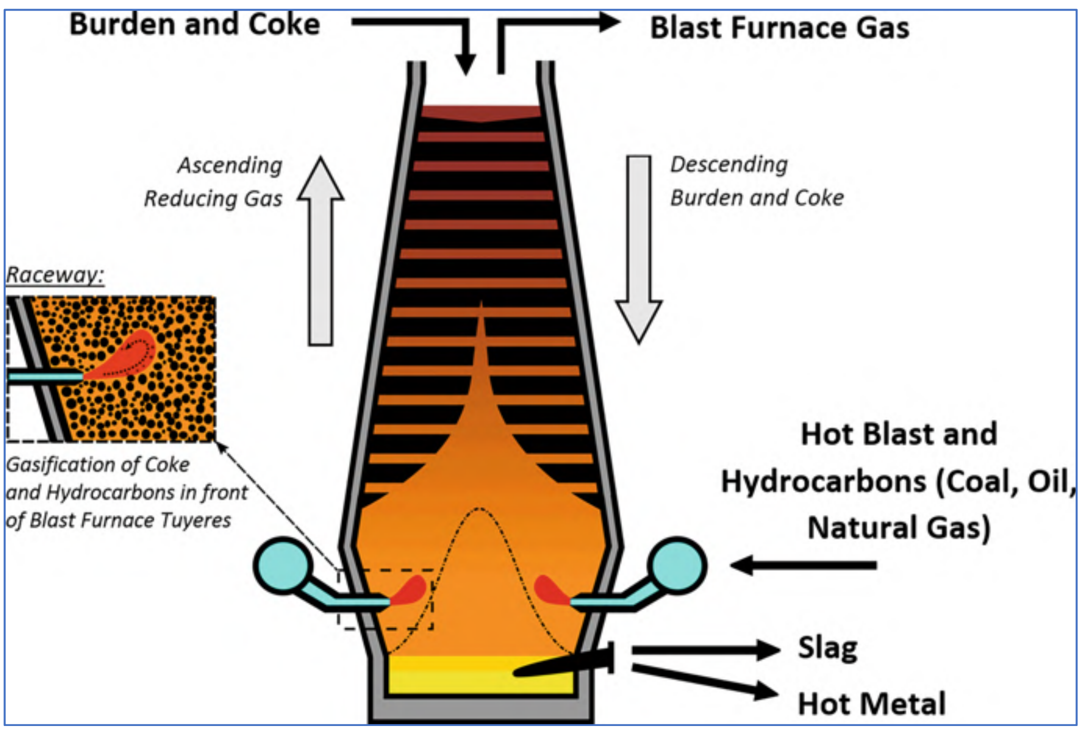
The Blast Furnace is a counter-current reactor, as depicted by the diagram below. Coke and Iron Ore Pellets and Sinter are charged in layers at the top and are drawn down as the process consumes both. Lower, in the Bosh, super-heated Hot Blast enriched with 2-4% Oxygen is injected at up to 1200°C through the tuyeres, often with Hydrocarbons to reduce coke consumption.

Up to 220 kg Coal/Tonne Hot metal can be injected; PCI coal is cheaper than Coking Coal and displaces expensive Coke as most is gasified to CO in the raceway at tuyere level. Flame temperatures of up to 2200°C, boosted by Oxygen Injection, can be achieved. Most of the coke is gasified to CO for there is insufficient oxygen to burn to CO_2, which is not desirable, since the CO is required to efficiently reduce the Iron Ore oxides to Iron, which is a liquid at these temperatures. The CO "takes" the oxygen from the iron ore, becoming CO_2, which travels up the Blast Furnace reactor column and expelled from the top as BF top-gas of low calorific value. Finally, the remainder of the coke is dissolved in the Hot Metal at the bottom of the Blast Furnace.

The Hot Metal (HM) and slag are tapped from the BF hearth at the bottom at approx. 1500°C. Slag floats on top of the HM; it originates from coke ash (from coal ash), ore siliceous material and the process fluxes. The Slag is skimmed off the heavier HM. The HM is transported in "torpedo cars" to the Steel Shop's BOF for refining (removal of Carbon, Sulphur and Phos).

A typical BF hearth diameter can be up to 14m, with 36 tuyeres in the Bosh, the column 35m high, with an internal volume of up to 4500m^3, producing up to 3mlnTonnes of Hot Metal annually or more. BF sizes vary, there are significantly smaller but also larger BFs. Apart from BF size, Production depends on BF operations and applied process technology and market demand.

The BF diagram below shows (Open Access Source: Development of a BF Model with Thermodynamic Process Depiction by Means of the Rist Operating Diagram. A. Spanlang et al, BHM, 17Feb20)[5]. The alternating ore and coke layers are shown.



Fuel injection together with the Hot Blast is shown in the diagram above. The higher the fuel injection rates, the stronger the coke needs to be. In Section 3, coke strength values at increasing Blast Furnace Pulverized Coal Injection Rates will be provided.

[5] Development of a BF Model with Thermodynamic Process Depiction by Means of the Rist Operating Diagram. A. Spanlang et al, BHM, 17Feb20 https://doi.org/10.1007/s00501-020-00963-6

3. METALLURGICAL COAL QUALITY ATTRIBUTES AND COKE QUALITY OVERVIEW

The value of Metallurgical Coal for cokemaking is determined by:

- **Chemical analyses:** Moisture, Ash, Volatile Matter (VM), Sulphur, Phosphorous, carbon content and the Mineral Ash Analysis. As per above, low Ash (finely dispersed rock minerals <1mm in washed coal), Sulphur (<0.60% adb) and Phos (<0.055% adb) are desirable. Volatile mater escapes during coking and can be of economic interest for by-products (Gas for power generation, chemicals for fertilizers, etc.). Lower Volatile Matter increases coke yield (Coal/Coke tonnage), but lower Volatile Mater coal can generate coking pressures detrimental to the coke oven's structural integrity and smooth operation.

- **Rheological coking properties:** In the coke oven coal (Typically 30 Tonnes/oven), is heated from ambient temperature to 1100^{o}C shielded from Oxygen. Metallurgical coal starts to melt at approx. 400^{o}C while volatile matter is released. Semi-coke is formed at approx. 550^{o}C, while the coke contracts. Good Rheological Coking Properties result in high coke strength against breakage and abrasion during transportation to the BF and inside the BF. The correlation between Rheological Properties and Coke strength differ, dependent on the specific coal deposit. In general, US Appalachian Coal requires higher Rheological Properties (Fluidity and Dilatation, measured by heating a small coal sample to its plastic phase in a Lab-oven) as compared to Australian and Canadian coals. There are optimal Fluidity and Dilatation values as the Coal's Rank increases (For Coal Rank definition, see Petrography below). Another Rheological measure is the Free Swelling Index (FSI), determined by heating a 12gram coal sample in a small Lab-oven and measuring the swell of the coke button. **Depending on coal Rank (Volatile Matter), hard coking coals generally have 7-9 FSI. Less strong Coking Coals are below that value.** FSI and CSN are slightly different testing standards, producing equivalent results.

- **Coking Pressure and Coke Contraction:** The higher the Rank (R_{om}) of a coal, the lower Volatile Matter content and the higher the coking pressure during cokemaking and the lower the semi-coke contraction. This is especially an issue with Appalachian coal basin coals from the Carboniferous era; these coals have to be blended with pressure mitigating coals. Younger coals from the Australian metallurgical coal basins typically display significantly lower coking pressure. Most Western Canadian metallurgical coals generally have exceptionally low coking pressures and high semi-coke contraction as the coke matrix is formed and hardens in the oven, which is a major asset to coke plant integrity and operations.

- **Coal Petrography:** Coal petrography is determined using a microscope to discern the coal maceral (organic carbon forms) composition. **There are reactive and inert coal macerals for cokemaking.** Reactive macerals transform during cokemaking, forming strong bonds with the inerts and within the forming coke matrix. There is an ideal balance between Reactives and Inertinites. Vitrinite is 100% Reactive, Semifusinite is 30% to 50% Reactive, other macerals are "inertinites". The ideal Reactives / Inertinite balance is coal Rank and coal-basin dependent. The Cokemaker makes an international coking coal blend of some eight coal components, often from 2 to 3 coal basins. Inappropriate blending can enhance or degrade the interaction between Reactives and Inertinites, as will the level of coking process control.

  Coal Petrography also determines the Rank of coal based on the **Maximum Vitrinite Reflectance R_{om}**; a higher **Vitrinite Reflectance** enhances coke strength; higher Reflectance coals have a lower Volatile Matter content and potentially higher coking pressures**. Typical Vitrinite R_{om} values are: High Volatile coal 0.90 - 1.02 / Mid-Volatile coal 1.03 – 1.29 and Low-Volatile coal 1.30 – 1.65.** (Note: Since petrographers have different interpretations although working to similar analysis standards, petrography results can differ.) Many Cokemakers have to trade off coke strength versus coking pressure (forced to produce lower strength coke to limit coking pressure). Some coke strength can be regained by increasing the coking time, but this will reduce the Coke Plant's production capacity.

- **Mineral Ash Analysis and Composition:** This is the analysis of the finely dispersed rock material (Ash) within the coke (Metallurgical coal is washed to reduce this ash content 6 to 15%). The Mineral Composition can carry impurities such as Sulphur and Phos (there is also Organic Sulphur). Other impurities are Ca, Mg, Fe, Na and K (which make the coke more reactive in the Blast Furnace, which is undesirable, for they are catalysts reducing coke strength by too rapid gasification under BF process conditions. Coals with a low content of these elements are less Reactive; Canadian and Australian Prime Coking Coals are very favorable in this aspect. These detrimental impurities can be partly counterbalanced by the elements Si and Al. All these elements are commonly expressed as their oxides as determined by the Mineral Ash Analysis, e.g. CaO, Fe_2O_3, MgO, Na_2O, K_2O, SiO_2 and Al_2O_3. The ratio of the oxides of **(Ca+Fe+Mg+Na+K)/(Si+Al) is referred to as the "Basicity Index"**; a lower Basicity Index is desirable for it makes the coke less reactive in the BF process.

- **Coke Strength:** "Cold" and "Hot" coke strength are determined.

  For cold coke strength, production coke is tumbled in a drum of specified dimensions for a specific number of rotations, then screened on specified screen sizes. After screening the size is determined to assess strength against breakage and abrasion during transportation to the Blast Furnace and charging into the Blast Furnace and its subsequent descent with the Blast Furnace burden. Typical testing standards are the IRSID I40/I10 in Europe, the Micum M40/M10 in China and S-America, the Japanese Drum Index DI in Japan, Korea, China and S-America and Stability/Hardness in N-America.

  For Hot Coke Strength the Coke Strength After Reaction with CO_2 is determined. This is where the above-mentioned Mineral Ash Analysis (MAA) is of importance, for higher catalysts make the coke too reactive, gasifying the coke too quickly, thus weakening the coke matrix and its strength, resulting in structural breakdown in the Blast Furnace. The testing standard was originally developed in Japan and is defined according to the ASTM testing standard. The coke sample is crushed and screen-sized at 19.0mm to 22.4mm. Then sample is brought to 1100^oC in an inert N_2 atmosphere. The sample is then exposed to a 100% CO_2 atmosphere for 120 minutes, when part of the sample is gasified. The oven is then purged and cooled with N_2 gas, after which the sample is weighed. Coke Reactivity% is defined as he sample's weight loss divided by Original sample weight x 100, the **Coke Reactivity Index (CRI)**; The lower the Reactivity the stronger the coke will be. After reaction sample is tumbled in a small drum of specified dimensions, for 600 revolutions. The sample is then screened on a 9.5mm screen. The +9.5mm sample weight after reaction with CO_2 divided by sample weight before reaction with CO_2 x 100 is defined as the **CSR (Coke Strength after Reaction)**. The lower the Reactivity and the higher the CSR, the stronger the coke will be in the blast Furnace. The CSR is also enhanced by strong coke abrasion resistance (determined on cold coke).

The larger the Blast Furnace, the higher the Production Rate and Fuel Injection Rate (such as Pulverized Coal Injection PCI), the stronger the Hot and Cold Coke Strengths need to be.

Typical Cold Coke Strength indicators are provided in Table E2 below, the larger, higher productivity and fuel-injected Blast Furnaces' coke strength is mostly at the top-end of the break-strength ranges.

- For the abrasion resistance, the I10 and M10 measure the size% less than 10mm after tumbling 500 and 100 drum rotations respectively, therefore the lower values are better.

- The ASTM Stability measures the size% >25mm, the ASTM Hardness measures the size% >6.3mm after 1400 drum rotations. Therefore, a higher% is better.

- The Japanese Drum Index measures the size% >15mm after 30 and 150 drum rotations respectively, higher values will be better.

Table E2 Typical Coke Cold Strength Indicators	**Break Strength (higher is better)**	**Abrasion Resistance**
IRSID I40 & I10	I40: 45 – 55	I10: 16 – 20 lower is better
MICUM M40 & M10	M40: 82 - 87	M10: 5 – 7 lower is better
ASTM Stability & Hardness	Stability: $\geq$62	Hardness: $\geq$69 higher is better
Drum Index DI^{30}_{15} & DI^{150}_{15}	DI^{30}_{15} $\geq$95	DI^{150}_{15} $\geq$85 higher is better

Typical Hot Coke Strength indicators for increasing Pulverized Coal Injection (PCI) levels per Tonne of produced Hot Metal (Iron) by the Blast Furnace are provided below:

Table E3	**Typical Coke Hot Strength CSR at Increased PCI Levels**
Up to 140 kg PCI / Tonne Hot Metal	60 - 62
140 – 180 kg PCI / Tonne Hot Metal	65 (Range 63 – 68)
>180, especially if >200 kg PCI / Tonne Hot Metal	69 - 70

4. METALLURGICAL COKING COAL SPECIFICATIONS, BENCHMARKING AND INTERNATIONAL INDEXING

4a. Coal Spec Benchmarking Platts 64

Next to the Rheological Coking Properties, and cold coke strength, the CRI and CSR are important attributes to determine the Value-in-Use of a Metallurgical coal product, as per Table E4 below. **Bench Mark Pricing, also referred to as Indexing, is established for each Coal Type.** All internationally traded coal is priced on a sliding scale relative to its appropriate bench mark, relative to the key quality attributes as listed in the Benchmarking (Index tables, see Tables E4 and E5 below).

Referring to the Table E4 below, the Volatile Matter, Ash and FSI refer especially to Australian and Canadian Elk Valley coals; these typical values were included in the table. Lower Ash content can a particular asset to lower coke strength coals, such as Semi-Hard and Semi-Soft Coking Coals. Table E4 gives an indicative overview of coal Types, CSR ranges defined as per 2018:

Table E4 **Coal Type**	**CSR**	**Ash (adb)**	**Volatile Matter (adb)**	**FSI**
Tier 1 Premium LV Hard Coking Coal	≥70	Typical 9.5% - 10.5%	Typical 18% - 22%	Typical 7 – 9
Tier 2 Premium MV Hard Coking Coal	68 - 69	Typical 9.5% - 10.5%	Typical 22% - 28%	Typical 7 – 9
Hard Coking Coal Platts 64	64 - 67	Typical 7.5% - 10.0%	Typical 20% – 25%	Typical 7
Semi-Hard Coking Coal	55 - 63	Typical 6.5% - 10.5%	Typical 19% – 34%	Typical 4 - 9
Semi-Soft Coking Coal	≤54	Typical 8.5% - 12.0%	Typical 23% - 28%	Typical 3 - 6
PCI	Not applicable / required	Typical <11.5% prefer <10.0%	--	No or little FSI, may be oxidized

S&P Global Platts Coal Trader International publishes benchmarks for specific international markets. These benchmarks for quality and pricing are regularly updated. The table below was published for July 2019[6], also including HCC 64 Mid-Volatile Coal Type, commonly used in contract Benchmarking and Pricing negotiations:

PLATTS DAILY METALLURGICAL COAL ASSESSMENTS

Asia-Pacific Coking Coal ($/mt)

	FOB Australia	**CFR China**	**CFR India**
HCC Peak Downs Region	HCCGA00	HCCGC00	HCCGI00
Premium Low Vol	PLVHA00	PLVHC00	PLVHI00
HCC 64 Mid Vol	HCCAU00	HCCCH00	HCCIN00
Low Vol PCI	MCLVA00	MCLVC00	MCLVI00
Low Vol 12 Ash PCI	MCLAA00	MCLAC00	MCVAI00
Semi Soft	MCSSA00	MCSSC00	MCSSI00
Premium Low Vol China Netback	PLVHD00		

TSI Coking coal indices ($/mt)

TSI Premium Hard (PHCC) FOB Austrialia			TS01034

6 S&P Global Platts, Code List – Coal Trader International July 2019 (Downloaded 11Jul20) https://www.spglobal.com/platts/plattscontent/_assets/_files/en/our-methodology/methodology-specifications/coal_trader_international_code_list.pdf%20

4b. The Blast Furnace Process Engineer's and Cokemaker's perspective

Table E4 above provides particular clarity for the Cokemaker's and Blast Furnace Process Engineer's valuation. Referring to Table E3 above (Section 3 of this Expert Report), larger, higher productivity Blast Furnaces in Japan, Korea, China, Europe, China and now also India (the major markets), prefer a Coke Hot Strength of 65 or better, often requiring at least CSR 68.

A coking coal blend typically consists of approx. 8 coking coals at a particular time. The blend is designed to optimize the value = cost / benefit balance to achieve the Blast Furnace's coke Quality requirements with respect to both coke strength and chemical composition.

The Tier 1 and Tier 2 Premium Hard Coking Coals (PHCC, Table E4 above) supplied by Australia and the Elk Valley in BC have the highest quality and are therefore the most valuable and expensive. They have the capability to absorb the cheaper and weaker Semi-Hard Coking Coals (SHCC) and Semi-Soft Coking Coals (SSCC) and some cheap "filler" PCI, to bring the blend's cost down.

The **Platts 64 classification is "neutral"** in this cost-optimization; it will probably be able to stand on its own but will not be able to absorb as much weaker Semi-Hard and Semi-Soft coking coals as compared to the Prime Hard Coking Coals. Furthermore, a Cokemaker never wants to be beholden to a single supplier.

4c. IHS market and S&P Global-Platts Benchmarks – International Coal Specification Indexing

The S&P Global-Platts and IHS Classifications are used in the international coal trade and will evolve over the years. Coking coals are benchmarked, priced on a sliding scale off the benchmark examples presented in Sections 4a and 4c of this Expert Report.

S&P Global-Platt's June 2020 open-sourced Specifications Guide Global Metallurgical Coal[7], shows Table E5 below:

- Peak Downs is seen as the top-ranking coal CSR 74;
- Premium Hard Coking Coal is defined as 71;
- Hard Coking Coal's CSR is defined as 62;
- For the weaker, less costly coals only Semi-Soft Coking Coal is defined;
- The Premium HCC are benchmarked against a CSN (FSI) of 8 – 9.
- Note the declining Vitrinite-content towards the lower classification coals; Vitrinite content is important to both hot and cold coke strength.

IHS Markit's December 2019 Coking Coal Methodology and Specifications[8] are also summarized in Table E5 below. The correlation to S&P Global-Platts is obvious, the Prime Hard Coking Coals CSR 68 – 71, the Tier 2 Hard Coking Coal at CSR 62 plus a Semi-Soft Coming Coal.

Table E5	IHS Markit Specs effective December 2019				S&P Global - Platts Spec Guide June 2020				
COAL TYPE	Low-Vol PHCC	Mid-Vol PHCC	Tier 2 HCC	Semi-Soft CC	Peak Downs HCC	Premium Low-Vol HCC	TSI Premium HCC	TSI HCC	Semi-Soft CC
CSR	71 70 Min.	68 67 Min.	62 Min. 55	--	74	71	71	62	--
Total Moisture %ar	10	10	11	<9.5	9.5	9.7	10	10.5	9.5
Volatile Matter %ad	20 21.5 Max.	22.5 21.5-25.0	21.5 19-28	33-35	20.7	21.5	21	21.5	34
Ash %ad	10 11 Max.	9.5 11 Max.	8 10 Max.	9-10	10.5	9.3	10	8	9.25
Sulphur %ad	0.55 0.8 Max	0.5 0.8 Max.	0.4	<0.6	0.6	0.5	0.45	0.45	0.58
Phosphorus %ad	0.05	0.04	0.07	<0.025	0.03	0.045	0.05	0.06	0.025
Fixed Carbon %	--	--	--	51-54	--	--	--	--	53
CSN (FSI)	9	8.5	--	5 - 6	8.5	--	8	--	5.5
Max. Fluidity ddpm	180	1000	120	150-500	400	500	600	100	200
Total Dilatation %	--	--	--	--	--	--	80	--	--
Vitrinite %	65	63	50	--	71	65	68	52	--
Rom Vitrinite	--	--	--	--	1.42	--	1.35	--	--
Particle Size	--	--	--	--	--	--	Min. 90% <55mm	--	--
Abbreviations: PHCC = Prime Hard Coking Coal. HCC = Hard Coking Coal. CC = Coking Coal									

Attachments relevant to Section 4c of this Expert Report:
- Attachment ER2: IHS Markit Coking Coal marker price Methodology and Specifications, effective December 2019
- Attachment ER3: S&P Global Platts, Global Metallurgical Coal, Specifications Guide of June 2020

[7] **S&P Global Platts** June 2020 Specifications Guide Global Metallurgical Coal
https://www.spglobal.com/platts/plattscontent/_assets/_files/en/our-methodology/methodology-specifications/global_metcoal.pdf

[8] **IHS Markit** Coking Coal Methodology and Specifications December 2019
https://cdn.ihs.com/Coal-Methodology/IHS-Energy-coking-coal-methodology.pdf

5. MINE PROJECT RESERVE QUALITY AND PROJECT VIABILITY – ALSO APPLICABLE TO PRODUCING MINING OPERATIONS

A mining project needs the following conditions to develop into a producing mine:

- Sufficient Value of the deposit's product for industry to effectively compete, cover the capital costs, mining & operational production cost, including the coal washplant to reduce the Ash-Content, environmental measures and obligations, plus return on investment. Coke value parameters were discussed in the previous paragraphs. They are Chemical Composition, Rheological Coking Properties, Petrography, Coking Pressure and contraction and Cold Coke Strength and Hot coke Reactivity (CRI) and Strength (CSR).

- Important are exploration & development cost, production cost (Stripping Ratio coal to Overburden), infrastructure, plant & equipment and the cost of ongoing reclamation and rehabilitation. Financial resources need to be set aside to meet rehabilitation obligations at the end. Standards need to be met for tailing disposal, air and water quality throughout the project and after mine shut down; all this comes at a cost.

- **Essential is a 3rd party "Bankable Document".** A "Bankable Document" is a feasibility study or a Techno-Economic Feasibility Review that is of bankable standard. In essence, it means the study is thorough and of high quality, but also contains all the essential information to allow banks to make an informed risk assessment. Essential to banks is if the company would maintain a free cashflow sufficient to service debt when market prices are falling (Refer to Section 1C of this document). Are plausible downside scenarios considered, such as construction delays, CAPEX overspend, exchange rate fluctuations, slower than planned ramp-up. **Adequate cashflow needs to be generated throughout the mine's operational life for ongoing environmental mitigation and reclamation. Assessment of market viability in relation to long-term adverse effects is particularly important where the project is likely to require remediation after operations cease.**

- Mineral Leases and Environmental Permitting are essential; there are significant differences between countries and jurisdictions. Some jurisdictions may (temporarily) relax operational and environmental standards, which increases risk, should the project/mine fail. An example of dire Environmental and Miners' health consequences is coal mining in the US Appalachians. Chinese authorities have been struggling to enforce higher operational and environmental standards.

- **Effective Product Development, Applied R&D** with customers and marketing are key to not only develop a valuable product, but realize its value in the marketplace. For this, systematic and timely resource exploration, analysis and quality planning are essential, to plan ahead.

- **Customer Development and Product Acceptance:** In general, most valuable long-term customers will only accept a product after extensive testing in a small pilot oven, 100% and blended with other coals. The next step is industrial testing in the Coke Plant's Coking Coal Blend, including the impact of its Coke on the Blast Furnace process. The potential customer expects a degree of certainty that the product will be available for a number of years. The customer's selection process can take up to two years. This potentially long customer acceptance process is a hurdle for new producers. Therefore, new producers often try to get a large steel company to invest in the mine, often as a Joint Venture partner. Another tactic is to involve a large international mining company involved as a Joint Venture partner for knowledge and established industrial and commercial contacts. In a projected oversupply scenario, investment by an international mining and/or steel company is less likely. **It is prudent and common practice to share bulk samples for testing 100% and in international blends with potential customers before actual major construction of the mine and facilities start, to get their feedback.**

6. THE GRASSY MOUNTAIN MINING PROJECT – RESOURCE AND PRODUCT QUALITY AND VALUE ASSESSMENT

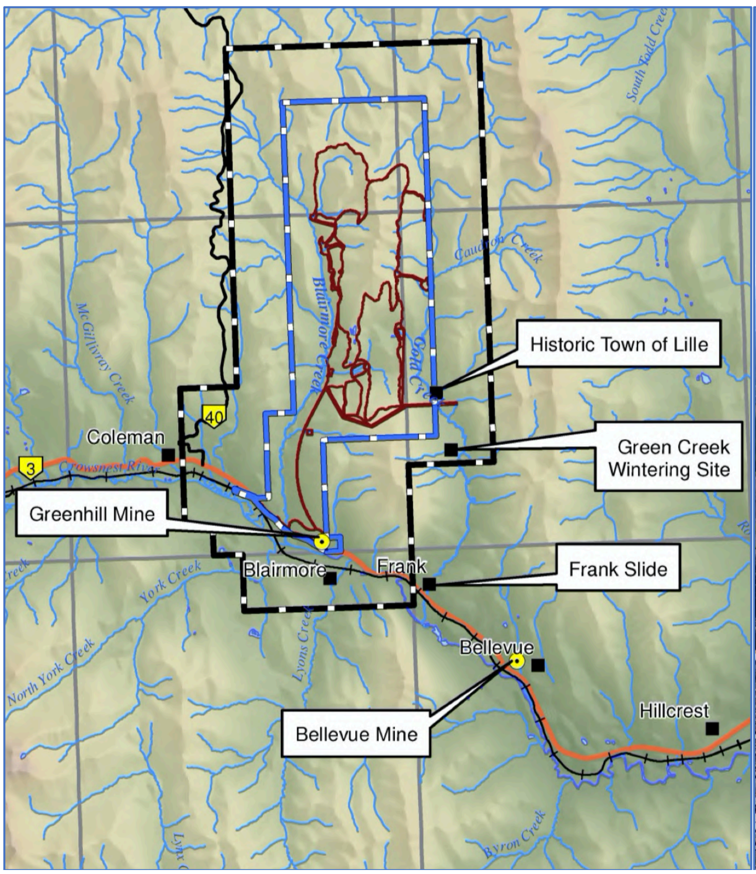
In the above paragraphs, this document contextualizes the context under which international coal producers develop and operate their coal mining operations and the market value of their product. This document focusses on the Grassy Mountain Mine Project's product quality aspects, based on publicly available information, mostly via Riverdale's and the Government of Canada's websites.

6a Grassy Mountain Project – Hancock (Riversdale) - Introduction

- **Project Location:** Approx. 7km north of Blairmore. Riverdale is planning an open pit truck & shovel metallurgical coal mine. Underground mining began in ~1909 and continued to about ~1960, but no quality data is available from that period. Exploration drilling and trench sampling, including bulk sampling have been completed between 1970 and 2015.

- **Proposed Production Capacity is up to 4mln Tonnes clean coal / Year,** Life of Mine approx. 23 – 25 years production, including secondary PCI production. The mine would employ 385 people, if approved. Measured resources are approx. 90mln Tonnes. The total stripping Ratio is 9.2 BCM/T Clean Coal.

The mine's location map and a picture of the pit abandoned in the 1960's made in 2015 are presented below:



6b Grassy Mountain Mining Area Seam Wash Quality Overview, Measured Resources and Seam Blends

Seam wash qualities are presented on three maps, Figures B.2.1-3, B.2.2-2 and B.2.3-4 in Riversdale Resources' Updated Environmental Impact Assessment, Section B Geology and Geotechnical Report of August 2016[9] (Please refer to Attachment ER4). They are summarized in Table E6 below:

Table E6 Figure	Seam #	Washed S.G. g/cc	Moisture % ad	Vol. Matter % ad	Ash % ad	FSI
B.2.1-3						
14-Jun-16	1C & 1A	1.40	1.8 - 1.2	25.7 - 24.6	8.2 - 10.9	0.5 - 3.5
	1C & 1B Blend	1.40	0.9	30.4	5.9	7.5
	1C & 1B Blend	1.40	1.3	26.3	4.0	2.5
	1C & 1B	1.40	0.7 - 0.9	26.5 - 25.9	10.9 - 10.1	5.5
	1C & 1B	1.45	1.0 - 0.9	27.0 - 25.3	9.0 - 8.9	5.5
	1C	1.45	1.1	25.6	6.4	7.5
B.2.2-2						
14-Jun-16	2	1.40	1.0	21.2	9.5	1.0
	2	1.40	1.0	22.5	8.0	2.5
	2	1.40	0.9	22.8	7.3	3.5
	2	1.40	1.0	23.4	7.0	4.0
	2	1.40	1.1	22.4	6.3	4.5
	2	1.40	0.9	22.1	9.7	1.5
	2	1.40	1.1	23.5	6.9	6.5
B.2.3-4						
14-Jun-16	4C	1.40	0.8	22.4	9.9	4.0
	4C & 4A	32.0 - 37.5	1.1 - 0.8	22.3 - 23 7	6.5 - 10.1	3.0 - 4.5
	4C & 4A	1.40	1.0	22.5	6.5	3.5
	4C	1.40	1.0	22.6	5.6	2.0
	4A	1.40	1.5	22.8	7.7	1.0
	4C & 4A	1.40	0.9 - 0.7	21.2 - 23.7	10.1 - 11.2	2.0 - 4.0

Table E6 shows the variability between the Seams and within the seams. In general, the Rheology, FSI values is low under 6, many well below FSI 5, even at low Ash% below the Indicative Clean Product Spec of 9.0 – 9.5% (ad). It should be noted the above values are based on samples, without giving their relationship to the overall Resource Tonnage.

Also, in Section B of Riversdale Resources' Updated Environmental Impact Assessment of August 2016, on page B-41 the following Seam-Ash content analyses were copied over. It can be assumed these Ash values represent the total resource base planned to be mined within a certain period, likely being the life of mine:

Product yields were based on washing Seam No. 1 coal at a float density of 1.50 g/cc, and Seam No. 2 and Seam No. 4 coal at a float density of 1.45 g/cc. Separable partings were removed in the pit prior to coal loading. Product tonnages are reported on a 10% total moisture (TM) basis. Product ash values are constant by seam on an air dried (ad) moisture basis as shown below:

- Seam No. 1 – 9.5% ad;
- Seam No. 2 – 9.7% ad; and
- Seam No. 4 – 9.8% ad.

[9] Riversdale Resources, Grassy Mountain Coal Project – Updated Environmental Impact Assessment, Section B Geology and Geotechnical of August 2016.
https://iaac-aeic.gc.ca/050/documents/p80101/115589E.pdf

In Riverdale's August 2016 report Section B of the Updated Environmental Impact Assessment, Grassy Mountain's coal resources are provided in Table B.0.0-1, please refer to the table below. Of particular significance is that Seam #1, of the highest quality is only 16% of Measured Resources, as calculated from Table B.0.0-1:

Table B.0.0-1 Coal Resources Summary

Seam	Depth (m)	Typical Thickness (m)	Coal Resources (Mt)		
			Measured	Indicated	Inferred
Seam No. 1	< 400	4.0	14.5	0.7	7
Seam No. 2		10.0	41.0	2.6	24
Seam No. 4		8.0	32.8	-	21
Total			**88.3**	**3.3**	**52**
Total (Rounded)			**90**	**3**	**50**

Measured Resources	
Seam #	%
1	16.4
2	46.4
4	37.1
Total	**100.0**

The Seam product blends used by Riversdale's production planning to constitute the clean coal product was calculated from produced Seam tonnages by the author of this report, based on Riversdale's Project Description, Section C[10], Table C.1.3-1, Page C-22, dated August 2016. (Refer to Attachment ER5 for details.) The blends are presented in Table E7 below, together with the Measured Seam Resources as per Table B.0.0-1:

Table E7 **CLEAN PRODUCT COAL**	**Year -1 (2018)**	**Year 1 (2019)**	**Year 2 (2020)**	**Year 3 (2021)**	**Year 4 (2022)**	**Year 5 (2023)**	**Year 6 (2024)**	**Year 7 (2025)**	**Year 8 (2026)**	**Year 9 (2027)**	**Years 10-14 ('28-'32)**	**Years 15-19 ('33-'37)**	**Years 20-23 ('38-'41)**	**Total**	**Measured Resources**
PRODUCT COAL (10% TM)															mln Tonnes
1-Seam Coal Tonnes (000s CMT)	22	591	639	723	1,077	822	707	644	758	757	1,848	411	1,317	**10,316**	**14.5**
2-Seam Coal Tonnes (000s CMT)	6	786	1,873	1,944	2,574	2,342	2,272	2,133	2,429	2,544	11,092	9,566	7,869	**47,430**	**41.0**
4-Seam Coal Tonnes (000s CMT)	8	534	891	1,443	801	1,339	1,455	1,648	1,347	1,405	8,882	8,921	6,191	**34,865**	**32.8**
Total Product Tonnes (000s CMT)	**35**	**1,911**	**3,403**	**4,111**	**4,452**	**4,503**	**4,435**	**4,425**	**4,534**	**4,706**	**21,820**	**18,899**	**15,378**	**92,612**	**88.3**
1-Seam Coal Tonnes %	63%	31%	19%	18%	24%	18%	16%	15%	17%	16%	8%	2%	9%	11%	16.4%
2-Seam Coal Tonnes %	17%	41%	55%	47%	58%	52%	51%	48%	54%	54%	51%	51%	51%	51%	46.4%
4-Seam Coal Tonnes %	23%	28%	26%	35%	18%	30%	33%	37%	30%	30%	41%	47%	40%	38%	37.1%
Total Product Tonnes %	**103%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100.0%**

Notes to Table E7 above:

- The Total Clean Coal Tonnage projection is approximately 5% over the Measured Resources, mostly allocated to Seams #2 and #4, probably due to the conversion estimate Resources to Clean Coal product and including some Indicated and Inferred Resources. Table E7 seam Tonnages from above-mentioned Table C.1.3-1 were generated by Riversdale / Benga using mine and product planning modelling tools. During actual production, seam accessibility and release are important factors. As mining progresses, infill drilling within the exploration grid is required for more quality detail. During the mining process, detailed in-pit sampling and sample analyses will be essential for effective product quality control.

- The over-all Measured Resource Seam-composition is 16% Seam#1 / 46% Seam#2 / 37% Seam#4. The clean coal product Specification appears to be based on this Seam-ratio (referring to this Expert Report Section 6d, below). In the blend, the contribution of the higher quality Seam #1 will be important to consistently achieve the clean product's coking properties Cold Strength and Hot Coke Strength CSR at 65.

- With respect to Coking Quality, Seam#1 has the highest Coking Quality and Reactives content, Seam#4 the second highest quality, with Seam #2 likely to have the lowest coking quality of all three seams (see Section 6d).

- Table E7 shows significant variability in the Seam Blends. Most notable Seam#1 is high during the Years 1 to 4, around the Resource Average Years 5 to 9. Seam #1 drops off to 2% - 9% during the Years 10 to 23.

- This fluctuating Seam#1 content is likely to impact product quality consistency over the years (Starting from Year 1, Year -1 is not very significant at approx. 1 cargo only).

[10] Riversdale Resources, Grassy Mountain Coal Project - Updated Environmental Impact Assessment, Project Description Section C, Page C-22, dated August 2016.
https://iaac-aeic.gc.ca/050/documents/p80101/115590E.pdf

- Between years 1 to 23, Seam#2 fluctuates from 41% to 58% and Seam#4 from 26% to 47%. From a Clean Coal Quality perspective, Years 10 to 23 are potentially of concern, with a low Seam#1 content and a high Seam#2 content.

- Throughout the life of the mine, production of a higher, consistent quality and value product containing more Seam#1, plus a lower quality and value product containing less Seam#1 seems logical. Riversdale did not present this option to the public.

6c <u>Resource Seam Clean Coal Properties</u>

In the above-mentioned Riversdale August 2016 report, and the earlier Grassy Mountain Coal Project Technical Overview[11], Section 2 Geology of December, 2nd, 2015 the below Table B.4.2-1 was presented. The Seam Ash-content and Measured Resource% of Section 6b of this expert report above is displayed in the box to the right:

Table B.4.2-1 Summary of Average Clean Coal Properties

Seam	Volatile Content (ad) %	Sulphur %	HGI	FSI	P %	Reactive Content %	Maximum Reflectance (Ro Max)[1]	Fluidity (Mddm)
No. 1	25.4	0.4 - 0.7	73 - 78	7	0.04	70	1.10	300 -1300
No. 2	22.1			3	0.04	60	1.20	10 – 200
No. 4	23.8			5	0.01	65	1.18	10 – 400

[1] Combined with the other rank indicator volatile content, all three seams fit centrally into the rank requirement for hard coking coal

Measured Resources

Seam #	Ash adb	Res.%
1	9.5%	16.4%
2	9.7%	46.4%
4	9.8%	37.1%

Riversdale Report's comment (1) at the bottom of Table B.4.2-1 refers to the rank and coking properties of all three seams in relationship to their Rank (Ro Max and Volatile Matter Content). The following can be commented with regard to Grassy Mountains Seams:

- Seam #1, containing Volatile Matter 25.4% looks comparable to a similar rank Prime Hard Coking Coal from the Elk Valley containing ~71% Reactives, although this Elk Valley Coal contains less Ash and has a little higher FSI. Essential information such as Mineral Ash Analysis, Dilatation, complete Petrography (Vitrinite, Semifusinite content and the nature of Inerts) and Pilot Oven Carbonization results including Coke Cold Strength and CSR are not available. Note the Max. Fluidity range difference from 300 to 1300ddpm is significant from a quality point of view.

- Seam #2 is of higher Rank relative to Seam #1. Compared to a similar rank Prime Hard Coking Coal product from the Elk Valley containing ~68 Reactives and FSI 7, Seam #2 Reactives at 60% are lower. Seam #2 FSI 3 is particularly low, with very low Fluidity at the lower end of the range. **The FSI 3 indicates a coal with very poor coking properties, well below the quality and value of a Hard Coking Coal,** referring to the Benchmarking Tables E4 and E5 of this Expert Report. The Seam #2 wash qualities of Table E6 confirm very low FSI values. The Max. Fluidity range difference from 10 to 200ddpm is significant from a quality point of view. The same important seam info referred to above is not provided.

- Seam #4, containing 23.8% Volatile Matter is in Rank in between the other two Seams. Compared to a similar rank Prime Hard Coking Coal product from the Elk Valley, Seam #4 Reactives content is approx. 4% less and its FSI at 5 is well below Elk Valley's Prime Hard Coking Coal's typical 7.5 of that rank. Note the Max. Fluidity range difference from 10 to 400ddpm is significant from a quality point of view. The same important seam info referred to above is missing.

Based on the above analysis, a blend of Seams #1 and #4 could possibly be combined into a Hard Coking Coal Product at 31% Seam #1 / 69% Seam #4, representing approx. 54% of Measured Resources. Adding more Seam #2, approx. 46% of Measured Resources would significantly degrade the product's compatibility to the Cokemakers' with other coal blend components, coke quality and product value.

[11] Kick off Meeting Benga Mining Ltd (Riversdale Resources) – Grassy Mountain Coal Project, 2-3 December, 2015. Grassy Mountain Coal Project Technical Overview[11], Section 2 Geology of December, 2nd, 2015 https://iaac-aeic.gc.ca/050/documents/p80101/104061E.pdf

Table 4-3 below predates Table B.4.2-1 on the previous page. The earlier Table 4-3 presents a materially different Seam #2 FSI value of 5. This earlier version of Table B.4.2-1 was presented at a later date in March 2019, as Table 4-3 in RPM Global's Grassy Mountain Technical Report[12] of March 26, 2019, Table 4-3 "Summary of Average Clean Coal Properties", published for Grant Thornton.

Table 4-3 originated from September 2015 (Bob Leach), as per the box at the bottom of this table and pre-dates the above Table B.4.2-1, published by Riversdale in December 2nd, 2015 and August 2016.

It is unclear why the table published at a later date showed the lower FSI 3 value, also considering FSI is the easiest and most robust Rheology test to be run in a laboratory as compared to Fluidity and Dilatation, including sensitivity to possible early stages of sample ageing.

Table 4-3 Summary of Average Clean Coal Properties

Seam	Volatile Content % (ad)	Sulphur % (ad)	HGI	FSI (CSN)	P% (ad)	Reactive Content%	Reflectance R_oMax	Fluidity ddpm
No. 1	25.4	0.4-0.7	73-78	7	0.04	70	1.1	300-1300
No. 2	22.1			5		60	1.2	10-200
No. 4	23.8			5		65	1.18	10-400

Note: Reproduced from Coal Quality Review Report Completed by Bob Leach Sept 2015

Table 4-3 Seam 2 FSI of 5, assuming this would be valid, would bring Seam #2's value closer to Seam #4, be it that the Reactive content is 5% lower and its upper Fluidity value half that of Seam #4. Seam #2 is still the weakest seam of the three. Note all Seam Phos-values are 0.04% (ad).

6d <u>Clean Coal Product Quality Calculation and Specifications</u>

A clean coal product quality calculation was made by the author of this Expert Report, based on the quality data provided in the previous sections of this Expert Report and the Measured Reserve Seam proportions. The calculation method is provided in Attachment ER6. The resulting calculated clean coal product quality is summarized in Table E8 below**, assuming FSI 5 for Seam #2 and the over-all Measured Resources by Seam**:

Table E8 Calculated Clean Coal Product Quality (Assuming Seam #2 FSI 5)

	Resource	Ash	V.M.	Sulfur	Sulfur	Phos	React.	Refl.	FSI	Ave.	Range
Seam #	**%**	**% ad**	**% ad**	**% ad**	**Range**	**% ad**	**%**	**R_{om}**		**ddpm**	**ddpm**
1	16.4	9.5	25.5	0.55	0.4-0.7	0.04	70	1.10	7.0	--	300-1300
2	46.4	9.7	22.1	0.55	0.4-0.7	0.04	60	1.20	5.0	--	10-200
4	37.1	9.8	23.8	0.55	0.4-0.7	0.04	65	1.18	5.0	--	10-400
Total	**100.0**	**9.7**	**23.3**	**0.55**	**0.4-0.7**	**0.04**	**63**	**1.18**	**5 - 6**	**135**	**80-190**

If FSI 3 were assumed for Seam #2, the calculated FSI assessment for the blend would have been 4 – 5 maximum. However when blending significantly different FSI Seams, the relationship is non-linear. Therefore, the calculated FSI would have to be verified by blended sample testing in a laboratory. **Assuming Seam#2 FSI 5, the Blend's FSI is likely to be 5 to 6**. For blended seam Fluidity calculations the Log(10) weighted average calculation method is generally accepted as an approximation.

Grassy Mountain's product Reactives-content is approx. 6% - 8% less than the comparable rank Prime Hard Coking Coal (CSR 71) from the Elk Valley. Grassy's FSI is approx. 2 points below this Elk Valley product, its Max. Fluidity is approx. 60ddpm lower.

[12] RPM Global's Grassy Mountain Technical Report[12] page 16 of March 26, 2019 and Grant Thornton's Independent Expert's Report and Financial Services Guide of 26 March 2019, both under **Riversdale's Target's Statement of 29th March 2019** http://www.rivresources.com/site/PDF/64aaf8c8-e338-4acc-95ad-db71ddcf66c7/%20RiversdaleResourcesTargetsStatement28March2019

In RPM's Grassy Mountain Technical Report of March 2019, Product Specs are provided for a limited number of attributes, however the CSR is included, based on reportedly 9 carbonization tests (of which 7 blends) of bulk samples from 2014 washed at Hazen and carbonized in ALS Australia's Pilot Oven (Section 5.1, page 20). Table 5-1 from Section 5.2, page 20 of this report shows the Indicative Product Spec to be very close to the above clean coal quality calculation results:

Table 5-1 Indicative Product Specification

Product	Ash %	Volatile Matter %	RoMax	Total Sulphur %	Phosphorous %	CSR
HCC	9.0 – 9.5	23.5	1.18-1.20	0.5	0.04	65

Missing from the Indicative Spec is the Max. Fluidity value, an important indicator for the compatibility of a product in the customers' multi-component coking coal blend. RPM's report of March 2019 mentions a **Max. Fluidity Range of 8 to 145ddpm** in Section 5.1, page 20. Grant Thornton's report of March 2019 in Section 3.2.1, page 30, sources its information from RRL Management's report, quoting a Spec Max. Fluidity of 150 ddpm.

The calculated Max. Fluidity value is very close to RPM's upper value and Grant Thornton's reported value. **Fluidity 145ddpm could be the achievable value when all seams are consistently blended close to the Resources' proportions throughout the life of the mine, since Seam #1 with its higher Rheology, and Vitrinite Reactives-content, essential to Rheology and Coke Strength, is only 16% of Measured Resources.** This is assuming Seam #2 FSI 5 is representative for the Resource.

Concluding: Blending Seam #1 into the product needs to be carefully managed throughout the mine's life to avoid shortages that compromise product quality, which will be challenging under real-life operational conditions. Given the differences between the three seams and Rheology's (Fluidity, FSI) variability within the individual Seams, assiduous seam in-pit sampling under Pit-Geologist supervision and coal testing will be required for quality control during production. This is in addition to ongoing exploration drilling ahead of production, filling in the initial exploration drill hole pattern, as per industry practice.

Reducing the risk of quality fluctuations: To consistently achieve the main product's target CSR 65 product quality, including consistent Rheology, Seam Release timing during production will be critical. Advanced customers, such as the integrated steel industry of Japan, S-Korea, Taiwan, Europe and increasingly China and India expect consistent product quality to drive their advanced and optimized coke, iron and steelmaking processes. These customers, especially Japan, highly value consistent shipment values for Fluidity and Dilatation to help optimize the less costly weaker coal content in their blends, paying for its value. Most international mining operations will co-produce a lower quality, less costly product to facilitate a consistent Seam blend for their highest value "flagship" product to safeguard its market value.

Pilot Oven Reporting Requirements

Pilot Oven Test results including coal and coke quality data were officially requested but not provided. A detailed overview of the all 9 pilot oven tests, including 100% Seam carbonizations, Seam-blends carbonized and coal and coke quality data, Coking pressures and Coke Contraction, which (ALS) Pilot ovens were used (Pilot Oven design, size, charge weight and carbonization conditions) is required to give more certainty. Since the carbonized bulk samples are from a specific sampling area, their representative nature for the total Resource should be carefully assessed.

Review of other Clean Coal attributes not mentioned above:

- Essential information such as Mineral Ash Analysis, Dilatation, complete Petrography (Vitrinite, Semifusinite content and the nature of Inerts) and Pilot Oven Carbonization results including Coke Cold Strength and CSR are not available.

- Blended Indicative Spec Ash is less than calculated, but can be achieved by washing the coal to lower ash, be it at a lower Product Tonnage Yield. Tonnage will be forgone, to be balanced against a higher product market value. Calculated Sulfur and Indicative Spec Sulfur are very close, no reason for concern; the same applies to the Rank R_{om}. Phos-content is low.

6e Coke and Coal Quality Statements in RPM's report, referring to abovementioned Pilot Oven Tests and Coal Testing

In Section 5.1 Coal Quality, page 20 of RPM Global's report of March 2019, the statements in the box below are made:

> Two bulk sampling programs have been undertaken to assess product quality and blending options; one at Hazen in August 2014 and further work with ALS in November 2014. As a result of the bulk sampling process sufficient material was available for carbonisation tests on a total of 7 blends, 2 from Hazen bulk sampling work and five from the ALS work. A further 2 check samples were subjected to carbonisation testing at ALS.
>
> The results show despite the variation in quality between the three seams particularly with regards to volatile content, ash, sulphur, phosphorus, fluidity and dilatation all 7 blends and the 2 checks produced a coking coal product that can be characterised as a Hard Coking Coal. The quality results of all blends exceeded a CSR of 60 (range 62 to 68) and CRI values in low to mid 20s, demonstrating that a hard coking coal similar to other Canadian hard coking coal products can be produced from a variety of blends from all three seam groups within the Grassy Mountain mining area.
>
> The carbonisation data demonstrates that despite Seam No.2 having low fluidity and minimal dilatation, blends containing up to 50% of Seam No.2 still maintained good carbonisation properties. This reflects a similar proportion to the Seam No.2 presence in the overall Resource.
>
> In general, the coal products blend from the seams demonstrate the following properties:
>
> - Low to moderate phosphorus;
> - Ash ranged from 8.4% to 9.7% ad;
> - Volatile content 22.9% to 23.9%,
> - Total sulphur 0.51% to 0.61%;
> - Uniform FSI (7 to 7.5);
> - Maximum fluidity varies from a low of 8 ddpm to a maximum of 145 ddpm;
> - Maximum dilatation varies from -16% to +20%;
> - Vitrinite content varied from 41% to 50%.
>
> The results demonstrate the Grassy Mountain coal to be medium volatile hard coking coal Resource with moderate in-seam ash. The carbonisation testing in particular, has demonstrated it will be possible to realise a hard coking product from Grassy Mountain with a widely variable blend consist of the three seams, thus simplifying the mine planning process.

Comments on the most important statements on Coal and Coke in the box above:

- Important attributes: Volatile Content: Indicative Spec is 23.5%, Rank R_{om} 1.18 – 1.20, Ash 9.0 – 9.5%.

- Ash Content: Indicative Spec is 9.0 – 9.5% Ash. Significantly lower ash-content, such as 8.4% Ash will reduce Coke Reactivity and therefore have a favourable impact on the CSR. Development, production and marketing of a potentially higher value Grassy Mountain product at e.g. 8.5% Ash content is not mentioned. This will reduce the Yield of washed Clean Coal to Raw Coal from the Pit. A balance between less product Tonnage but higher Market Value must be considered, including its impact in the project's profitability.

- Uniform FSI of 7 to 7.5: This is highly unlikely for a product containing only 16% Seam #1 at 7 FSI, combined with 83% FSI 5 Seam material. A high quality 100% Seam #1 clean coal sample could probably produce CSR 68 coke, but this seam is only 16% of Measured Resources. It is not clear if FSI 7 to 7.5 refers to the higher quality Product containing mostly Seam #1, produced separately from a lower quality product.

- Max. Fluidity varies from 8ddpm to a maximum of 145ddpm. At Grassy's coal Rank of R_{om} 1.20 max, a Fluidity of 8ddpm generally indicates weak Semi-Soft Coking Coal (FSI ~3) with considerably lower CSR and market value (referring to table E4, section 4a of this report). At this Rank, an Elk Valley Prime Hard Coking coal will typically be at 200ddpm, FSI 7.5.

- Maximum Dilatation varies from -16% to +20%. At Grassy's coal Rank of R_{om} 1.20 max, a Dilatation of -16% indicates virtually no expansion in the dilatometer after max. contraction, generally indicating a weak Semi Soft Coking Coal (referring to Table E4). At this Rank, an Elk Valley Prime Hard Coking coal will typically be at +25% Max. Dilatation.

- Vitrinite content at the high end is good of the range at 50%, although 4% to 7% lower to comparable Rank Elk Valley Coals. However, 41% Vitrinite generally indicates a weak, Semi-Soft Coking Coal of considerably lower market value.

Concluding, based on the above assessment, and available information:

- RPM's report claims a high Blend flexibility with regard to Seam-blend ratios. However, the fact that the higher Rheology and Vitrinite Seam #1 (Riversdale August 2016 report, Section B.4.2. page 25) is only 16% of the Measured Resource will demand very diligent management of this precious resource, including assiduous in-pit sampling and quality management during production as mentioned in Section 6d of this Expert Report. There is probably some flexibility in the blending ratios between Seams #2 and #4 but Seam #1 has to lift the blend's coking capability to increase its value. This is likely to give little flexibility with regard to the Blend's Seam#1 content to consistently hit the coke CSR 65 target. A binary blend consisting of exclusively Seam#2 and Seam#4 is unlikely to consistently achieve a coke CSR 65.

- The significant quality difference between Seam #1 versus the Seams #2 and #4 with regard to Rheology (Fluidity, Dilatation, FSI) and the variability within the individual Seams is a given. Producing a product, consistently achieving the Resources' ideal Seam-Blend proportions to consistently achieve CSR 65 can be expected to be operationally challenging to say the least. Therefore, it is reasonable to expect Grassy to develop and market a higher quality and a lower quality product.

- This product-split would be its "flagship" product targeting CSR 65, plus a lower quality Coking Coal product, possibly in the Range CSR 55-63. This seems to be already indicated in the Rheology and Vitrinite ranges reviewed above. This practice would also help guarantee the quality of its "flagship" product. As stated, many customers, including Japan highly value consistent shipment values for Fluidity to help optimize the less costly weaker coal content in their blends.

- A study is recommended to determine the blend-ratios and produced Tonnage for the higher-value Hard Coking Coal product versus the lower value Semi-Hard Coking Coal and a possibly Semi-Soft Coking Coal product. Which Rheology and CSR levels would these products have, what would their market value be versus production costs, important to the project's economic viability. This ratio is likely to shift over the mine's 23-25 year operational lifespan. It is very common for mining operations to produce more than one product for the reasons stated above.

- The number of 9 Pilot Oven tests for a mine and deposit this size is too limited (also referring to pilot oven reporting requirements, section 6d). Additional carbonizations of bulk samples from at least one other part of the deposit are recommended. Ultimately, carbonizations of Grassy Mountain's clean coking coal products in international blends is important to assess its compatibility on these blends, especially in combination with weaker coking coals**. The next step would be sending 500-1000kg samples to customers for their Pilot Oven carbonization tests, pure and in their blends to assess the products' value for the customers. This needs to be done before mine construction commences and is important to assess the product's market value from the customers' perspective.**

7. GRASSY MOUNTAIN'S CLEAN COAL PRODUCT MARKET VALUE

7a. Benchmarking Grassy Mountain's 65 CSR Target Product

In Section 6 above, Grassy Mountain's Clean Coal Product quality and technical merits were reviewed. Based on the publicly available information provided by Riversdale's quoted publications, there is uncertainty based on inconsistencies and conflicting and incomplete quality information.

The Indicative Product Specification's Clean Coal target coke quality is CSR 65. From the available information, it is likely Grassy Mountain will produce at least two marketable products, which is very common in industry to assure the quality of the mine's top-product and create a measure of product diversification in the market. In practice the producer will balance the Quality, Market value and Tonnage of the products to optimize revenue, within the possibilities and constraints of the coal resources, taking operating ad production costs, including the cost of environmental mitigation and reclamation into account.

Atrum Coal's, ELAN project Scoping Study[13], of April 2020 shows a comparison of Elan's projected product quality versus the Platts Index, Elk Valley Premium and Grassy Mountain's CSR 65 product, as presented in the table below:

	Elan Project (Atrum) (ad basis)	Elk Valley (Teck Premium)[1]	Grassy Mount. (Riversdale)[2]	Platts Premium Low Vol Index[3]	Platts Peak Downs Index[3]
CSR	**69 – 71**	70	65	71	74
Coal Rank R_oMax (%)	**1.16 – 1.20**	1.14	1.18 - 1.20	1.35	1.42
Yield (%)	**60**	(est 60 – 70)	55	-	-
Ash Content (%)	**8 - 9**	8.8	9 - 9.5	9.3	10.5
Volatile Matter (%)	**22 – 26**	25.5	23.5	21.5	20.7
Total Moisture (%)	**10**	10	10	9.7	9.5
Total Sulphur (%)	**~ 0.60**	0.65 – 0.70	0.50	0.50	0.60
Phosphorus (%)	**< 0.050**	0.075	0.040	0.045	0.03
CSN	**7 - 8**	7.5	-	8	8.5
Fluidity (ddpm)	**100 – 300**	200 – 500	150	500	400

1 S&P Global Platts Coal Trader International (pg8), 3 August 2018.
2 Riversdale Resources Targets Statement, Grassy Mountain Technical Report by RPM Global (pg21), 28 March, 2019.
3 S&P Global Platts. Specifications Guide, Metallurgical Coal, April 2020.

Comments to the above table:

- According to Platt's and IHS' Indexing, the Australian Peak Downs, Elk Valley's Premium and Elan's products are all Prime Hard Coking Coals. Grassy Mountain's CSR 65 product falls short of this Benchmark. For international Cokemakers, Grassy Mountain's product would be still be seen as a Hard Coking Coal, but of lower value, as explained in Section 4 of this Expert Report, referring to the 2018 Platts indexing "Hard Coking Coal 64", CSR Range 64 – 67, table E4.

- Elk Valley Premium at CSR 70, of slightly higher Rom and similar Volatile Matter as compared to Grassy Mountain's Seam #1, with Vol. Matter 25.4, Vitrinite R_{om} 1.10. Elk Valley's Premium's value is close to Elk Valley Standard's (CSR 70-71) value. Elk Valley Standard's Volatile Matter Content 23.5% and Vitrinite Rank Rom 1.20 is similar to Grassy Mountain's Seam #4, Vol. Matter 23.8, Rom 1.18. Yet both Elk Valley products produce stronger coke. Elk Valley Standard's Max. Fluidity often exceeds its 200ddpm Spec. The customer's choice between Elk Valley Premium and Elk Valley Standard will depend on the other Coking Coals in his blend.

- Grassy Mountain's Yield, the Clean Product Coal to Raw Mined Coal before washplant cleaning is 55% (as per RPM's March 2019 report page 20), at least 5% below the Elk Valley. This implies a cost disadvantage to Grassy Mountain.

[13] Atrum Coal, Elan Scoping Study, Investor Presentation, slide 27, dated April 2020
http://www.atrumcoal.com/wp-content/uploads/2020/04/ATU_Investor-Presentation.pdf

7b. Grassy Mountain's Coal Products' Potential Long-Term Market Value

As per sections 1e and 1f of this Expert Report, based on US$ FOB, Dalrymple Bay Terminal, Queensland, the following was projected:

As of the end of July 2020, expert consensus (including Wood Mackenzie) for the long term Prime Hard Coking Coal pricing ranged from:

- **Platts TSI PHCC CSR 71 – 74: US$130 to US$150 FOB maximum for the upside.**

Referring to Table E1 above, and using the relativity HCC/PHCC pricing of 82% for the long term Hard Coking Coal pricing:

- **Platts TSI HCC CSR 62: US$107 to US$123 FOB maximum for the upside.**

Historically, Canadian Coking Coal at times sells up to a **3% discount** to comparable Australian Coking Coal, mainly due to the cost of longer Seaborne transportation distances to some of the key markets. During shortages, price parity will be achieved, especially on the spot market.

Grassy Mountain Product's Long-Term Market Value Projection:

- The above assessment concludes that although Grassy Mountain is capable of producing the target CSR 65 product, simultaneous production of a lower quality and lower value product, possibly in the range of CSR 55 to 63 or some lower CSR Tonnage is more likely (possibly for the PCI market). This will help mitigate the differences in seam quality and quality variability within the seams to guarantee the "flagship" product's quality.

- Production of this lower CSR and lower value product will be required to optimize utilization of the limited amount of the highest quality Seam #1 (only 16% of Measured Resources) to stabilize Grassy Mountain's prime quality Hard Coking Coal Product from cargo to cargo and over time.

- This more likely 2-product scenario has not been published; it is unclear to which level this possibility has been studied. Published Information lacks the level of detail required for the public to make this assessment. Important is to ascertain is the tonnage-split between Grassy Mountains' products and their respective tonnages, qualities and market values.

- **Together with the resources' quality variability and inconsistencies in the published information, there is significant uncertainty to determine the value of Grassy Mountain's product suite considering the tonnage split between the higher value and lower value products.**

- **Grassy Mountain's product pricing will be established by negotiations between Grassy Mountain's Marketers and the Customers' purchasing departments, referring to the current Benchmark qualities and pricing. The market value is likely to be determined on a sliding scale from the S&P Global Platts CSR 62 and CSR 64 index, which is below the S&P Global Platts Premium Hard Coking Coal Price Index (CSR 71-74).**

ATTACHMENT LISTING

Attachment ER1: Australian Coking Coal (Platts) Low Vol Futures Quotes July 30, 2020

Attachment ER2: IHS Markit Coking Coal marker price Methodology and Specifications, effective December 2019

Attachment ER3: S&P Global Platts, Global Metallurgical Coal, Specifications Guide of June 2020

Attachment ER4: Riversdale Resources, Grassy Mountain Coal Project – Updated Environmental Impact Assessment, Section B Geology and Geotechnical, Seam Wash Quality Maps August 2016

Attachment ER5: Clean Coal Product Seam Blends During Mine Life (CJK August 19, 2020)

Attachment ER6: Grassy Mountain Seam and Product Quality Calculation Sheet (CJK August 6, 2020)

ATTACHMENT ER1

Australian Coking Coal (Platts) Low Vol Futures Quotes

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MONTH	CHARTS	LAST	CHANGE	PRIOR SETTLE	OPEN	HIGH	LOW	VOLUME	UPDATED
JUL 2020		-	-	111.00	-	-	-	0	16:45:00 CT 30 Jul 2020
AUG 2020		-	-	115.00	-	-	-	0	16:45:01 CT 30 Jul 2020
SEP 2020		-	-	119.00	-	-	-	0	16:45:42 CT 30 Jul 2020
OCT 2020		-	-	132.00	-	-	-	0	16:45:39 CT 30 Jul 2020
NOV 2020		-	-	132.00	-	-	-	0	16:45:00 CT 30 Jul 2020
DEC 2020		-	-	132.00	-	-	-	0	16:45:00 CT 30 Jul 2020
JAN 2021		-	-	139.00	-	-	-	0	16:45:45 CT 30 Jul 2020
FEB 2021		-	-	139.00	-	-	-	0	16:45:00 CT 30 Jul 2020
MAR 2021		-	-	139.00	-	-	-	0	16:45:46 CT 30 Jul 2020
APR 2021		-	-	138.33	-	-	-	0	16:45:22 CT 30 Jul 2020
MAY 2021		-	-	138.33	-	-	-	0	16:45:00 CT 30 Jul 2020
JUN 2021		-	-	138.33	-	-	-	0	16:45:00 CT 30 Jul 2020
JUL 2021		-	-	138.33	-	-	-	0	16:45:13 CT 30 Jul 2020
AUG 2021		-	-	138.33	-	-	-	0	16:45:40 CT 30 Jul 2020
SEP 2021		-	-	138.33	-	-	-	0	16:45:00 CT 30 Jul 2020

Legend: OPT Options Price Chart About This Report

MONTH	CHARTS	LAST	CHANGE	PRIOR SETTLE	OPEN	HIGH	LOW	VOLUME	UPDATED
OCT 2021		-	-	138.33	-	-	-	0	16:45:06 CT 30 Jul 2020
NOV 2021		-	-	138.33	-	-	-	0	16:45:01 CT 30 Jul 2020
DEC 2021		-	-	138.33	-	-	-	0	16:45:00 CT 30 Jul 2020
JAN 2022		-	-	139.00	-	-	-	0	16:45:32 CT 30 Jul 2020
FEB 2022		-	-	139.00	-	-	-	0	16:45:08 CT 30 Jul 2020
MAR 2022		-	-	139.00	-	-	-	0	16:45:49 CT 30 Jul 2020
APR 2022		-	-	139.00	-	-	-	0	16:45:29 CT 30 Jul 2020
MAY 2022		-	-	139.00	-	-	-	0	16:45:00 CT 30 Jul 2020
JUN 2022		-	-	139.00	-	-	-	0	16:45:51 CT 30 Jul 2020
JUL 2022		-	-	139.00	-	-	-	0	16:45:00 CT 30 Jul 2020
AUG 2022		-	-	139.00	-	-	-	0	16:45:46 CT 30 Jul 2020
SEP 2022		-	-	139.00	-	-	-	0	16:45:00 CT 30 Jul 2020
OCT 2022		-	-	139.00	-	-	-	0	16:45:01 CT 30 Jul 2020
NOV 2022		-	-	139.00	-	-	-	0	16:45:21 CT 30 Jul 2020
DEC 2022		-	-	139.00	-	-	-	0	16:45:00 CT 30 Jul 2020
JAN 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
FEB 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
MAR 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
APR 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
MAY 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
JUN 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
JUL 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
AUG 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
SEP 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
OCT 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
NOV 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020
DEC 2023		-	-	135.00	-	-	-	0	16:45:00 CT 30 Jul 2020

Legend: OPT Options Price Chart ? About This Report

CPAWS
54

Coking coal marker price

ATTACHMENT ER2

Methodology and specifications

Effective December 2019

Extract from pages 12, 13 and 16

The monthly average of the weekly Asian markers are compiled from markers published on each and every Friday within the calendar month or, in the event of a Singapore public holiday on the Friday, the weekly markers published on the preceding working day.

The monthly average of the weekly Atlantic markers are compiled on and published on each and every Friday within the calendar month or, in the event of a Singapore public holiday on the Friday, the weekly markers are published on the preceding working day.

Daily coking coal markers

MCC1 Australian FOB low-vol PHCC

IHS Markit publishes a daily marker assessing the price of high quality low-volatile prime hard coking coal being loaded into vessels at the main East Coast Australian ports. Prices are assessed on a Free on Board (FOB) basis. IHS Markit will use its in-house mathematical model to normalize market price data inputs to the specifications shown below:

- CSR: 71 (70 min)
- Volatile Matter (ad): 20% (21.5% max)
- Max Fluidity: 180 ddpm
- Total moisture (ar): 10%
- Ash (ad): 10% (11% max)
- Sulphur (ad): 0.55% (0.8% max)
- Phosphorus (ad): 0.05%
- Vitrinite: 65%
- CSN: 9

The minimum cargo size is 25,000 t – though smaller parcels of a minimum 12,500 t may be considered, if there is a lack of evidential transactional data and the deals are logical and validated.

MCC2 Australian FOB mid-vol PHCC

IHS Markit publishes a daily marker assessing the price of high quality mid-volatile, high fluidity, prime hard coking coal being loaded into vessels at the main East Coast Australian ports. Prices are separately assessed on a Free on Board (FOB) basis. IHS Markit will use its in-house mathematical model to normalize market price data inputs to the specifications shown below:

- CSR: 68 (67 min)
- Max fluidity: 1,000 ddpm
- Volatile matter (ad): 22.5% (21.5%-25%)
- Ash (ad): 9.5% (11% max)
- Sulphur (ad): 0.5% (0.8% max)
- Total moisture (ar): 10%
- Phosphorus (ad): 0.04%
- Vitrinite: 63%
- CSN: 8.5

The minimum cargo size is 25,000 t – though smaller parcels of a minimum 12,500 t may be considered, if there is a lack of evidential transactional data and the deals are logical and validated.

IHS Markit | Coking coal marker price - Methodology and specifications

MCC3 Australian FOB second-tier HCC

IHS Markit publishes a daily Australian "second-tier" hard coking coal FOB marker, which assesses the price of a basket of Australian brands loaded into vessels at the main East Coast Australian ports. IHS Markit will use its in-house mathematical model to normalize market price data inputs to the specifications shown below:

- CSR: 62 (min 55)
- Max fluidity: 120 ddpm
- Volatile matter (ad): 21.5% (19%-28%)
- Ash (ad): 8% (10% max)
- Sulphur (ad): 0.4%
- Total moisture (ar): 11%
- Phosphorus (ad): 0.07%
- Vitrinite: 50%

The minimum cargo size is 25,000 t – though smaller parcels of a minimum 12,500 t may be considered, if there is a lack of evidential transactional data and the deals are logical and validated.

From page 16, IHS Report Effective December 2019

Australian FOB semi-soft coking coal

IHS Markit publishes a weekly FOB marker assessing the price of Australian semi-soft coking coals being loaded into vessels at the main East Coast Australian ports adhering to the following specifications:

- Fixed Carbon: 51-54%
- CSN: 5-6
- Volatile Matter (ad): 33-35%
- Fluidity: 150-500ddpm
- Total moisture (ar): <9.5%
- Ash (ad): 9-10%
- Sulphur (ad): <0.6%
- Phosphorous (ad): <0.025%

Australian FOB low-vol PCI

IHS Markit publishes a weekly marker assessing the price of low-volatile matter PCI being loaded into vessels at the main East Coast Australian ports. Prices are assessed on a Free on Board (FOB).

The marker is defined by the following typical specifications:

- Energy: 7,400 kc GAD (min)
- Volatile Matter (ad): 18% max
- Total Moisture (ar): 10% max
- Ash (ad): 8-10%
- Sulphur (ad): 0.65% max

https://cdn.ihs.com/Coal-Methodology/IHS-Energy-coking-coal-methodology.pdf

Specifications Guide
Global Metallurgical Coal

ATTACHMENT ER3

S&P Global
Platts

Latest update: June 2020

SEABORNE HARD COKING COAL

Extract from Page 3

Assessment	CODE	Mavg	Wavg	Rolling month	Type	Published	Page	Quality	Quantity	Incoterms	Location	Timing	Payment	UOM
Australia														
HCC Peak Downs FOB Australia	HCCGA00	HCCGA03			Assessment	Daily	205	74% CSR, 20.7% VM, 9.5% TM, 10.5% ash, 0.6% sulfur, 0.03% phosphorus, 400 ddmp max fluidity, 8.5 CSN, 71% vitrinite, 1.42% Ro Max, particle size 50 mm max	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	$/mt
Premium Low Vol HCC FOB Australia	PLVHA00	PLVHA03			Assessment	Daily	205	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm max fluidity, 65% vitrinite	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	$/mt
TSI Premium Hard Coking Coal Australia Export FOB East Coast Port	TS01034	TSMBH03		TSMBV03	Index	Daily	205	71% CSR, 21% VM, 10% TM, 10% ash, 0.45% sulfur, 0.05% phosphorus, 600 ddpm fluidity, 68% vitrinite, 1.35% Rvmax, FSI 8, totdal dilatation 80%, paricle size below 55 mm for at least 90% of the cargo	Min 15,000 mt	FOB	East Coast Port, Australia	Loading 7-60 days forward	L/C at sight	$/mt
Hard Coking Coal FOB Australia	HCCAU00	HCCAU03	HCCAU04		Assessment	Daily	205	62% CSR, 21.5% VM, 10.5% TM, 8% ash, 0.45% sulfur, 0.06% phosphorus, 100 ddpm max fluidity, 52% vitrinite	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	$/mt
TSI Hard Coking Coal Australia Export FOB East Coast Port	TS01035	TSMBI03			Calculation	Daily	205	62% CSR, 21.5% VM, 10.5% TM, 8% ash, 0.45% sulfur, 0.06% phosphorus, 100 ddpm max fluidity, 52% vitrinite	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	$/mt
HCC Peak Downs FOB Australia (China Netback)	HCCGD00				Calculation	Daily	205	74% CSR, 20.7% VM, 9.5% TM, 10.5% ash, 0.6% sulfur, 0.03% phosphorus, 400 ddmp max fluidity, 8.5 CSN, 71% vitrinite, 1.42% Ro Max, particle size 50 mm max	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	$/mt
Prem Low Vol HCC FOB Australia (China Netback)	PLVHD00				Calculation	Daily	205	71% CSR, 21.5% VM, 9.7% TM, 9.3% ash, 0.5% sulfur, 0.045% phosphorus, 500 ddpm max fluidity, 65% vitrinite	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	$/mt

SEMI-SOFT COKING COAL

Extract from Page 10

Assessment	CODE	Mavg	Type	Published	Page	Quality	Quantity	Incoterms	Location	Timing	Payment	UOM
Semi Soft FOB Australia	MCSSA00	MCSSA03	Assessment	Daily	205	34% VM, 9.5% TM, 9.25% ash, 0.58% sulfur, 0.025% phosphorus, 53% fixed carbon, 200 ddpm max fluidity, 5.5 CSN	Min 10,000 mt	FOB	Hay Point, Australia	Loading 7-45 days forward	L/C at sight	$/mt
Semi Soft CFR China	MCSSC00	MCSSC03	Assessment	Daily	205	34% VM, 9.5% TM, 9.25% ash, 0.58% sulfur, 0.025% phosphorus, 53% fixed carbon, 200 ddpm max fluidity, 5.5 CSN	Min 10,000 mt	CFR	Qingdao, China	Delivered 20-65 days forward	L/C at sight	$/mt
Semi Soft CFR India	MCSSI00	MCSSI03	Calculation	Daily	205	34% VM, 9.5% TM, 9.25% ash, 0.58% sulfur, 0.025% phosphorus, 53% fixed carbon, 200 ddpm max fluidity, 5.5 CSN	Min 10,000 mt	CFR	Paradip, India	Delivered 22-65 days forward	L/C at sight	$/mt

https://www.spglobal.com/platts/plattscontent/_assets/_files/en/our-methodology/methodology-specifications/global_metcoal.pdf

ATTACHMENT ER4

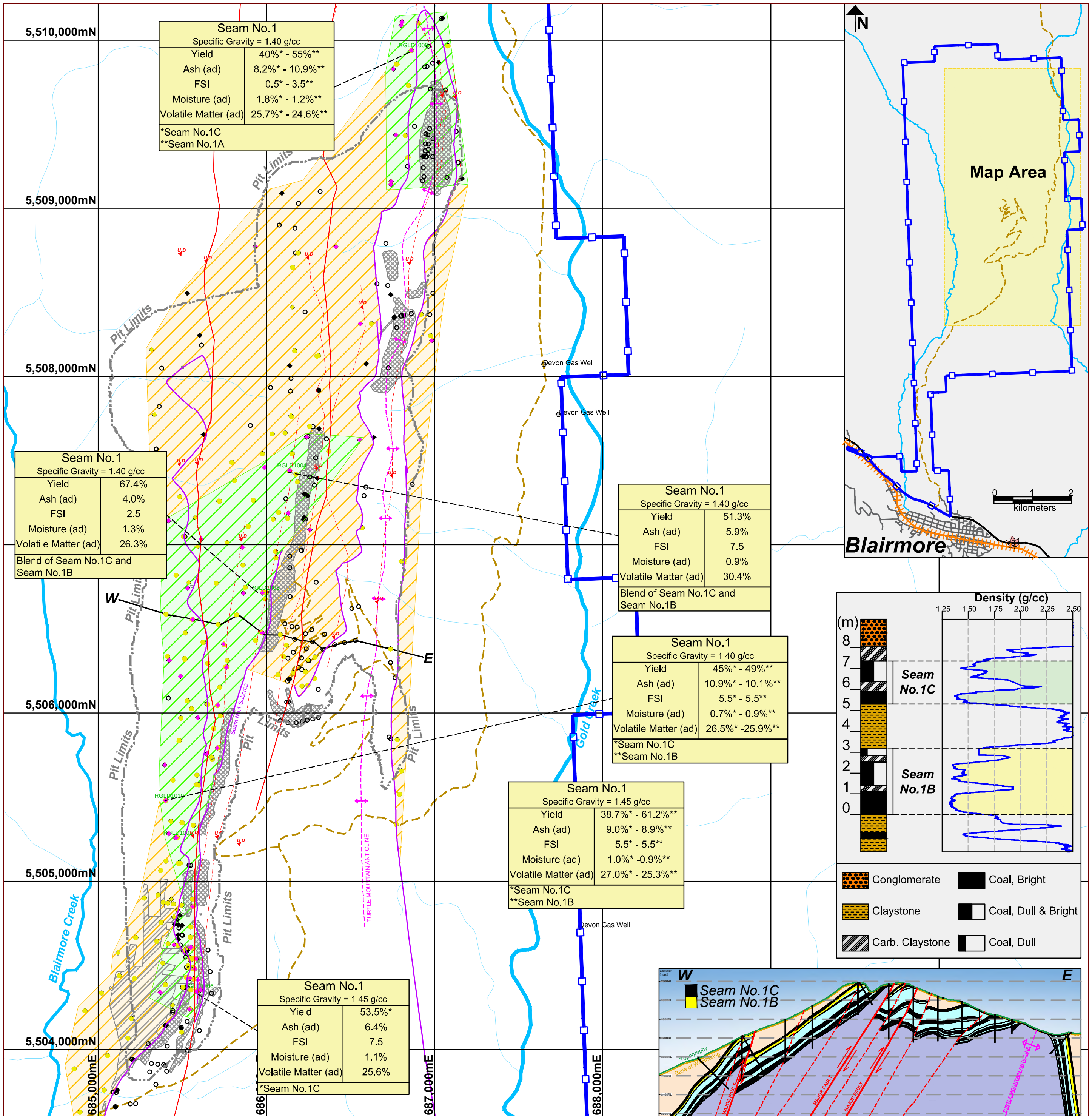
RIVERSDALE RESOURCES

Section B

Geology and Geotechnical

August 2016

Geotechnical Seam Wash Quality Maps



LEGEND

SURFACE FEATURES
- WATERCOURSE
- ACCESS ROAD
- FAULT (MINOR) (AT SEAM NO.1 LEVEL)
- FAULT (MAJOR) (AT SEAM NO.1 LEVEL)
- ANTICLINE
- SEAM NO. 1 SUBCROP

HISTORICAL MINES*
- SURFACE
- UNDERGROUND

* SEAM NO. 1 & SEAM NO. 2

LAND OWNERSHIP
- PROPOSED MINE PERMIT BOUNDARY

DRILL HOLE
- CORED HOLE
- OPEN HOLE

DRILL HOLE INTERSECTING SEAM NO.1
- CORED HOLE
- OPEN HOLE
- SEAM NO.1 RAW ANALYSIS

CONFIDENCE LEVEL
- GOOD
- MODERATE

NOTE(S)
1. ALL DEPTH, ELEVATION AND THICKNESS VALUES IN METERS
2. ALL QUALITY AT 1.40 G/CC EXCEPT RGLD1001 (1.45 G/CC)
3. COAL QUALITY RESULTS FROM ALS VANCOUVER LAB
4. WASHED COAL RESULTS DISPLAYED IN AREA OF GOOD CONFIDENCE. RAW COAL DATA AVAILABLE AT ALL HIGHLIGHTED LOCATIONS IN AREAS OF GOOD AND MODERATE CONFIDENCE

REFERENCE(S)
- DATUM/PROJECTION: UTM NAD 83 ZONE 11
- MINING LEASE BOUNDARIES PROVIDED BY MILLENNIUM EMS SOLUTIONS (MEMS)
- WATERCOURSE MAP PROVIDED BY MILLENNIUM EMS SOLUTIONS (MEMS)

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

Seam 1 Wash Quality

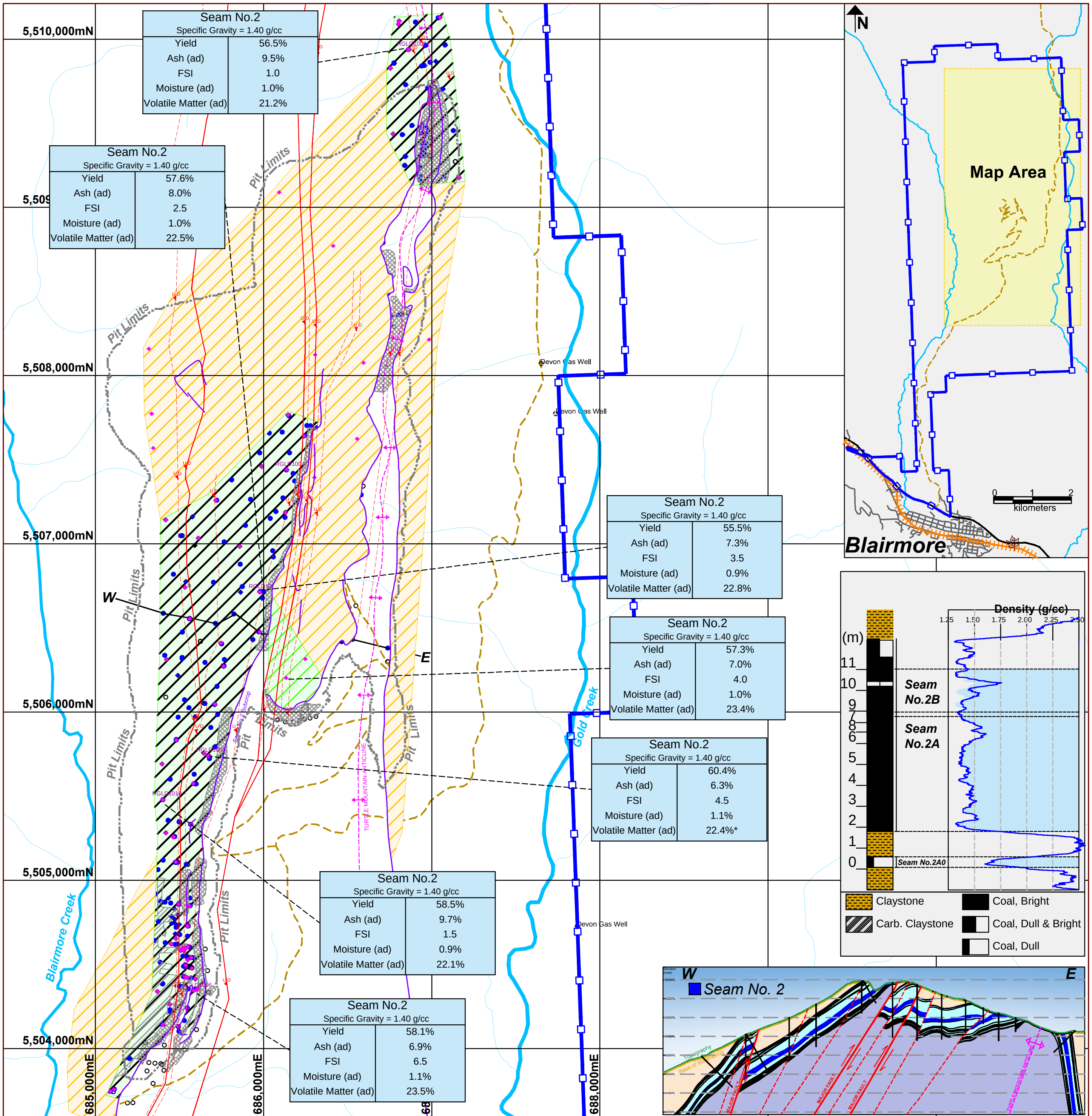
NOTES

Original figure from McElroy Bryan Geological Services
Datum/Projection: UTM NAD 83 Zone 11

0 400 800 1600
Metres

PROJECT: 14-00201-01
DRAWN BY: RS/SL
CHECKED BY: JM/CP
DATE: JUNE 14, 2016

FIGURE
B.2.1-3



LEGEND

SURFACE FEATURES
- WATERCOURSE
- ACCESS ROAD
- FAULT (MINOR) (AT SEAM NO.2 LEVEL)
- FAULT (MAJOR) (AT SEAM NO.2 LEVEL)
- ANTICLINE
- SEAM NO. 2 SUBCROP

HISTORICAL MINES*
- SURFACE
- UNDERGROUND

* SEAM NO. 1 & SEAM NO. 2

LAND OWNERSHIP
- PROPOSED MINE PERMIT BOUNDARY

DRILL HOLE
- CORED HOLE
- OPEN HOLE

DRILL HOLE INTERSECTING SEAM NO.2
- CORED HOLE
- OPEN HOLE
- SEAM NO.2 RAW ANALYSIS

CONFIDENCE LEVEL
- GOOD
- MODERATE

NOTE(S)
1. ALL DEPTH, ELEVATION AND THICKNESS VALUES IN METERS
2. ALL QUALITY AT 1.40 G/CC EXCEPT RGLD1001 (1.45 G/CC)
3. COAL QUALITY RESULTS FROM ALS VANCOUVER LAB
4. WASHED COAL RESULTS DISPLAYED IN AREA OF GOOD CONFIDENCE. RAW COAL DATA AVAILABLE AT ALL HIGHLIGHTED LOCATIONS IN AREAS OF GOOD AND MODERATE CONFIDENCE

REFERENCE(S)
- DATUM/PROJECTION: UTM NAD 83 ZONE 11
- MINING LEASE BOUNDARIES PROVIDED BY MILLENNIUM EMS SOLUTIONS (MEMS)
- WATERCOURSE MAP PROVIDED BY MILLENNIUM EMS SOLUTIONS (MEMS)

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

SEAM 2 WASH QUALITY

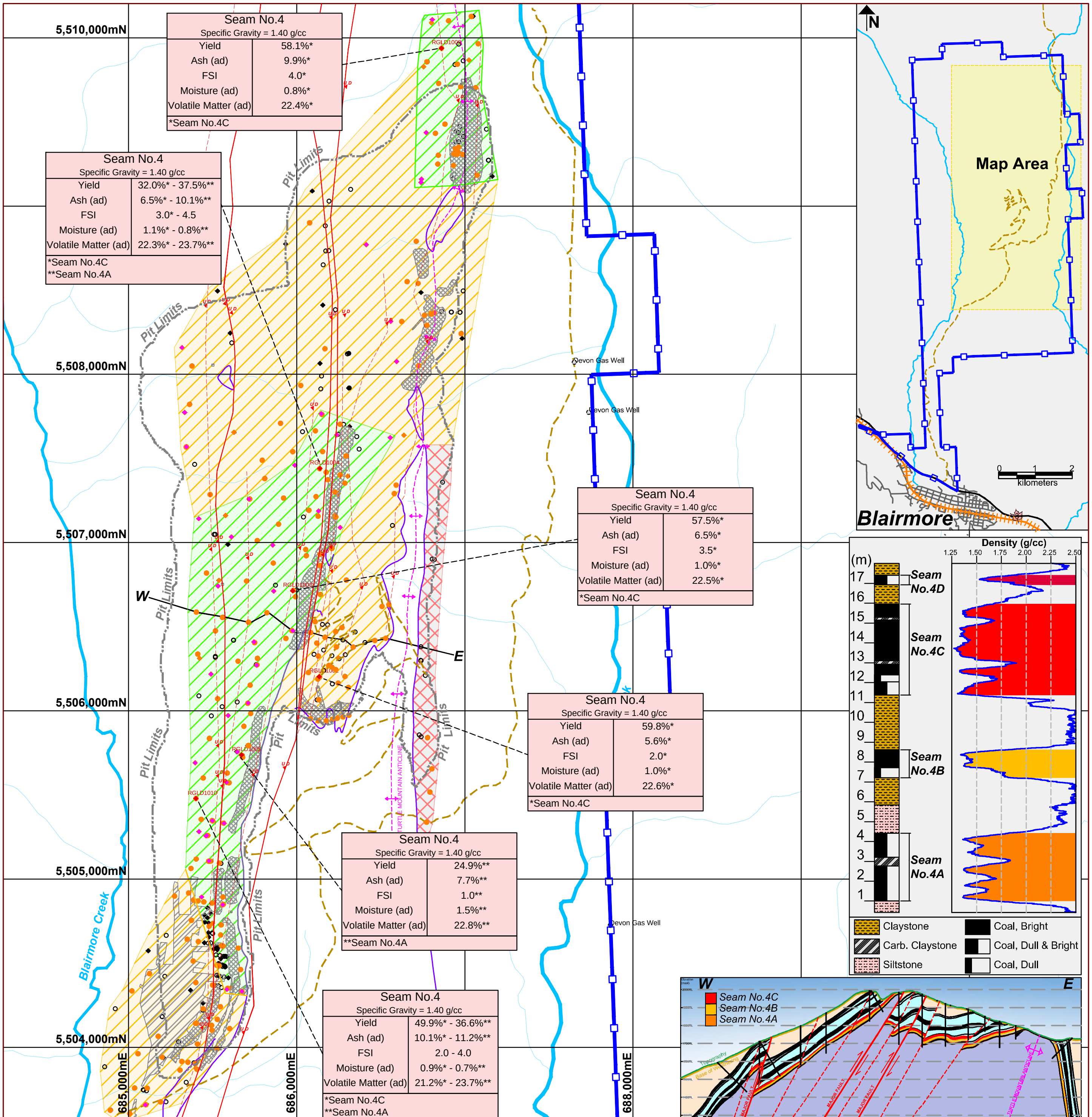
NOTES

Original figure from McElroy Bryan Geological Services
Datum/Projection: UTM NAD 83 Zone 11

0 400 800 1600
Metres

PROJECT: 14-00201-01
DRAWN BY: RS/SL
CHECKED BY: JM/CP
DATE: JUNE 14, 2016

FIGURE
B.2.2-2



LEGEND

SURFACE FEATURES
- WATERCOURSE
- ACCESS ROAD
- FAULT (MINOR) (AT SEAM NO.4 LEVEL)
- FAULT (MAJOR) (AT SEAM NO.4 LEVEL)
- ANTICLINE
- SEAM NO. 4 SUBCROP

HISTORICAL MINES*
- SURFACE
- UNDERGROUND

* SEAM NO. 1 & SEAM NO. 2

LAND OWNERSHIP
- PROPOSED MINE PERMIT BOUNDARY

DRILL HOLE
- CORED HOLE
- OPEN HOLE

DRILL HOLE INTERSECTING SEAM NO.4
- CORED HOLE
- OPEN HOLE
- SEAM NO.4 RAW ANALYSIS

CONFIDENCE LEVEL
- GOOD
- MODERATE
- LOW

NOTE(S)
1. ALL DEPTH, ELEVATION AND THICKNESS VALUES IN METERS
2. ALL QUALITY AT 1.40 G/CC EXCEPT RGLD1001 (1.45 G/CC)
3. COAL QUALITY RESULTS FROM ALS VANCOUVER LAB
4. WASHED COAL RESULTS DISPLAYED IN AREA OF GOOD CONFIDENCE. RAW COAL DATA AVAILABLE AT ALL HIGHLIGHTED LOCATIONS IN AREAS OF GOOD AND MODERATE CONFIDENCE

REFERENCE(S)
- DATUM/PROJECTION: UTM NAD 83 ZONE 11
- MINING LEASE BOUNDARIES PROVIDED BY MILLENNIUM EMS SOLUTIONS (MEMS)
- WATERCOURSE MAP PROVIDED BY MILLENNIUM EMS SOLUTIONS (MEMS)

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

SEAM 4 WASH QUALITY

NOTES

Original figure from McElroy Bryan Geological Services
Datum/Projection: UTM NAD 83 Zone 11

0 400 800 1600
Metres

PROJECT: 14-00201-01
DRAWN BY: RS/SL
CHECKED BY: JM/CP
DATE: JUNE 14, 2016

FIGURE

B.2.3-4

CPAWS
60

CLEAN COAL PRODUCT SEAM BLENDS DURING MINE LIFE

Date: 19Aug20

Table C.1.3-1 as reported in Riversdale Project Description Section C, Page C-22, of August 2016:

Table C.1.3-1 Mine Plan Production Statistics

Description	Year -1 (2018)	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)	Year 8 (2026)	Year 9 (2027)	Years 10-14 ('28-'32)	Years 15-19 ('33-'37)	Years 20-23 ('38-'41)	Total
ROM COAL (5% TM)														
Total ROM Coal Tonnes (000s RMT)	63	3,625	6,333	7,632	8,008	8,008	8,009	8,008	8,136	8,260	39,253	34,500	27,774	167,609
Ash (%) @ 5% Moisture	33%	33%	33%	34%	33%	32%	32%	32%	33%	33%	32%	32%	32%	32%
PRODUCT COAL (10% TM)														
1-Seam Coal Tonnes (000s CMT)	22	591	639	723	1,077	822	707	644	758	757	1,848	411	1,317	**10,316**
2-Seam Coal Tonnes (000s CMT)	6	786	1,873	1,944	2,574	2,342	2,272	2,133	2,429	2,544	11,092	9,566	7,869	**47,430**
4-Seam Coal Tonnes (000s CMT)	8	534	891	1,443	801	1,339	1,455	1,648	1,347	1,405	8,882	8,921	6,191	**34,865**
Total Product Tonnes (000s CMT)	**35**	**1,911**	**3,403**	**4,111**	**4,452**	**4,503**	**4,435**	**4,425**	**4,534**	**4,706**	**21,820**	**18,899**	**15,378**	**92,612**
Air Dry Ash (%) @ 1% Moisture	9.6	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
Plant Yield (%)	56%	53%	54%	54%	56%	56%	55%	55%	56%	57%	56%	55%	55%	55%
STRIPPING VOLUME														
Prime Stripping (000s BCM)	1,319	20,237	21,263	26,228	36,592	33,568	37,010	41,416	41,278	40,321	209,722	221,597	102,903	833,454
Rehandle (000s BCM)	33	506	532	656	915	839	925	1,035	1,032	1,008	5,243	5,541	2,572	20,837
Total Effective Stripping (000s BCM)	**1,352**	**20,743**	**21,795**	**26,884**	**37,507**	**34,408**	**37,935**	**42,451**	**42,310**	**41,329**	**214,964**	**227,138**	**105,476**	**854,292**
STRIPPING RATIO														
Prime Stripping Ratio (BCM/RMT)	20.8	5.6	3.4	3.4	4.6	4.2	4.6	5.2	5.1	4.9	5.3	6.4	3.7	5.0
Effective Stripping Ratio (BCM/RMT)	21.3	5.7	3.4	3.5	4.7	4.3	4.7	5.3	5.2	5	5.5	6.6	3.8	5.1
Product Stripping Ratio (eff. BCM/CMT)	38.8	10.9	6.4	6.5	8.4	7.6	8.6	9.6	9.3	8.8	9.9	12.0	6.9	9.2

Table E7 CLEAN PRODUCT COAL	Year -1 (2018)	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)	Year 8 (2026)	Year 9 (2027)	Years 10-14 ('28-'32)	Years 15-19 ('33-'37)	Years 20-23 ('38-'41)	Total	Measured Resources
PRODUCT COAL (10% TM)															mln Tonnes
1-Seam Coal Tonnes (000s CMT)	22	591	639	723	1,077	822	707	644	758	757	1,848	411	1,317	**10,316**	**14.5**
2-Seam Coal Tonnes (000s CMT)	6	786	1,873	1,944	2,574	2,342	2,272	2,133	2,429	2,544	11,092	9,566	7,869	**47,430**	**41.0**
4-Seam Coal Tonnes (000s CMT)	8	534	891	1,443	801	1,339	1,455	1,648	1,347	1,405	8,882	8,921	6,191	**34,865**	**32.8**
Total Product Tonnes (000s CMT)	**35**	**1,911**	**3,403**	**4,111**	**4,452**	**4,503**	**4,435**	**4,425**	**4,534**	**4,706**	**21,820**	**18,899**	**15,378**	**92,612**	**88.3**
1-Seam Coal Tonnes %	63%	31%	19%	18%	24%	18%	16%	15%	17%	16%	8%	2%	9%	11%	16.4%
2-Seam Coal Tonnes %	17%	41%	55%	47%	58%	52%	51%	48%	54%	54%	51%	51%	51%	51%	46.4%
4-Seam Coal Tonnes %	23%	28%	26%	35%	18%	30%	33%	37%	30%	30%	41%	47%	40%	38%	37.1%
Total Product Tonnes %	**103%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100.0%**

Notes to the above Table E7

- Clean Product Coal produced Tonnage projection is approx. 5% over Measured Resources, most allocated to Seams #2 and #4, probably due to conversion estimate Resources to Clean Coal Product and possibly including some Indicated & Inferred Resources.
- Table C.1.3-1 seam blends were generated using mine and product planning modelling tools. During actual production, Seam accessibility and release are important factors.
- The over-all Measured Resource Seam-composition is 16% Seam#1 / 46% Seam#2 / 37% Seam#4. The clean coal product Spec appears to be based on this Seam-ratio. (Expert Report Section 6d)
- Table E7 shows significant variability in the Seam Blends. Most notable Seam#1 is high during the Years 1 to 4, around the Resource Average Years 5 to 9. Drops off to 2% - 9% Years 10 to 23. Between years 1 to 23, Seam#2 fluctuates from 41% to 58% and Seam#4 from 26% to 47%.

C.J. Kolijn
Date: 19 August 2020

Grassy Mountain Seam and Product Quality Calculation Sheet

Date: 06Aug20 Update 19Aug20

Clean Coal Product Quality Total Measured Coal Resource - Three Seams - Seam #2 FSI 3

Seam #	Measured mln Tonnes	Measured %	Thickness m	Ash % ad	Vol.Mat. % ad	S Min. % ad	S Max. % ad	Phos % ad	FSI	React. %	Reflect. Romax	Min. Fluid. Ddpm	Max. Fluid. Ddpm	Ave. Fluid. Ddpm (1)	Ave. Fluid. Ddpm(2)
1	14.5	16.4	4.0	9.5	25.5	0.4	0.7	0.04	7.0	70	1.10	300	1300	624	800
2	41.0	46.4	10.0	9.7	22.1	0.4	0.7	0.04	3.0	60	1.20	10	200	45	105
4	32.8	37.1	8.0	9.8	23.8	0.4	0.7	0.01	5.0	65	1.18	10	400	63	205
TOTAL	**88.3**	**100.0**	**8.3**	**9.7**	**23.3**	**0.4**	**0.7**	**0.03**	**4.4**	**63**	**1.18**	**17**	**352**	**78**	**188**
						Ave. S%	**0.55**				**Method 1&2 Ave. MF ddpm**			**133**	

Seam #	Min. Fluid. Ddpm	Max. Fluid. Ddpm	Ave. Fluid. Ddpm (1)	Ave. Fluid. Ddpm(2)
	Log	Log	Log	Log
1	2.48	3.11	2.80	2.90
2	1.00	2.30	1.65	2.02
4	1.00	2.60	1.80	2.31
TOTAL	**1.24**	**2.55**	**1.89**	**2.27**

Approximation of Fluidity by Calculation
Max. Fluidity calculated via the seam-tonnage weighted averaged Log Max. Fluidity method.
(1) Max. Fluidity calculated via the average of log(10) of Fluidity range, the generally accepted approximation method.
(2) Max. Fluidity calculated via the average of Fluidity Range (MFmax + MFmin)/2
FSI Approximation by weighted Average

Clean Coal Product Quality Total Measured Coal Resource - Three Seams - Seam #2 FSI 5 and Phos 0.04%

Seam #	Measured mln Tonnes	Measured %	Thickness m	Ash % ad	Vol.Mat. % ad	S Min. % ad	S Max. % ad	Phos % ad	FSI	React. %	Reflect. Romax	Min. Fluid. Ddpm	Max. Fluid. Ddpm	Ave. Fluid. Ddpm (1)	Ave. Fluid. Ddpm(2)
1	14.5	16.4	4.0	9.5	25.5	0.4	0.7	0.04	7.0	70	1.10	300	1300	624	800
2	41.0	46.4	10.0	9.7	22.1	0.4	0.7	0.04	5.0	60	1.20	10	200	45	105
4	32.8	37.1	8.0	9.8	23.8	0.4	0.7	0.04	5.0	65	1.18	10	400	63	205
TOTAL	**88.3**	**100.0**	**8.3**	**9.7**	**23.3**	**0.4**	**0.7**	**0.04**	**5.3**	**63**	**1.18**	**17**	**352**	**78**	**188**
						Ave. S%	**0.55**				**Method 1&2 Ave. MF ddpm**			**133**	

Seam #	Min. Fluid. Ddpm	Max. Fluid. Ddpm	Ave. Fluid. Ddpm (1)	Ave. Fluid. Ddpm(2)
	Log	Log	Log	Log
1	2.48	3.11	2.80	2.90
2	1.00	2.30	1.65	2.02
4	1.00	2.60	1.80	2.31
TOTAL	**1.24**	**2.55**	**1.89**	**2.27**

Clean Coal Quality Tables from Reports

Grassy Mt Indicative Quality Report RPM Section 5.2 Table 5-1 page 21 26 March 2019

Table 5-1 Indicative Product Specification

Product	Ash %	Volatile Matter %	RoMax	Total Sulphur %	Phosphorous %	CSR
HCC	9.0 – 9.5	23.5	1.18-1.20	0.5	0.04	65

Coal Quality Spec Grant Thornton Report Section 3.2.1 Page 30 26 March 2019

Coking Coal Specification — **Grant Thornton Report dated March 26, 2019, Section 3.2.1, Page 30**

	CSR	Volatile Matter	Ash	Sulfur	Phosphorus	Fluidity
Grassy Mountain Project	65.0	23.5	9.0-9.5	9.5	0.04	150.0

Source: RRL Management

Comments to calculated Clean Coal Quality vs Indicative Specification:

- Weighted average Ash content is above Indicative Spec. However, Ash can be brought within Spec by the Wash plant, be it at the expense of some coal yield (less product Tonnage).
- The calculated Volatile Matter content is just about on Indicative Spec.
- The Calculated Sulfur content is a little over Indictive Specification, but within accuracy allowed taking assumptions into account. (Grant's S-content is obviously wrong.)
- The Phos-content is on Indicative Spec., with all seams being at Phos 0.04% ad.
- The FSI: If Seam #3 were FSI 3, the quoted Fluidity and CSR results would be unlikely and the Mineral Ash Analysis, important to Reactivity and CSR is missing.
  With Seam #2 at FSI 5, a CSR 65 product could very well be possible, given a favorable Mineral Ash Composition. The by calculation average approx. Max. Fluidity is 130ddpm to 140ddpm.
  The product's FSI could possibly be 5 to 6, which is low for a HCC. Actual Lab data are required.
- Unfortunately, Coal Dilatation and Petrography Vitrinite and Semifusinite content and nature of inters is missing to give more certainty.
- The CSR 65 is on-par with a Hard Coking Coal, but falls short from the Prime Hard Coking Coal Products at CSR 68 - 74.
  Given Blast Furnace requirements, the CSR 65 is adequate, but the ability to assist improving the Blend's CSR to absorb costly weaker coals is not as potent as Prime Hard Coking Coals are be capable of.
- To give more certainty on the product's value, also Coke Cold Strength indicators are required, as determined in a Pilot Oven. These are missing.
- Given the coal's Rank, Rom 1.18 - 1.20, Vol. Matter 23.5%, Fluidity of 140-150ddpm and 64% Reactives, Grassy's Coal has ~60ddpm less Fluidity, approx. 2 points FSI less and 6% - 8% less Reactives relative to comparable Elk Valley Product with 71 CSR. Mineral Ash Analysis and Vitrinite Content will also impact the outcome but complete info is missing.
- In this variable deposit it is important and potentially challenging to provide a consistent Seam Blend and Product Quality throughout the Mines' life, especially since Seam #1 is only 16% of resources, the quality potentially dropping off to SHCC at times. There is an option to sell lower grade product Tonnage separately to maintain the mine's top-quality product Specs.

C.J. Kolijn
Date: 06 August 2020

Grassy Mountain Seam and Product Quality Calculation Sheet Data Source Date: 06Aug20 Update 19Aug20

Geology & Geotech Report Riverside Section B.0 Table B.0.0-1 Page B-3 Reserves August 2016

Table B.0.0-1 Coal Resources Summary

Seam	Depth (m)	Typical Thickness (m)	Coal Resources (Mt)		
			Measured	Indicated	Inferred
Seam No. 1	< 400	4.0	14.5	0.7	7
Seam No. 2		10.0	41.0	2.6	24
Seam No. 4		8.0	32.8	-	21
Total			**88.3**	**3.3**	**52**
Total (Rounded)			**90**	**3**	**50**

Grassy Mt Coal Quality Table 4.2.1 Section B4.2 Page B25 Riverside Report August 2016

Table B.4.2-1 Summary of Average Clean Coal Properties

Seam	Volatile Content (ad) %	Sulphur %	HGI	FSI	P %	Reactive Content %	Maximum Reflectance (Ro Max)[1]	Fluidity (Mddm)
No. 1	25.4	0.4 - 0.7	73 - 78	7	0.04	70	1.10	300 -1300
No. 2	22.1			3	0.04	60	1.20	10 – 200
No. 4	23.8			5	0.01	65	1.18	10 – 400

[1] Combined with the other rank indicator volatile content, all three seams fit centrally into the rank requirement for hard coking coal

Grassy Mt Coal Quality Table 4-3 Section 4.4 Page 16 RPM Report 26 March 2019

Table 4-3 Summary of Average Clean Coal Properties

Seam	Volatile Content % (ad)	Sulphur % (ad)	HGI	FSI (CSN)	P% (ad)	Reactive Content%	Reflectance R_oMax	Fluidity ddpm
No. 1	25.4	0.4-0.7	73-78	7	0.04	70	1.1	300-1300
No. 2	22.1			5		60	1.2	10-200
No. 4	23.8			5		65	1.18	10-400

Note: Reproduced from Coal Quality Review Report Completed by Bob Leach Sept 2015

Grassy Mt Indicative Quality Report RPM Section 5.2 Table 5-1 page 21 26 March 2019

Table 5-1 Indicative Product Specification

Product	Ash %	Volatile Matter %	RoMax	Total Sulphur %	Phosphorous %	CSR
HCC	9.0 – 9.5	23.5	1.18-1.20	0.5	0.04	65

Coal Quality Spec Grant Thornton Report Section 3.2.1 Page 30 26 March 2019. Note the 9.5% Sulfur value is obviously wrong.

Coking Coal Specification — **Grant Thornton Report dated March 26, 2019, Section 3.2.1, Page 30**

	CSR	Volatile Matter	Ash	Sulfur	Phosphorus	Fluidity
Grassy Mountain Project	65.0	23.5	9.0-9.5	9.5	0.04	150.0

Source: RRL Management

Grassy Clean Seam Ash-content Section B.7.2 Page B-41 Riverside Report August 2016

Product yields were based on washing Seam No. 1 coal at a float density of 1.50 g/cc, and Seam No. 2 and Seam No. 4 coal at a float density of 1.45 g/cc. Separable partings were removed in the pit prior to coal loading. Product tonnages are reported on a 10% total moisture (TM) basis. Product ash values are constant by seam on an air dried (ad) moisture basis as shown below:

- Seam No. 1 – 9.5% ad;
- Seam No. 2 – 9.7% ad; and
- Seam No. 4 – 9.8% ad.

EXHIBIT
A

PUBLIC INTEREST LAW CLINIC
FACULTY OF LAW

UNIVERSITY OF CALGARY

MURRAY FRASER HALL
2500 University Drive NW
Calgary, AB, Canada T2N 1N4
<contact information removed>

September 14, 2020

Cornelis Kolijn

Re: Expert Retainer
Grassy Mountain Coal Project
IAA Reference No. 80101

Dear Cornelis Kolijn,

I am counsel to the Canadian Parks and Wilderness Society Southern Alberta Chapter (CPAWS) in the above referenced hearing for the Grassy Mountain Coal project before the Joint Review Panel for the Grassy Mountain Coal Project.

Iconfirm that you intend to provide an affidavit containing your expert opinion for this proceeding. I am writing to set out the questions that we would like you to address in your expert report.

Material Facts

1. Benga Mining Limited ("Benga") has applied for licenses to construct and operate the Grassy Mountain Coal Project ("The Project"), an open-pit metallurgical coal mine near the Crowsnest Pass, approximately seven kilometres north of the community of Blairmore, in southwest Alberta.

2. The Joint Review Panel under the *Responsible Energy Development Act*, *CEAA 2012*, and the *Impact Assessment Act*, is the responsible authority in regards to the approval of the Project.

Relevant Documents

1. 'Section B – Geology and Geotechnical' of the Updated Environmental Impact Assessment;

2. 'Section C – Project Description' of the Updated Environmental Impact Assessment;

3. Such other parts of the Updated Environmental Impact Assessment and Addenda or other information released by Benga for the project Mr. Kolijn may identify as important.

Questions

Based on the facts set out above, your own research, your review of the Relevant Documents described above, your review of any other relevant material on the Project on the *CEAA* public registry, and any other materials you deem relevant, please provide your professional opinion on the following:

1. How do the properties of different coals impact their usefulness for steel-making and their value?

2. What can you determine about the coking potential of the different seams of coal in the Grassy Mountain Coal Project site?

3. How does the coking potential of the coal at the Grassy Mountain Coal Project site compare to other metallurgical coalmines already operating or planned to begin operating?

4. What impacts does your analysis have on the feasibility, expected lifespan, and the likely total coal production of the project?

In preparing your expert opinion, you should rely on any source that you consider to be reliable in support of your opinion and on your own knowledge and experience.

Please feel free to offer any additional expert opinion beyond answers to the above questions that you believe is necessary to provide a full and comprehensive expert opinion.

Form of Affidavit

In your affidavit, please:

1. State your full name and address;
2. Describe your areas of expertise and qualifications in relation to the issues addressed in your affidavit;
3. State the facts and assumptions on which your opinions are based;
4. Provide your answers and opinions to the questions set out above, and your reasons for those answers and opinions;
5. List any literature or other materials specifically relied on in support of your answers and opinions;
6. If applicable, describe the methodology that you used in providing your answers and opinions, including any research, tests, or other investigations on which you have relied, including (if applicable) details of the qualifications of the person who carried them out, and whether a representative of any other party was present;
7. State any caveats or qualifications necessary to render your expert opinion complete and accurate, including those relating to any insufficiency of data or research and an indication of any matters that fall outside your field of expertise;
8. State, if applicable, the particulars of any aspect of your relationship with a party to the proceeding or the subject matter of your proposed evidence that might affect your duty to the Joint Review Panel;
9. Attach, as Exhibit A to your affidavit, this retainer letter;
10. Attach, as Exhibit B to your report, your most up-to-date *curriculum vitae*; and,
11. Attach, in successive Exhibits to your affidavit as needed, any other material you deem relevant or necessary to render your expert opinion complete and accurate.

Timeline

You must complete your report by September 8, 2020.

Privilege and Confidentiality

Please be advised that all communications between us, including this letter, are confidential and privileged. However, if we introduce into evidence any report that you prepare, that privilege is waived. At that time, all correspondence between us, and any drafts of reports and related notes may become available to other parties in the proceedings.

You understand that your work product may, at our discretion on the instructions of our client, be shared with common interest parties, any other intervenors, and their legal representatives who may ultimately be granted standing to join in these proceedings.

Sincerely,

<Original signed by>

Drew Yewchuk
Staff Lawyer
Public Interest Law Clinic
3310, 2500 University Drive NW
Calgary, Alberta, T2N 1N4
<contact information removed>

EXHIBIT

B

CURRICULUM VITAE – CORNELIS JAN KOLIJN

EDUCATION:

1981 Bachelor's Degree, Mining Engineering. The study's scope included Metallurgy. University of Technology, Delft, The Netherlands.

1983 Master of Science Degree, Mining Engineering. The study's scope included Metallurgy. University of Technology, Delft, The Netherlands.

WORK EXPERIENCE:

April 2019 – Present: CJK MetCoal Consulting

Consultant Metallurgical Coal, Cokemaking and Product Development.
June 2020: Senior Consultant – Cokemaking, assigned to Metals, Pyrometallurgy Sector Practice.

October 2002 - March 2019: Teck Coal Ltd (Elk Valley Coal Corp., Fording Coal, Ltd.), Calgary, AB.

Position:
Manager, Technical Marketing, reporting to the Vice President – Marketing and the Global Manager Technical Marketing. Responsible for the internal and external aspects of Technical Marketing. Developed the Technical Marketing department, managing up to four direct reports. As the business grew and markets expanded my focus moved more towards the external, customer-oriented areas of Technical Marketing. I retired from Teck Coal Ltd. as of 31st March, 2019.

August 2011: Awarded Teck Resources' Productivity and Innovation Award, Metallurgical Coal Business Unit.

Job responsibilities and Scope:

- Cooperated with and advised the six mines in the area of product and quality planning. As the coal reserves were developed and mined, research and pilot oven carbonizations were required to maintain quality Specifications of existing products and develop new products. Total mine production was up to 27 million Tonnes clean coal per year. Work with the mines informed customer-interaction. Responsible for 3rd party Port-Lab contracts;
- Cooperating with Teck Coal's customers to develop Teck's Metallurgical coal products and optimize the value in their Coking Coal Blends. Made value-in-use assessments of Teck Coal's vs. competitor's products;
- Projects were executed and coking coal products developed with the Integrated Steel Industry's Coke and Ironmaking departments and R&D in Japan, Europe, North and South America, South Korea, Taiwan, India, China and Africa;
- Contributed to Coke Reactivity and Phos - mineralization research with Teck's Applied Research and Technology department and the University of Alberta, Edmonton;
- Board member of the Canadian Carbonization Research Association (CCRA);
- Emphasized knowledge transfer, mentoring and training of young colleagues. Gave Coal and Coke Quality presentations for Staff and personnel at the mines.

July 2001– Sept 2002: Fording Coal, Ltd., Calgary, Alberta, Canada

Position:
Senior Business Development Analyst, reporting to the Vice President, Corporate Planning & Alberta Operations. In this interim position, I prepared myself to succeed the retiring Manager Technical Services, by the end of the year 2002. For Business Development: Analysis of the world's coal, coke, iron ore and steel markets and producers. Assessment of existing and potential markets, competitors and clients for Fording Coal's products. For the Mines, Coal and Coke Technology: Familiarize myself with Fording's mines, organization, clients, products and Coal and Coke Technology. Co-operated with the Manager, Technical Services to develop products, technology and client relations.

Aug. 1993 - July 2001: Corus Consulting, Inc., Burlington, Ontario, Canada and Hoogovens Technical Services TOA, BV, IJmuiden, The Netherlands

Position:
Technical Manager and Process Consultant – Raw Materials and Ironmaking, reporting to the Technical Director – Ironmaking. Based in the IJmuiden office (The Netherlands, Hoogovens TOA) till July 1997, then in Burlington (Ontario, Canada) till July 2001.

Job responsibilities and Scope:
- Acquisition and execution of international projects in the Raw Materials and Ironmaking Consultancy, utilizing teams of up to six experts. Participate in projects as Project Manager and/or Technical Specialist;
- Product and Market Development: Match Technology and Training packages to the client's needs in the areas of coal and iron ore mining, pelletizing, sintering, cokemaking, blast furnace ironmaking and coal/fuel injection;
- Develop technical and commercial project proposals, including the financial and legal sections. Develop, monitor and control project budgets;
- Contract negotiations for Technical Assistance and Training projects;
- Project Manager for projects with up to five on-site Specialists, plus backup by a team of Research and Operational Technologists working from the home base. Selection of personnel for project execution;
- Report to Corus Consulting's Management and the Client's Management up to Board-level on project results and progress;
- Organize emergency assistance: Contracts and quick-response teams;
- Co-develop Training Manuals and Computer Based Training Modules;
- Write and present lectures/papers concerning operational technology and its application.

Major Technical Assistance and Training projects with:
- RINL/VIZAG (Visakhapatnam, India) on-site Project Manager for Blast Furnace optimization, sinter and coke quality;
- US Steel, LTV, NSC, Inland Steel, Rouge Steel (USA): Blast Furnace operational and process optimization and fuel/coal injection projects. Review of burden material and coke quality. Advice on coal and coke specifications and purchasing strategies;
- AHMSA (Mexico): Managed blast furnace technical assistance projects;
- CST and CSN (Brazil): Assistance for blast furnace optimization and fuel/coal injection, including operator and staff training;
- CVRD (Brazil) and Mobarakeh (Iran): Assistance for Pellet Plant operations and maintenance and personnel training;
- US Steel and Inland Steel (USA) and Stelco (Canada): Sinter Plant assistance;
- Minnesota Iron and Steel 2.2mln tpy Steelplant feasibility study (USA);
- ISCOR Vanderbijlpark, Newcastle Coke Plant and Coal Mines (RSA);
- LTV Hazelwood Coke Plant (USA);
- Co-developer of computer-based training modules in the areas of blast furnace ironmaking and pelletizing for major N-American steel companies.

Aug. 1989 - July 1993: Koninklijke Hoogovens, NV, IJmuiden, The Netherlands
Business Unit Ironmaking, Technology Department

Position:
Technologist Coal and Coke Quality, reporting to the Ironmaking Technology Manager.

Job responsibilities and Scope:
- Development and optimization of Hoogovens' coking coal blend and PCI coal selection, in all ~4 million tonnes coal per year supplied by up to eight suppliers, plus spot market opportunities;
- Develop and coordinate the coal and coke research-program for testing existing and new coal sources in the pilot plant and during field trials;
- Assess the technical and financial impact of coke from different coal blends, and various injection coals on blast furnace ironmaking. Value-in-use calculations for all coal sources;
- Development of coal and coke specifications, in concert with blast furnace technologists, cokemaking technologists, coke plant operators, the financial and purchasing departments;
- Technical auditing of coal mines and suppliers and supplier performance, in North and South America, Europe, Asia and Australia;
- Determination of a number of possible coking coal blends and PCI coal sources for the next coal year, based on quality criteria, value-in-use considerations, market price, supply routes and supplier reliability assessment;
- Specify for the Purchasing Department which coal to buy at which maximum price, specification and tonnage;
- Contribute to the LP-Model to assess the technical and financial impact of all burden materials and coal & coke on blast furnace ironmaking;
- Contributed to the VDEH, Germany, as a member of the project group studying coal and coke quality and economic value assessment;
- Visited Babcock & Wilcox and ARMCO (USA) to acquire coal pulverization and injection technology (1991).

April 1988 - July 1989: Koninklijke Hoogovens, NV, IJmuiden, The Netherlands
Ironmaking Division, Coke Plant #2 (1 million Tonnes / year)

Position:
Section Manager – Coke Plant Heating and Coal Preparation, reporting to the Coke Plant Operational Manager.

Job responsibilities and Scope:
- Coke battery heating and maintenance of the heating system;
- Implementation of an Operator and Management information system; Coal preparation and blending and Coal blend sampling.

Aug.1987– March '88: Hoogovens Delfstoffen BV, Amstelveen, The Netherlands, and
OREMCO, Inc. Coal Trading Company, New York, USA
(60% Hoogovens, 40% British Steel)

Position:
Mining Engineer, reporting to the Director of Hoogovens Delfstoffen.

Job responsibilities and Scope:
- Audit Hoogovens' mining assets in Australia and the USA;
- Low Volatile Coal Market Study;
- Assessment of Hoogovens' long term supply situation.

July 1984 - July 1987: Oaky Creek Coal JV, Tieri, Queensland, Australia
2.5 million tonnes coking coal / year (8.5% Hoogovens, 82% MIM)

Position:
Mining Engineer – Production Planning and Overburden Drilling & Blasting, reporting to the Senior Mining Engineer.

Job responsibilities and Scope:
- Short and medium-term production and quality planning;
- Mine planning, development of stripping and mining methods and optimization of strip/pit design. Overburden blast design;
- Planning of haul roads and other mine infrastructure;
- Geological and reserve assessment;
- Develop yearly production budget and monitor actual versus budget (cost vs actual);
- Assessment of future multi-seam stripping methods and underground mining areas;
- Represent Hoogovens Delfstoffen BV, contribute and attend to the Joint Venture Meetings.

Feb. 1984– June 1984: Hoogovens Delfstoffen, BV, Nijmegen, The Netherlands

Position:
Mining Engineer, reporting to the Senior Mining Engineer.

Job responsibilities and Scope:
- Assessment of Hoogovens' mining assets;
- Prepare for assignment to Oaky Creek Coal, JV, Queensland, Australia.

Work Experience during Study

- **Winter 1982/83:** EBV, Grube Anna, Alsdorf, Germany: Worked to gather data for my Master's Thesis (Development of an underground coal field), which was written in German.
- **Summer 1981:** Noranda, Geco Division, Manitouwadge, Ontario. Underground Copper Mine; Worked underground and in the concentrator. Used the experience to write a paper for my Master's degree, concerning the copper concentrator;
- **Summer 1979:** Bergbau AG, Niederrhein, Germany. Underground Coal Mine Friedrich Heinrich; practical training and work.

COMPUTER LITERACY

- Microsoft Office suite and MAC, Adobe Acrobat and Internet Explorer/Safari/Google.

LANGUAGE SKILLS:

- Fluent, written and verbal: English, Dutch, German;
- Basic understanding for Technical subjects: French, Spanish.

PROFESSIONAL ASSOCIATIONS:

- Royal Dutch Institute of Engineers (KIVI);
- Association for Iron & Steel, AIST (Formerly ISS & AISE);
- Association of Mining Engineers (MV, Delft).

SPECIAL INTERESTS:

- Playing Piano (classic), literature, culture and history;
- Camping, canoeing, swimming, sailing, hiking and navigation;
- Travel and multicultural interaction, geology and ecology.

LECTURES, PRESENTATIONS AND PAPERS:

2019
- METEC, 2019 Conference, co-authored "Findings of Inter Laboratory Study on Coal Dilatation under ISO/TC27 and Importance of Correcting Experimental Dilatation Results to a Reference Coal Mass".

2013
- AISTech Conference, co-author of "Predictive Model for Blending Coking Coals, Part 1: Western Canadian Coals".
- AISTech Conference, co-author of "Coke Size and Shape Characterization for Bed Permeability Estimation".

2012
- Elsevier-Fuel publication: co-authored "Small Scale determination of Metallurgical Coke CSR".

2011
- METEC Iron & Steel Congress, Dűsseldorf, Germany. Presented "Deterioration of Coking Coal Quality in Samples and Stockpiles" as co-author. Published "A facile approach to the CSR determination of Metallurgical Coke", as co-author.

2007
- AISTech 2007 Conference, Indianapolis co-author of "Use of higher levels of Canadian Coal in blends with a high percentage of semi-soft coking coals, Part 1: Lab and Pilot Scale Studies" and "Use of higher levels of Canadian Coal in blends with a high percentage of semi-soft coking coals, Part 2: Industrial Trail Trial", based on joint research with NSC.

2006
- Fuel Processing Technology Journal, co-author of publication "Storage of Small Samples of Coking Coal for Thermal Rheological Tests".
- ICSTI Conference, Japan, co-author of "Higher Canadian coal ratio and high coke strength oven operation with high blend% of semi-soft coal", based on joint research and industrial trials with NSC.

2003
- ISS, Tech 2003 Conference, Indianapolis, Indiana. Presentation and paper, titled: "Utilization of Mid-Volatile Coal Resources to Satisfy Present Blast Furnace Coke Quality Demands".
- METEC/VDEh, Congress 03, Dűsseldorf, BRD. Presentation and paper, titled "The Revival of Predominantly Mid-Volatile Coal Blends to Produce High Quality Blast Furnace Coke".
- AISE, "Steel Technology", publication in July/August 2003 issue: "Medium Volatile Coal, The Solution for Coke Oven Blends with Reduced Low Volatile Coal Content".
- Intertech Conference "Met Coke World Summit", Toronto, presentation and paper titled "Effective Use of Mid-Volatile Coking Coal to produce High Quality Blast Furnace Coke".

2002
- AISE, 2002 Annual Convention and Steel Expo, Nashville, TN. Presentation and paper, titled "Medium Volatile Coal, The Solution for Coke Oven Blends with Reduced Low Volatile Coal Content".

2001
- McMaster University: Guest Speaker representing Materials Engineering as a program choice available to 1st year students.
- ABM, 1st International Meeting on Reduction, Belo Horizonte, Brazil: Presentation and paper, titled "Coke Quality and Blast Furnace Hearth Life".

2000
- McMaster University, Center for Continuing Education: Lecture for the course "Physical Chemistry and Metals Extraction", concerning cokemaking, pelletizing and sintering, including the impact of burden material quality on the blast furnace process.

1999
- McMaster University, Hamilton, Ontario, Canada: 2nd Cokemaking Course. Presentation and Paper, "International Cokemaking Issues" (no co-authors). Bart vd Velden updated and presented this paper for the 3rd Cokemaking Course, May 2003.

1991
- University of Technology, Delft, The Netherlands: Two lectures as a Guest-Lecturer:
  - Open Cut Coal Mining, based on Oaky Creek Coal.
  - Coal and Coke Quality and coal's value-in-use.

CANADIAN PARKS AND WILDERNESS SOCIETY
SOUTHERN ALBERTA CHAPTER

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88 Canada Olympic Road SW
Calgary AB T3B 5R5
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EXPERT REPORTS OF CPAWS

I. INTRODUCTION AND OVERVIEW

1. My name is Martin Z. Olszynski. I currently reside in Calgary, Alberta.

2. Presently, I am an Associate Professor at the University of Calgary, Faculty of Law. My primary research interests are in environmental, natural resources, and water law and policy, and include the intersection of environmental science, law, and policy. My articles have been published in various peer-reviewed journals, both in law and in science. I obtained my B.Sc. (Biology) and LL.B. degrees from the University of Saskatchewan and my LL.M from the University of California at Berkeley. I am currently pursuing a Ph.D. in resource management at the University of British Columbia's Institute for Resources, Environment and Sustainability (IRES). A copy of my *cv* is attached as Exhibit B.

3. One of my primary research interests is an environmental management tool known as "adaptive management." As further explained in the next part, adaptive management is "supposed to be an iterative process in which decision outcomes are continually monitored and evaluated to determine whether they are achieving objectives."[1] Unfortunately, research over the past two decades – including my own empirical research – shows that adaptive management is largely misunderstood and misused in the Canadian impact assessment context. Relevant peer-reviewed publications include the following (beginning with the most recent):

   - "The Post-Decision Phase: Monitoring, Follow-up, Compliance, and Adaptation" in Meinhard Doelle and John Sinclair, eds, *The New Impact Assessment Act* (Irwin Law) (forthcoming 2020) (**"The Post-Decision Phase"**);
   - "Failed Experiments: An Empirical Assessment of Adaptive Management in Alberta's Energy Resources Sector" (2017) 50:3 UBC L Rev 657 (**"Failed Experiments"**);
   - "Environmental Monitoring and Ecosystem Management in the Oil Sands: Spaceship Earth or Escort Tugboat?" (2014) 10(1) McGill JSDLP 1 (**"Environmental Monitoring"**);
   - "Adaptive Management in Canadian Environmental Assessment Law: Exploring Uses and Limitations" (2010) 21 J. Env. L. & Prac. 1 **("Adaptive Management Uses and Limitations")**

4. It was on the basis of some of this research, and especially "Failed Experiments," that I was previously invited by the Alberta Energy Regulator (AER) to give a presentation on the topic of adaptive management in the context of the-then proposed Teck Frontier Oil Sands Mine project. I also submitted comments with respect to adaptive management to the Teck Frontier Joint Review Panel Report, as noted by that panel.[2]

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[1] Robert L Fischman & JB Ruhl, "Judging Adaptive Management Practices of U.S. Agencies" (2016) 30:2 Conservation Biology 268 at 269.

[2] These comments are available online on the Canadian Impact Assessment Registry: https://ceaa-acee.gc.ca/050/evaluations/proj/65505/contributions/id/36387; See also the Teck Frontier Oil Sands Project Joint Review Panel Report at para 118.

5. This report focuses on Benga Mining Ltd's (Benga) approach to adaptive management as revealed through content analysis of its environmental impact statement (EIS), including its responses to numerous rounds of supplemental information requests (SIRs). **My overall conclusion is that Benga has badly misconstrued adaptive management, its potential, and limitations**. Benga appears to be of the view that adaptive management will guarantee positive environmental outcomes (i.e. that it is fail-safe) and that it can be applied to an unlimited number of management issues on an essentially *ad hoc* basis. The likely results of this oversold but under-delivered version of adaptive management are specious effects predictions in the short term and little – if any – improvement in environmental performance over the long term.

6. This report is organized as follows. Part II sets out a primer on adaptive management in theory and in practice, especially in the Canadian impact assessment context. Part III sets out the methodology applied to evaluate Benga's approach to adaptive management, while Part IV sets out the results. Part V sets out my conclusions.

II. ADAPTIVE MANAGEMENT IN THEORY AND PRACTICE

7. Most accounts of the origins of adaptive management begin with the publication of *Adaptive Environmental Assessment and Management* by Canadian ecologists C.S. Holling and Carl J. Walters in the late 1970s.[3] The need for an adaptive approach to environmental assessment and management was subsequently well described by Murray and Marmorek:

> In most environmental management domains ... there are varying degrees of certainty regarding the effectiveness of our actions in achieving desired objectives – due to either gaps in our understanding, or changes in the ecosystems we are trying to manage. Adaptive management provides a way to systematically reduce this uncertainty. It is a rigorous approach for learning through deliberately designing and carrying out management actions as experiments, specifically to learn how the system responds to management and to increase the level of certainty regarding how best to achieve desired results... It incorporates explicit articulation of hypotheses, designing management experiments to test these hypotheses, and then monitoring outcomes to refine hypotheses and build knowledge.[4]

8. From its origins over four decades ago, adaptive management is now applied – or purported to be applied – to a wide variety of resource issues. One consequence of this variety of application, however, is that adaptive management has also become "a highly

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[3] CS Holling, ed, *Adaptive Environmental Assessment and Management*, International Series on Applied Systems Analysis, vol 3 (Chichester: Wiley, 1978).

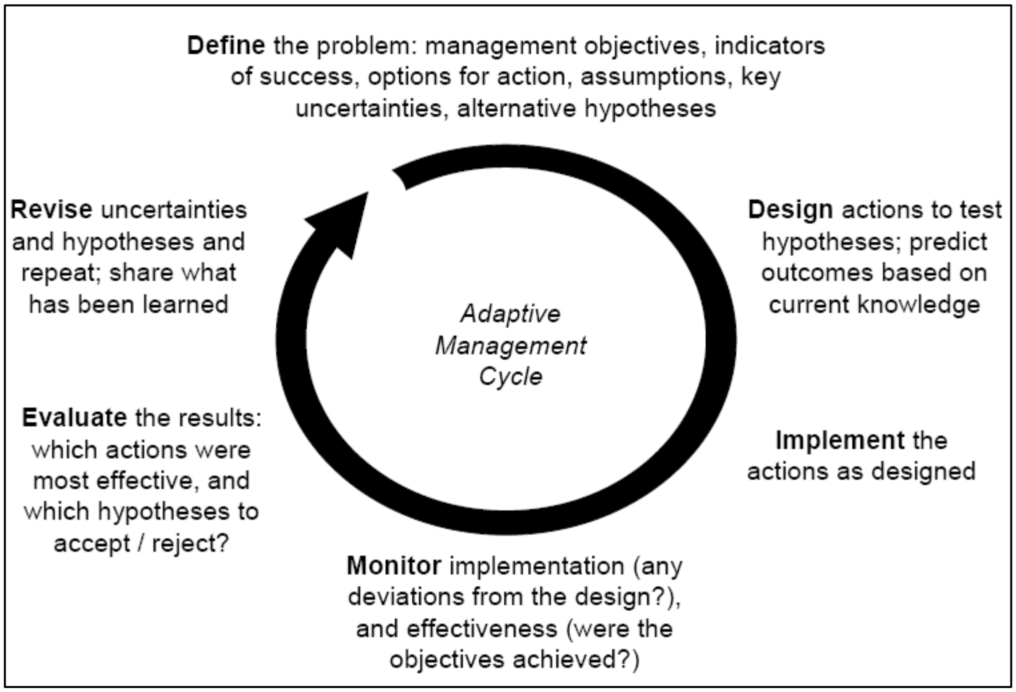
[4] C. Murray & D.R. Marmorek, "Adaptive Management: A Spoonful of Rigour Helps the Uncertainty Go Down" (2004) in Proceedings of the 16th Annual Society for Ecological Restoration Conference, Victoria, B.C. (24-26 August, 2004) at 1.

malleable term. It has been defined and applied in a variety of ways, ranging from highly detailed and rigorous to nearly vacuous."[5]

9. Current policy guidance in both Canada and the US falls somewhere in the middle of this definitional spectrum. The Impact Assessment Agency of Canada (IAAC) defines adaptive management as "a planned and systematic process for continuously improving environmental management practices by learning about their outcomes."[6] Similarly, the US Department of the Interior defines adaptive management as "a systematic approach for improving resource management by learning from management outcomes."[7] While omitting certain important limitations (further discussed below), both definitions are laudable for their recognition that adaptive management is supposed to be *systematic*.

10. Indeed, while definitions of adaptive management may vary, scholars and practitioners of genuine adaptive management all agree that, in order to be effective, adaptive management must be planned and systematic, and generally involves the following six-step cycle:

Figure 1: The Adaptive Management Cycle[8]



[5] Holly Doremus, "Adaptive Management, the Endangered Species Act, and the Institutional Challenges of New Age Environmental Protection" (2001) 41:1 Washburn LJ 50 at 52.
[6] Canadian Environmental Assessment Agency, "Operational Policy Statement: Adaptive Management Measures Under the *Canadian Environmental Assessment Act*", Canadian Environmental Assessment Agency (6 July 2016), online: <www.ceaa-acee.gc.ca/default.asp?lang=En&n=50139251-1&pedisable=true>.
[7] Byron K. Williams, Robert C Szaro & Carol D Shapiro, *Adaptive Management: The U.S. Department of the Interior Technical Guide*, (Washington, DC: Adaptive Management Working Group, 2009,), at 1, online: <https://www2.usgs.gov/sdc/doc/DOI-%20Adaptive%20ManagementTechGuide.pdf>.
[8] Murray and Marmorek, *supra* note 4 at 2.

11. There are also two main types of adaptive management, active and passive:

> In active [adaptive management], managers explicitly recognize in step 1 that they are uncertain about which activities will best meet management objectives and select several as alternatives to test according to the steps and elements in the cycle. In passive [adaptive management], the management action believed to be the best (e.g. best practice) is taken through the cycle, still following the elements in each step (e.g. in step 1 the rigour of identifying objectives, uncertainties, hypotheses, assumptions and indicators, and making predictions, would still occur). The only thing missing with good passive [adaptive management] is the design and implementation of alternative treatments.[9]

12. While generally regarded as a potentially useful tool, there is widespread agreement that adaptive management is not suitable for all environmental problems. First and perhaps most importantly, adaptive management is not "fail-safe"[10]: "no form of adaptive management, no matter how rigorous, can guarantee successful resource protection… Adaptive management can help us recognize management mistakes and limit the damage they cause… But it does not prevent mistakes, nor does it guarantee that the mistakes we make will be reversible."[11] This is an important nuance: management and management practices will always be improved as a result of learning, but that does not necessarily mean positive outcomes. It may mean recognizing that some effects cannot be mitigated and incorporating that knowledge on a go-forward basis when similar projects are proposed.

13. Second, adaptive management is not a *panacea*: there are environmental problems for which adaptive management is not suitable. Ideal conditions for adaptive management have been described as those where the "management-problem context presents a dynamic system for which uncertainty and controllability are high and risk is low."[12] All else being equal, controllability becomes more difficult over greater spatial and temporal scales.

14. Finally, in order to be effective adaptive management must be fully and rigorously implemented: "If the management actions are implemented in a way that strays from the design, if the experimental design does not isolate the signal of interest from background noise (through spatial/temporal contrasts, replicates and controls), or if monitoring focuses on the wrong variables, scale or frequency, it will be difficult if not impossible to learn anything meaningful."[13]

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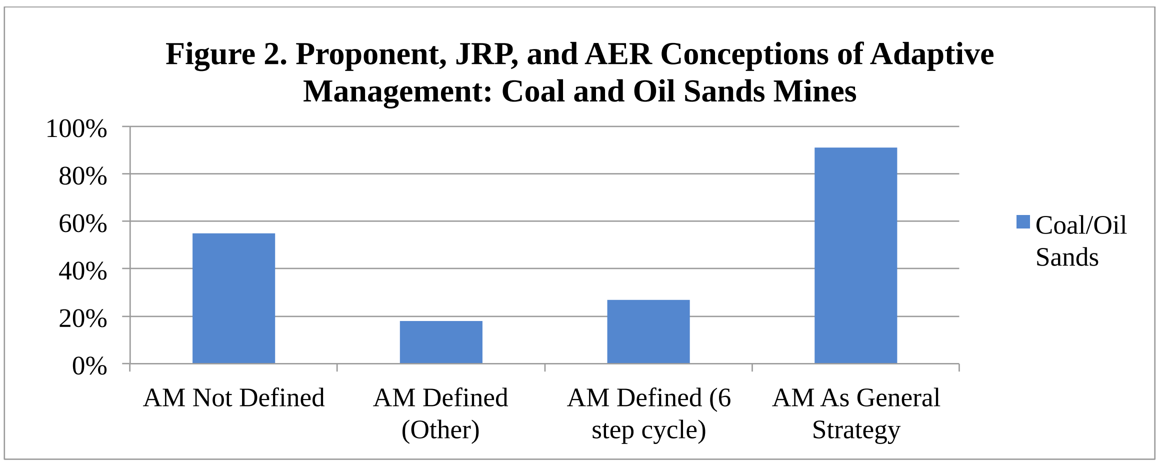
[9] C. Murray & M. Nelitz, Review of Diavik and EKATI Adaptive Management Plans (2008) Prepared by ESSA Technologies Ltd., Vancouver B.C., for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife, N.T. 23 pp.
[10] Lorne Grieg & Carol Murray, "Peer Review of Rockfort Quarry Adaptive Management Plan", prepared for Caledon Coalition of Concerned Citizens (Terra Cotta: ESSA Technologies, 20 November 2008) at 6.
[11] Doremus, *supra* note 5 at 53.
[12] Robert Kundis Craig & JB Ruhl, "Designing Administrative Law for Adaptive Management" (2014) 67:1 Vand L Rev 1 at 19.
[13] Murray and Markmorek, *supra* note 4 at 1.

15. Unfortunately, throughout Canada, the U.S. and Australia, research shows that the practice of adaptive management often diverges—sometimes drastically—from the theory. In a 2010 article, Ruhl and Fischman observed that:

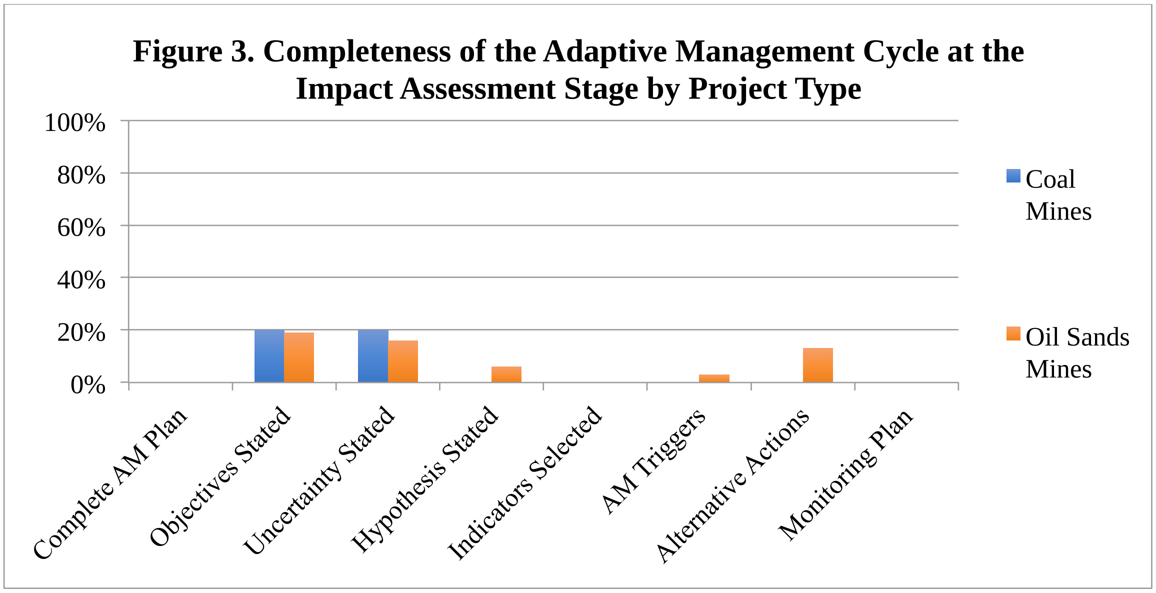
> agencies in practice have employed what we call "a/m-lite," a stripped-down version of adaptive management that almost always neglects to develop testable hypotheses as the basis for management actions. Often a/m-lite fails even to structure a learning procedure, whether through experimentation, historical research, or modeling. Furthermore, lack of follow-through plagues implementation... This a/m-lite approach, in its most extreme form, is open-ended contingency planning or "on-the-fly" management that promises some loosely described response to whatever circumstances arise.[14]

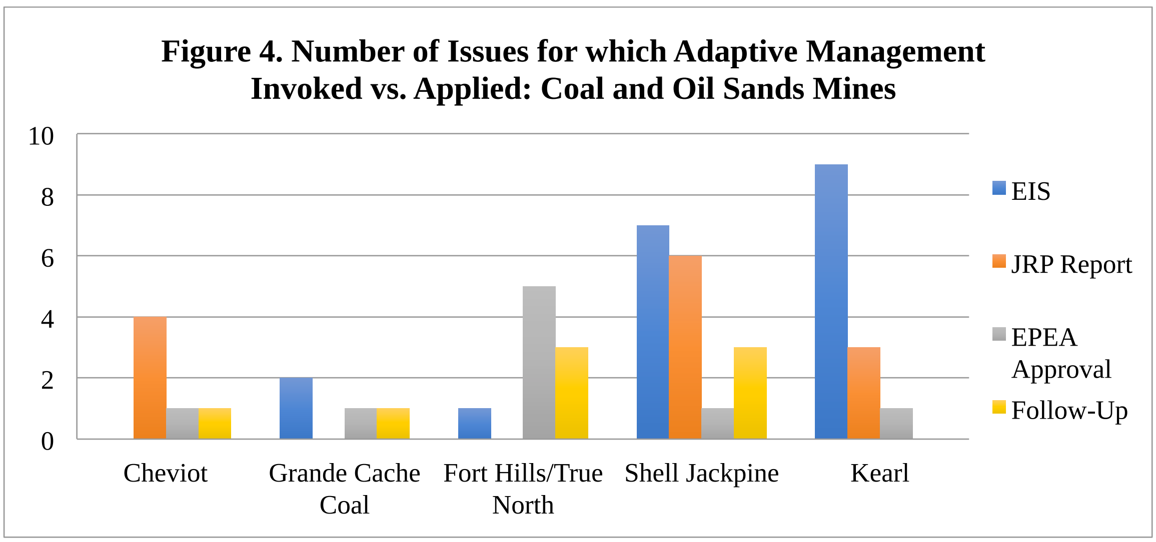
16. My own assessment of over a dozen existing energy resource projects in Alberta ("Failed Experiments," *supra*) confirms the existence of many of the same deficiencies:

- Varying and generally erroneous conceptions of adaptive management, including as a routine strategy that ensures positive environmental outcomes (see Figure 2, below);
- Insufficient attention being paid to experimental design at the impact statement stage, essentially a form of "a/m-lite" or "on the fly" management (Figure 3, below);
- No or incomplete implementation at the reporting stage (Figure 4, below).



[14] Robert L Fischman & JB Ruhl, "Adaptive Management in the Courts" (2010) 95:2 Minn L Rev 424 at 424 [footnotes omitted]. This assessment was mostly unchanged following a 2015 reappraisal of the case law; see *supra* note 1. For Australia, see Jessica Lee & Alex Gardner, "A Peek Around Kevin's Corner: Adapting Away Substantive Limits?", Comment, (2014) 31:4 Environmental & Planning LJ 247 at 250: "the rhetoric of adaptive management has been used to justify the approval of projects with uncertain environmental impacts."





17. These findings are consistent with those from other resource contexts, including forestry.[15]

III. METHODOLOGY

18. Several methodologies have been used for evaluating proposed applications of adaptive management. In their Review of Diavik and EKATI Adaptive Management Plans

[15] See Duinker, P N and L M Trevisan, "Adaptive Management: Progress and Prospects for Canadian Forests" in *Towards Sustainable Management of the Boreal Forest*, ed. V. Adamowicz et al., pp. 857–892. (2003) (Ottawa, ON: NRC Press);

(AMPs),[16] Murray and Nelitz applied the following framework, subsequently formalized by Greig (2008)[17]:

AMP Component in the Guide	Present?	Comments
1. A clear statement of the management goals and objectives for the adaptive management initiative (AMI), in measurable terms.		
2. A list of the key uncertainties (management questions) to be addressed by the AMI.		
3. A description of the alternative management actions to be employed in the AMI, and how they relate to the uncertainties listed above.		
4. A graphic (map based) and textual description of the spatial /temporal bounds of the AMI.		
5. Documentation of any conceptual models used to describe the hypotheses to be tested.		
6. A description of the indicators that will be measured to assess the effects of management treatment(s).		
7. A description of the sampling design for collecting any baseline data used to develop or inform the AMI, and a presentation of the results of the baseline monitoring.		
8. A description of how what is learned from the AMI will be used to change management policy or practice.		
9. A description of the involvement of stakeholders, scientists, and managers in the development of the design of the AMI.		
10. A description of the contrasts, replications, controls to be employed in the AMI (if "active" AM is planned)		
11. Predicted outcomes of the management treatments, and a description of the next steps to be taken in response to each of the alternative outcomes.		
12. A data management plan.		
13. A monitoring plan, including a description of implementation and effectiveness monitoring.		
14. A description of the plan for implementation of the treatment(s) to be explored in the AMI.		
15. A description of the plan for data analysis, evaluation and reporting.		

19. This framework and others informed my own approach to the assessment of adaptive management in Alberta's energy resources sector (see *e.g*. Figure 3, above, wherein I assessed for the presence or absence of the core elements of the adaptive management cycle).[18] Applying content analysis, defined as "the systematic, objective, quantitative

[16] C. Murray & M. Nelitz, Review of Diavik and EKATI Adaptive Management Plans (2008) Prepared by ESSA Technologies Ltd., Vancouver B.C., for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife, N.T. 23 pp.
[17] Greig, L, D. Marmorek and C. Murray. 2008. Guide for Preparation of Adaptive Management Plans. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife, NT. 8 pp.
[18] See *Failed Experiments*, supra.

analysis of message characteristics,"[19] to various regulatory documents, including EISs, my goal was to discern both manifest and latent meaning with respect to adaptive management,[20] as well as to assess the extent to which it was implemented.

20. The same methodology was applied for the purposes of preparing this report. With the assistance of the Public Interest Law Clinic staff, all references to "adaptive management" throughout the Grassy Mountain EIS were identified and collected in a single document (Exhibit C), with citations to their original source in the EIS (see Exhibit D for methodology). I then analyzed these references to determine:

    A. Benga's understanding, or conception, of adaptive management;
    B. The number and kind of environmental problems for which adaptive management is being proposed (e.g., wildlife management, groundwater management, reclamation, etc…)
    C. Whether a complete adaptive management plan has been included for any proposed applications or, if not, which of the steps of the adaptive management cycle were explicitly discussed;

    From time to time (*i.e.* randomly), I would consult the original EIS documents to verify that the excerpts in Exhibit C accurately captured Benga's treatment of adaptive management.

21. The potential sources of error for this methodology are similar to those set out in *Failed Experiments*. First, the keyword search function was used to locate references to "adaptive management." It is possible that some references were not recognized by this function. Second, it is possible that there are parts or sections within various documents that may be relevant to proposed applications of adaptive management that were not captured because they were not sufficiently proximate to the term "adaptive management" within the document.

22. In the following part, except where clearly stated otherwise, references to adaptive management refer to excerpts in Exhibit C by page and row number. Each of these rows contains a citation to the original EIS document.

IV. RESULTS

A. Benga's Understanding of Adaptive Management: Routine and Fail-Safe?

23. "Adaptive management" is referred to at least **560 times** throughout the Grassy Mountain EIS. This includes references in Supplemental Information Requests (SIRs) and Benga's responses to those SIRs and includes duplicate references. The Grassy Mountain EIS thus contains the most references to adaptive management – by almost a factor of 10 –

[19] Kimberly A Neuendorf, *The Content Analysis Guidebook* (Thousand Oaks: Sage Publications, 2002) at 1.
[20] See Vincent J Duriau, Rhonda K Reger & Michael D Pfarrer, "A Content Analysis of the Content Analysis Literature in Organization Studies: Research Themes, Data Sources, and Methodological Refinements" (2007) 10:1 Organizational Research Methods 5.

compared to other energy projects EISs that I have previously reviewed, including coal projects.[21]

24. This high number is consistent with Benga's references to adaptive management as a "routine component" of its environmental management activities (6 references, see *e.g.* 4-1, 53-2). Benga also refers to "adaptive management techniques" (15 references), an "adaptive management approach" (43 references), and even an "adaptive management philosophy" (21-1). It is not clear what the use of these different modifiers is intended to convey.

25. Benga also refers to several different definitions of adaptive management. Initially, Benga suggests that adaptive management "is intended to respond to changes and advances in technology, such as reclamation material replacement and revegetation, to meet specific objectives" (see 4-1). I am not aware of any peer-reviewed literature that defines adaptive management in this way, which overlooks the need to intentionally and systematically design management actions as experiments in order to drive such innovation. Subsequently, Benga appears to also incorporate the IAAC's policy definition of adaptive management (cited above) as "a planned and systematic process for continuously improving environmental management practices by learning about their outcomes" (see *e.g.* 53-1, 63-2). Benga also refers to the adaptive management cycle in the context of draft monitoring and adaptive management plans for closure and reclamation, air quality, and the aquatic environment (see Grassy Mountain EIS, Figures 7.0-1 (air quality), F.3.10 (reclamation)).

26. Benga also seems to acknowledge the role that uncertainty plays in driving adaptive management (see e.g. 44-1) but then proposes to rely on adaptive management in instances where confidence ratings for predicted effects are high, and where effects and mitigative techniques are well understood (see e.g. 7-3, 8-1, 14-2, 14-3, 15-3, 39-1 39-4).

27. Benga also appears to consider adaptive management **as ensuring** successful environmental outcomes, *i.e.* that it is fail-safe. The following excerpts are illustrative:

"…to allow for effective adaptive management of mitigation measures over time **to ensure** that the Project-related effects on wildlife are avoided or minimized." (1-4)
"…will utilize the adaptive management program **to ensure** that healthy rangeland communities are established." (5-4)
"Benga will utilize best management practices currently used in the industry as well as adaptive management **to ensure** that reclamation practices are effective" (13-1)
"An adaptive management approach, including non-native invasive species control and monitoring… will be used **to ensure** that sites have been re-vegetated to meet target vegetation communities" (13-2)
"Tree plantation **success will be assured** by application of adaptive management" (24-1)

[21] See *Failed Experiments*, Figures 2a, 2b and 2c at p. 747 – 748. Previously analysed coal mine EISs have had a maximum of 20 references to adaptive management, while some oil sands mine EISs have had over eighty.

"Ecosystems are highly complex and dynamic, therefore monitoring, adaptive management, and contingency measures are an integral part of this Plan **to ensure** the effectiveness of the selected offsets…" (43-1)
"Monitoring and adaptive management where appropriate will be part of **ensuring** the measures are successful (75-1 to 84)

B. Number of Issues for which Adaptive Management is Proposed

28. Benga proposes to rely on adaptive management in the context of at least 18 different environmental issues or challenges (as before, references are to page and row numbers in Exhibit C). As with the total overall number of references to adaptive management, this is higher than any other energy resource project I have reviewed[22]:

#	Issue	Ref. (see Exhibit C)
1.	Erosion control	1-1
2.	Infill planting	1-2
3.	Wildlife	1-4
4.	Reclamation	2-2
5.	Water quality (sulphate issues)	3-1
6.	Revegetation	4-1 (see also 38-1)
7.	Salvage practices	6-4
8.	Invasive Species	13-2
9.	Species at risk (olive sided fly catcher)	15-4
10.	Aquatics/species at risk (Westslope Cutthroat Trout or WSCT)	20-3
11.	Water quality (selenium)	22-1
12.	Water quality (end pit lakes (EPLs))	23-1
13.	Species at risk (whitebark pine)	24-1
14.	Sand mobilization	28-2
15.	NOx emissions	31-1
16.	Eagle nesting sites	48
17.	Dust mitigation	143-1
18.	Light pollution	144-2

29. One of the concerns with such broad invocation of adaptive management, in addition to the considerable resources that it would require to actually generate learning, is that it is not clear how Benga will be able to control for all of the variability that could confound adaptive management efforts, including not just background natural variability but variability introduced by the numerous and inter-related effects of the project itself.

C. Completion of an Adaptive Management Plan

30. In the vast majority of instances, Benga does not even attempt to complete an adaptive management plan. Uncertainties are often not identified, nor are clear objectives, suitable

[22] See *Failed Experiments*, Figures 3a, 3b and 3c at p. 749.

indicators, relevant thresholds, or alternative management actions. Indeed, Benga generally defers such completion to the post-EA phase. For example:

"Benga's adaptive management approach *will involve establishing* end land use; monitoring reclamation, soils, revegetation, and wildlife to allow objectives and end point to be reviewed" (2-2)
"monitoring and adaptive management for sulphate *should include development* of a site specific water quality for sulphate for Blairmore Creek (3-1)
"An adaptive management strategy *would also be developed* to mitigate identified changes…" (28-1)

This is so notwithstanding numerous requests for additional details through the SIR process.

31. Notwithstanding this general tendency to postpone completion of any adaptive management plan to the post EA or regulatory phase, my review of the Grassy Mountain EIS suggests that, of all the instances where adaptive management is proposed, the discussions with respect to reclamation, air quality, and the aquatic environment are among the most detailed. Consequently, the following section evaluates those plans by applying the framework applied by Murray and Nelitz (2008).

32. As will be seen, these plans do contain some of the components of adaptive management, but no plan is complete. Indeed, Benga admits that these plans will need to be finalized post-approval without providing a reason for why completed draft adaptive management plans could not be submitted at this phase. In addition, where some components are present, they have other deficiencies, such as the use of ambiguous or subjective language. This is precisely why a compete draft adaptive management plan should be included in the assessment phase: so that it can be scrutinized and improved by participants.

a. Reclamation (Addendum 10, package 2, especially Tables F.2.8-1, F.3.9-1, and F.3.10-1 Adaptive Management Strategies)

AMP Component in the Guide	Present?	Comments
1. A clear statement of the management goals and objectives for the adaptive management initiative (AMI), in measurable terms.	No	
2. A list of the key uncertainties (management questions) to be addressed by the AMI.	No	
3. A description of the alternative management actions to be employed in the AMI, and how they relate to the uncertainties listed above.	Somewhat	No relation to uncertainties identified, identified as "options" only
4. A graphic (map based) and textual description of the spatial /temporal bounds of the AMI.	No	

5. Documentation of any conceptual models used to describe the hypotheses to be tested.	No	
6. A description of the indicators that will be measured to assess the effects of management treatment(s).	Somewhat	Use ambiguous and/or subjective language.
7. A description of the sampling design for collecting any baseline data used to develop or inform the AMI, and a presentation of the results of the baseline monitoring.	Somewhat	
8. A description of how what is learned from the AMI will be used to change management policy or practice.	Somewhat	No clear commitment to adaptation (*i.e.* "options" only).
9. A description of the involvement of stakeholders, scientists, and managers in the development of the design of the AMI.	No	
10. A description of the contrasts, replications, controls to be employed in the AMI (if "active" AM is planned)	No	
11. Predicted outcomes of the management treatments, and a description of the next steps to be taken in response to each of the alternative outcomes.	Somewhat	Light on details, non-committal w/r/t next steps.
12. A data management plan.	No	
13. A monitoring plan, including a description of implementation and effectiveness monitoring.	Yes	
14. A description of the plan for implementation of the treatment(s) to be explored in the AMI.	No	
15. A description of the plan for data analysis, evaluation and reporting.	No	

b. Draft Air Quality Monitoring and Adaptive Management Plan (Addendum 10, and especially Tables 6.0-1 and 7.2-1)

AMP Component in the Guide	Present?	Comments
1. A clear statement of the management goals and objectives for the adaptive management initiative (AMI), in measurable terms.	Somewhat	"Reduce" is not a measurable term
2. A list of the key uncertainties (management questions) to be addressed by the AMI.	No	
3. A description of the alternative management actions to be employed in the AMI, and how they relate to the uncertainties listed above.	Somewhat	No relation to uncertainties identified
4. A graphic (map based) and textual description of the spatial /temporal bounds of the AMI.	No	
5. Documentation of any conceptual models used to describe the hypotheses to be tested.	No	
6. A description of the indicators that will be measured to assess the effects of management treatment(s).	Yes	
7. A description of the sampling design for collecting any baseline data used to develop or inform the AMI, and a presentation of the results of the baseline monitoring.	Some	

8. A description of how what is learned from the AMI will be used to change management policy or practice.	Somewhat	No clear commitment to adaptation; monitoring result validation contemplated. Benga appears to reserve some discretion for itself;
9. A description of the involvement of stakeholders, scientists, and managers in the development of the design of the AMI.	Somewhat	Generally future-oriented (*i.e. will* be involved)
10. A description of the contrasts, replications, controls to be employed in the AMI (if "active" AM is planned)	No	
11. Predicted outcomes of the management treatments, and a description of the next steps to be taken in response to each of the alternative outcomes.	Somewhat	Light on details, non-committal w/r/t next steps.
12. A data management plan.	Somewhat	Light on details
13. A monitoring plan, including a description of implementation and effectiveness monitoring.	Yes	
14. A description of the plan for implementation of the treatment(s) to be explored in the AMI.	No	
15. A description of the plan for data analysis, evaluation and reporting.	No	Envisioned

c. Aquatic Management Plan (Appendix 6.23-1, including Table 7.5-1)

AMP Component in the Guide	**Present?**	**Comments**
1. A clear statement of the management goals and objectives for the adaptive management initiative (AMI), in measurable terms.	Somewhat	Mitigation objectives incorporate vague language ("minimize or eliminate")
2. A list of the key uncertainties (management questions) to be addressed by the AMI.	Somewhat	Some uncertainties identified
3. A description of the alternative management actions to be employed in the AMI, and how they relate to the uncertainties listed above.	Somewhat	Alternative actions referred to as "options" only, not clearly related to uncertainties
4. A graphic (map based) and textual description of the spatial /temporal bounds of the AMI.	No	
5. Documentation of any conceptual models used to describe the hypotheses to be tested.	No	
6. A description of the indicators that will be measured to assess the effects of management treatment(s).	Yes	

7. A description of the sampling design for collecting any baseline data used to develop or inform the AMI, and a presentation of the results of the baseline monitoring.	Yes	Additional baseline sampling is anticipated post-approval.
8. A description of how what is learned from the AMI will be used to change management policy or practice.	Somewhat	No clear commitments to adaptation. Monitoring result validation contemplated.
9. A description of the involvement of stakeholders, scientists, and managers in the development of the design of the AMI.	Somewhat	Generally future-oriented (*i.e. will* be involved)
10. A description of the contrasts, replications, controls to be employed in the AMI (if "active" AM is planned)	Somewhat	Clearest with respect Bionergetics monitoring (s. 6.7)
11. Predicted outcomes of the management treatments, and a description of the next steps to be taken in response to each of the alternative outcomes.	Somewhat	Predicted outcomes are that mitigation measures will be effective; next steps are described but use ambiguous language.
12. A data management plan.	No	
13. A monitoring plan, including a description of implementation and effectiveness monitoring.	Yes	
14. A description of the plan for implementation of the treatment(s) to be explored in the AMI.	No	
15. A description of the plan for data analysis, evaluation and reporting.	No	Envisioned

V. CONCLUSION

33. **The Grassy Mountain EIS exhibits all of the hallmarks of deficient adaptive management practice**, including the erroneous view that: it can ensure successful outcomes (*i.e.* that it is "fail-safe"); it can be applied to virtually any and all environmental problems without regard to spatial, temporal, and other limitations; and that it can be implemented as a routine matter as opposed to the result of careful and deliberate planning and rigorous implementation. This is Professor Ruhl and Fischman's "a/m lite": "a stripped-down version of adaptive management that almost always neglects to develop testable hypotheses as the basis for management actions. Often a/m-lite fails even to structure a learning procedure, whether through experimentation, historical research, or modeling."[23]

34. To further reiterate the discussion from Part II, adaptive management is not fail-safe. Rigorously implemented, adaptive management can help in recognizing management

[23] Fischman and Ruhl, *supra* note 14.

mistakes, but it does not prevent such mistakes, nor does it guarantee that they will be reversible. This is particularly important bearing in mind Benga's reliance on adaptive management in the context of several Species at Risk, including the WSCT, as well as water quality issues, especially selenium.

35. While the Aquatic Monitoring Plan (AMP) contains considerably more detail than other proposed applications of adaptive management (especially with respect to monitoring), **Benga has failed to complete an adaptive management plan in every instance where adaptive management has been invoked**. As noted above, this makes it exceedingly difficult – if not impossible – for stakeholders to comment on the feasibility and appropriateness of the proposed application of adaptive management. As one example, Benga barely discusses controllability as a limiting factor to the application of adaptive management.

36. If environmental assessment is supposed to be a planning process, then numerous parts of the Grassy Mountain EIS are essentially a plan to plan. Previous experience with other energy projects suggests that such an approach is unlikely to yield effective project management, to say nothing of continuous improvement. Two examples from the oil sands mining context are demonstrative. For the Kearl Oil Sands Project (2007), Imperial Oil proposed – and a Joint Review Panel accepted – vague reliance on adaptive management in relation to both peatland restoration and end-pit lakes.[24] Five year later, however, in the context of the-then proposed Jackpine Oil Sands Mine expansion, Shell acknowledged that peatlands cannot be reclaimed,[25] while end-pit lakes continue to be unproven – almost fifteen years later.[26]

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Dated: 18 September 2020

[24] *Failed Experiments* at p. 719 – 721.
[25] Ibid.
[26] See *e.g.* Decision 2019 ABAER 006: Syncrude Canada Ltd. Mildred Lake Extension Project and Mildred Lake Tailings Management Plan at para 831: "…there is significant uncertainty about whether [water capping] technology will be successfully demonstrated by [2023]."

EXHIBIT A

PUBLIC INTEREST LAW CLINIC
FACULTY OF LAW

UNIVERSITY OF CALGARY

MURRAY FRASER HALL
2500 University Drive NW
Calgary, AB, Canada T2N 1N4
<contact information removed>

September 11, 2020

Martin Olszynski

Re: Expert Retainer
Grassy Mountain Coal Project
IAA Reference No. 80101

Dear Martin Olszynski,

I am counsel for the Canadian Parks and Wilderness Society Southern Alberta Chapter (CPAWS) in the above referenced hearing for the Grassy Mountain Coal project before the Joint Review Panel for the Grassy Mountain Coal Project.

I confirm that you intend to provide an affidavit containing your expert opinion for this proceeding. I am writing to set out the questions that I would like you to address in your affidavit.

Material Facts

1. Benga Mining Limited ("Benga") has applied for licenses to construct and operate the Grassy Mountain Coal Project ("The Project"), an open-pit metallurgical coal mine near the Crowsnest Pass, approximately seven kilometres north of the community of Blairmore, in southwest Alberta.

2. The Joint Review Panel under the *Responsible Energy Development Act*, *CEAA 2012*, and the *Impact Assessment Act*, is the responsible authority in regards to the approval of the Project.

Relevant Documents

1. The Aquatic Monitoring adaptive management plan (Addendum 11, JRP IR-6.23 and Appendix 6.23);

2. The Conservation and Reclamation plan (Addendum 10 Package 2: Vegetation and Reclamation, Appendix 2.6-1);

3. The Air Quality Adaptive Management Plan (Addendum 10, Appendix 1.3-1);

4. The Hydrology Adaptive Management Plan (Addendum 10, JRP IR-5.25); and

5. Such other parts of the Updated Environmental Impact Assessment and Addenda or other information released by Benga for the project you may identify as relevant to your report.

Questions

Based on the facts set out above, your own research, your review of the Relevant Documents described above, your review of any other relevant material on the Project on the *CEAA* public registry, and any other materials you deem relevant, please provide your professional opinion on the following:

1. How does adaptive management as a regulatory tool work in theory?

2. How has adaptive management worked in practice?

3. How does the adaptive management proposed for the Grassy Mountain Coal Project compare to past adaptive management approaches?

In preparing your expert opinion, you should rely on any source that you consider to be reliable in support of your opinion and on your own knowledge and experience.

Please feel free to offer any additional expert opinion beyond answers to the above questions that you believe is necessary to provide a full and comprehensive expert opinion.

Form of Affidavit

In your affidavit, please:

1. State your full name and address;
2. Describe your areas of expertise and qualifications in relation to the issues addressed in your affidavit;
3. State the facts and assumptions on which your opinions are based;
4. Provide your answers and opinions to the questions set out above, and your reasons for those answers and opinions;
5. List any literature or other materials specifically relied on in support of your answers and opinions;
6. If applicable, describe the methodology that you used in providing your answers and opinions, including any research, tests, or other investigations on which you have relied, including (if applicable) details of the qualifications of the person who carried them out, and whether a representative of any other party was present;
7. State any caveats or qualifications necessary to render your expert opinion complete and accurate, including those relating to any insufficiency of data or research and an indication of any matters that fall outside your field of expertise;
8. State, if applicable, the particulars of any aspect of your relationship with a party to the proceeding or the subject matter of your proposed evidence that might affect your duty to the Joint Review Panel;
9. Attach, as Exhibit A to your affidavit, this retainer letter;
10. Attach, as Exhibit B to your report, your most up-to-date *curriculum vitae*; and,
11. Attach, in successive Exhibits to your affidavit as needed, any other material you deem relevant or necessary to render your expert opinion complete and accurate.

Timeline

You must complete your report by September 17, 2020.

Privilege and Confidentiality

Please be advised that all communications between us, including this letter, are confidential and privileged. However, if we introduce into evidence any report that you prepare, that privilege is waived. At that time, all correspondence between us, and any drafts of reports and related notes may become available to other parties in the proceedings.

You understand that your work product may, at our discretion on the instructions of our client, be shared with common interest parties, any other intervenors, and their legal representatives who may ultimately be granted standing to join in these proceedings.

Sincerely,

<Original signed by>

Drew Yewchuk
Staff Lawyer
Public Interest Law Clinic
3310, 2500 University Drive NW
Calgary, Alberta, T2N 1N4
<contact information removed>

EXHIBIT B

Martin Z. Olszynski, LL.M., LL.B., B.Sc.
Associate Professor
Faculty of Law, University of Calgary
<contact information removed>

I. QUALIFICATIONS AND EDUCATION

Member in Good Standing, Law Society of Upper Canada (2007 – present)

Doctor of Philosophy (Resource Management), University of British Columbia (*in progress*)

Master of Laws (Specialization in Environmental Law), University of California at Berkeley (2011)

Bachelor of Laws (*Distinction*), University of Saskatchewan (2006)

Bachelor of Science (Biology) (*Distinction*), University of Saskatchewan (2002)

II. WORK EXPERIENCE

Associate Professor – University of Calgary Faculty of Law (2018 – Present)
Courses taught: Tort Law, Administrative Law, and Water Law

Assistant Professor – University of Calgary Faculty of Law (2013 – 2018)
Courses taught: Tort Law, Administrative Law, Environmental Law, and Water Law

Part-time Professor – University of Ottawa Faculty of Law (2011 – 2013)
Courses taught: Environmental Law

Legal Counsel – Department of Justice, Fisheries and Oceans Canada Legal Services (2007 – 2013)

Policy Analyst – Environment Canada, Legislative and Regulatory Affairs Division (secondment, 2009)

Law Clerk – Honourable Justice Denis Pelletier, Federal Court of Appeal (2006 – 2007)

III. JOURNAL ARTICLES

"Breaking Ranks (and Precedent): Reference re Greenhouse Gas Pollution Pricing Act, 2020 ABCA 74" (2020) 33(2) J. Env. L. & Prac. (SSRN) (with Nigel Bankes and Andrew Leach)

"The Role of Science in Contemporary Canadian Environmental Decision-Making: The Example of Environmental Assessment" (2019) 50 UBC L. Rev. 697 (with Alana Westwood, Aerin Jacob, Caroline Fox, JW Moore, Wendy Palen and Adam Ford) (2nd author) (SSRN)

"*Tsleil-Waututh Nation v. Canada (Attorney General)*: Clarifying the (F)Laws in Canada's Pipeline Approval" Canadian Environmental Law Reports (2019) 22(4) C.E.L.R. 8 (with David Wright) (SSRN)

"*Dunsmuir*is Dead – Long Live *Dunsmuir*! An Argument for a Presumption of Correctness" (2018) Can. J. Admin. L. & Prac 99 (Special Issue)

"Testing the Jurisdictional Waters: The Provincial Regulation of Interprovincial Pipelines" (2018) 23:1 Rev Const Stud 91 (SSRN)

"A(nother) New Federal Regime for Assessing Interprovincial Pipeline Projects: The Proposed *Impact Assessment Act*" (2018) 6:2 Energy Reg. Q. 11 (Link) (SSRN)

"Towards Linking Environmental Law and Science" (2018) 3 Facets 375 (with JW Moore, Linda Nowlan, Martin Olszynski, Aerin Jacob, Brett Favaro, Lynda Collins, GLT-L Williams-Davidson, and Jill Weitz) (Link)

"From Smokes to Smokestacks: Lessons from Tobacco for the Future of Climate Change Liability" (2018) 30:1 Georgetown Env. L. Rev. 1 (with Sharon Mascher and Meinhard Doelle) (Link) (SSRN)

"Failed Experiments: An Empirical Assessment of Adaptive Management in Alberta's Energy Resources Sector" (2017) 50:3 UBC L Rev 657 (SSRN)

"Authorized Net Losses of Fish Habitat Demonstrate Need for Improved Habitat Protection in Canada" (2017) 74 Can. J. Fish. Aquat. Sci. 285-291 (with Dr. Brett Favaro) (Link)

“Does Slow and Steady Win the Race? Ecosystem Services in Canadian and Chilean Environmental Law and Policy" (2018) 29:B Ecosystem Services 240 (with Roberto Pasten and Michael Hantke-Domas) (Link)

“From ‘Badly Wrong’ to Worse: An Empirical Analysis of Canada’s New Fish Habitat Protection Laws” (2015) 28(1) J. Env. L. Prac. 1 (SSRN)

“Environmental Assessment as Planning and Disclosure Tool: *Greenpeace Canada v. Canada (Attorney General)*” (2015) 38(1) Dalhousie L. J. 207 (Link) (SSRN)

“Ancient Maxim, Modern Problems: *De Minimis*, Cumulative Environmental Effects and Risk-based Regulation” (2015) 40(2) Queen's L. J. 705 (Link) (SSRN)

“Can Environmental Laws Fulfill their Promise? Stories from Canada” (2014) 6(9) Sustainability pp.6024-6048 (with Nigel Bankes and Sharon Mascher) (Link)

“Environmental Monitoring and Ecosystem Management in the Oil Sands: Spaceship Earth or Escort Tugboat?” (2014) 10(1) McGill JSDLP 1 (SSRN)

“Environmental Damages after the Federal *Environmental Enforcement Act*: Bringing Ecosystem Services to Canadian Environmental Law?” (2012) 50(1) Osgoode Hall L. J. 129 (Link) (SSRN)

“Old Puzzle, New Pieces: *Red Chris* and *Vanadium* and the Future of Federal Environmental Assessment” (2011) 89 Can. Bar. Rev. 445 (with Marie-Ann Bowden) (SSRN)

“Adaptive Management in Canadian Environmental Assessment Law: Exploring Uses and Limitations” (2010) 21 J. Env. L. & Prac. 1 (SSRN)

“The Commodification of Canadian Water: Exploring International Trade Implications” (2006) 68 Sask. L. Rev. 221 (SSRN)

“*Hoffman v. Monsanto Canada Inc.:* Looking for a Generous Approach to the Elephant in the Garden” (2006) 16 J. Env. L. & Prac. 53

“The Assessment of Environmental Damages Following the Supreme Court’s Decision in *Canfor*” (2005) 15 J. Env. L. & Prac. 257 (SSRN)

IV. BOOK CHAPTERS

“The Post-Decision Phase: Monitoring, Follow-up, Compliance, and Adaptation” (Chapter 11) in Meinhard Doelle and John Sinclair, eds, *The New Impact Assessment Act* (Irwin Law) (*forthcoming 2020*)

“Science, Evidence, and Indigenous Knowledge” (Chapter 20) in Meinhard Doelle and John Sinclair, eds, *The New Impact Assessment Act* (Irwin Law) (*forthcoming 2020*)

“Impact Assessment” (Chapter 17) in William A Tilleman, Alastair R Lucas, Sara L Bagg & Patrícia Galvão Ferreira, Environmental Law and Policy, 4th ed (Toronto: Emond, 2020)

"Reconsidering Red Chris: Federal Environmental Decision-Making after *MiningWatch Canada v. Canada (Fisheries and Oceans)*" (Chapter 15) in Alastair R Lucas and William Tilleman, *Litigating Canada's Environment: Leading Canadian Environmental Cases by the Lawyers Involved* (2018) (SSRN)

“The Law and Economics of Environmental Harm: A Primer and Update for Environmental Sentencing” (Chapter 32) in Allan Ingelson, ed., *Environment in the Courtroom* (Calgary: University of Calgary Press, 2019) (with Peter Boxall)

“Who Should Prosecute II: Intragovernmental Issues” (Chapter 17) in Allan Ingelson, ed., *Environment in the Courtroom* (Calgary: University of Calgary Press, 2019)

V. PRESENTATIONS AND OTHER PUBLICATIONS

“Adaptive Management in Canadian Natural Resources Law & Policy: Lessons for EU GI Policy & Implementation” presented at *Uncertainty and Multifunctionality: Legal Challenges and Opportunities for Green Infrastructure Policy* (Woodnet Online Seminar, April 2020)

“Overview of Bill C-69: Providing Clarity on New Regulations” presented at *Cumulative Effects 2019*, Canadian Institute (Calgary, Alberta, June 2019)

“An Agile Regulations Agenda for Canada” presented at *JELP7: Back to the Future: Re-Defining Canada’s Environmental Priorities*, the Journal of Environmental Law and Practice's 7th biennial conference (Victoria, British Columbia, June 2019)

Council of Canadian Academies, 2019. *Greater Than the Sum of Its Parts: Toward Integrated Natural Resource Management in Canada.* Ottawa (ON): The Expert Panel on the State of Knowledge and Practice of Integrated Approaches to Natural Resource Management in Canada

“Bill C-69 – The Last of a Thousand Cuts or a Solution to Regulatory Frustration?” School of Public Policy Luncheon (Calgary, AB, November 2018) (with Jennifer Winter, Robert Skinner and Al Reid)

“Science, Decision Making & the Law: The Impact Assessment Cat in the Science Hat” presented at the Environmental Law Centre’s *Green Regs and Ham* (Calgary, AB, October 2018) (with Dr. Aerin Jacob)

“The Quashed Trans Mountain Expansion Approval: Scoping, Considerations and Reviewability” presented to the Canadian Bar Association (Alberta South Branch) (Calgary, AB, October 2018)

"Bill C-68: Amendments to the *Fisheries Act*” Submission to the House of Commons Standing Committee on Fisheries and Oceans (Ottawa, ON, April 2018) (Brief)

"Bill C-69: The Proposed *Impact Assessment Act*": Submission to the House of Commons Standing Committee on Environment and Sustainable Development (Ottawa, ON, April 2018) (Brief)

“Bills C-68 and C-69: Amendments to the *Fisheries Act* and a new *Impact Assessment Act*” presented at *Symposium on Environment in the Courtroom (VII): Enforcement Issues in Canadian Wildlife Protection*, Canadian Institute of Resources Law (CIRL) (Calgary, AB, February 2018)

"Has Trudeau Delivered? A Discussion of Bills C-68 and C-69" York University's Sustainable Energy Initiative's Seminar Series (webcast, March 2018) (Link)

“The Trudeau Administration on Water: Restoring (Improving?) Protections for Fish and Fish Habitat" presented at the University of Toledo's *Great Lakes Water Conference* (Toledo, OH, November 2017)

"Federal Environmental and Regulatory Review," York University's Sustainable Energy Initiative's Seminar Series (webcast, November 2017) (Link)

"Reconsidering Federal Environmental Jurisdiction," presented at Canada 150 - Constitutional Law Symposium, Legal Education Society of Alberta (Edmonton, AB, 2017)

“Strengthening Canada's Environmental Assessment and Regulatory Processes: Recommendations and Model Legislation for Sustainability," Response to the Government of Canada's Discussion Paper on Environmental and Regulatory Reform (August, 2017) (with Jocelyn Stacey, Jason MacLean, Arlene Kwasniak and Robert Gibson) (Link)

"Education and Awareness Initiatives to Encourage Zero Emission Vehicles Adoption": Submission to the Federal Zero Emission Vehicles Advisory Panel (June, 2017) (with Sharon Mascher and Meinhard Doelle)

"Energy and the Environment: Are Our Laws Keeping Up?" University of Calgary webinar (Calgary, AB, June 2017) (Link)

"From Smokes to Smokestacks: Lessons from Tobacco for the Future of Climate Change Liability" presented at *We'll always have Paris: Climate Change Law & Policy following the Paris Agreement*, the Journal of Environmental Law and Practice's 6th Biennial Conference (Halifax, NS, 2017)

"Should Courts Act as 'Academies of Science'" presented at the Canadian Society for Ecology and Evolution's (CSEE) 2017 Meeting (Victoria, BC, May 2017)

“The Great Canadian Pipeline Debate – What Is It Really About?” presented at the Canadian Association of Members of Public Utility Tribunals (CAMPUT) 2017 Annual Conference (Vancouver, BC, May 2017)

"The Federal Environmental and Regulatory Review Processes: Integration or Disconnection?" York University's Sustainable Energy Initiative's Seminar Series (webcast, March 2017) (Link)

"Recent Research Insights: Adaptive Management in the Oil Sands" presented at the Canadian Energy Research Institute's (CERI) 2017 Oil and Gas Symposium, *Where Do We Go From Here?* (Calgary, AB, March 2017)

“Keynote Panel Debate” at *Making Waves: Environmental Policy and Practical Change*, the 5th Conference of the Canadian Association of Environmental Law Societies (CAELS) (Ottawa, ON, February 2017)

"Avoiding the 'Tyranny of Small Decisions': A Canadian Environmental Assessment Regime for the 21st Century": Submission to the Federal Expert Panel Review of Environmental Assessment Processes (Calgary, AB, November 2016)

"Fisheries Act Review: An Empirical Analysis of the Section 35 Regime and Recommendations for Reform": Submission to the House of Commons Standing Committee on Fisheries and Oceans (Ottawa, ON, October 2016)

"The Duty to Consult and Accommodate: An Overview and Discussion" prepared for the Canadian Chamber of Commerce (September, 2016) (Link)

“Experiments Gone Wrong? An Empirical Analysis of Adaptive Management in Canada’s Energy Resources Sector” presented at the *Sabin Colloquium on Innovative Environmental Law Scholarship,* Columbia Law School (New York, NY, May 2016)

"Compliance and Enforcement in Canadian Environmental Law: A Crisis in the Making?" presented at *Symposium on Environment in the Courtroom (V): Inspections and Enforcement*

Issues: Onsite and in Court, Canadian Institute of Resources Law (CIRL) (Ottawa, ON, February 2016)

"The Past, Present and Future of Environmental Assessment in Canada" presented at *Environmental and Social Assessment Forum,* Columbia Mountains Institute for Applied Ecology (Cranbrook, BC, February 2016)

“Recognizing and Protecting Ecosystem Services” presented at *Imagineering a Compassionate Calgary, Change-Makers for a Healthier Future* (Calgary, AB, November 2015)

“Ecosystem Services in the Courts and other Adjudicative Contexts: The Canadian Experience” presented at *Adjudication of Environmental Disputes*, a conference organized by Chile’s 3rd Environmental Court (Valdivia, Chile, November 2015)

“An Abdication of Responsibility: Assessing Canada's Habitat/Fisheries Protection Regime” presented at *'Après...le Déluge': Future Directions for Environmental Law and Policy in Canada*, the Journal of Environmental Law and Practice's 5th Biennial Conference (Calgary, AB, June 2015)

“The Horse is There But Will it Ever Drink? Environmental Damages and Bill C-46” *The Negotiator* (Canadian Association of Petroleum Landmen) (June, 2015 at 11 – 15)

“Environmental Damages under Bill C-46 (*Pipeline Safety Act*)”: Formal Briefs to the House of Commons Standing Committee on Natural Resources (Ottawa, ON, April 2015) and the Senate Committee on Energy, the Environment and Natural Resources (via webconference, May, 2015)

“Tort Liability of Public Authorities: ‘Chaotic and Uncertain, with No End in Sight,’” presented to the Environmental Law section of the CBA-Alberta South Section meeting (Calgary, AB, April 2015)

“Hydraulic Fracturing: A Primer and Overview of Western Canadian Regimes,” presented at *Igniting a Spark*, the 3rd Conference of the Canadian Association of Environmental Law Societies (CAELS) (Calgary, AB, February 2015)

“Revisiting Regulatory Negligence: The *Ernst* Fracking Litigation” *The Negotiator* (Canadian Association of Petroleum Landmen) (December, 2014 at 11 – 15)

“Keeping the Rivers Flowing: The Potential Role of the *Fisheries Act*" presented at *As Long as the Rivers Flow: Coming Back to the Treaty Relationship in our Time* (Fort McMurray, AB, June 2014)

“Getting a Perspective on Project Proposals in a Shifting Regulatory Landscape: The Federal Regime" presented at the Pacific Business Law Institute's (PBLI) conference on Aboriginal Law 2014 (Vancouver, BC, June 2014)

“The Trend Towards ‘Adaptive Management’” *Lawyer's Weekly* Vol. 33, No. 34 (January 24, 2014)

“Recognizing the Value of Nature in Environmental Sentencing: Applying the Ecosystem Services Framework” (with Andrew Kadykalo) presented at *Thinking Big and Small: Inaugural Conference of the Canadian Association of Environmental Law Students* (CAELS) (Ottawa, ON, February 2013)

“The Alberta Oil Sands: Fuelling Innovation in Environmental Law and Policy?” presented at the 23rd Annual Meeting of the Canadian Bar Association – National Environment, Energy and Resources Law Section (NEERLs) and Justice Canada (Ottawa, ON, November 2011)

“Thirty Years after Berger Report, Joint Review Panel Gives MGP Green Light” *Eco-bulletin*, Canadian Bar Association – NEERLs Newsletter (March 2010)

“Recent Developments in Environmental Assessment” (co-panellist with John Dodsworth, Department of Justice, Canada), presented at the 19th Annual Meeting of the Canadian Bar Association – NEERLs and Justice Canada (Ottawa, ON, November 2009)

VI. PROFESSIONAL AND VOLUNTEER ACTIVITIES

Global Fellow, Smart Prosperity Institute (2019 – present)

Panel Member, "The Expert Panel on the State of Knowledge and Practice of Integrated Approaches to Natural Resource Management in Canada" Canadian Council of Academies (2017 – 2019)

Research Fellow, School of Public Policy, University of Calgary (2018 – 2020)

Member of the Board, Canadian Institute for Resources Law (2013 – 2019)

Co-Editor, *Journal of Environmental Law and Practice* (2011 – 2020)

VII. LANGUAGES

English (Fluent)

French (Fluent) (Federal government classification: C/C/E)

Polish (Fluent)

Spanish (Intermediate)

EXHIBIT C

Part of EIA	Page Number	Reference	Topic
Section A-Project Introduction	A-117	"based on monitoring results of reclaimed landscapes, **adaptive management** will be incorporated by Benga in order to allow for continual improvement of erosion control processes;	
Section A-Project Introduction	A-118	When the follow-up monitoring program identifies issues requiring mitigation, Benga will undertake maintenance activities such as erosion control and in-fill planting of areas with selected species to enhance the reclamation process. An **adaptive management** program will allow for specialized responses to specific issues that may arise.	
Section A-Project Introduction	A - 123	When the follow-up monitoring program identifies issues requiring mitigation, Benga will undertake maintenance activities such as erosion control and in-fill planting of areas with selected species to enhance the reclamation process. An **adaptive management** program will allow for specialized responses to specific issues that may arise	
Section A-Project Introduction	A - 124	The proposed mitigation measures and wildlife monitoring program described in this section were designed to reduce or minimize the effects of the Project on wildlife and to monitor the effects of the Project to allow for effective **adaptive managemen**t of mitigation measures over time to ensure that the Project-related effects on wildlife are avoided or minimized.	
Section A-Project Introduction	A - 131	improving Benga's understanding of the effects of Project construction and operation on wildlife within the WLSA and surrounding area to enable the implementation of **adaptive management** practices when required; and	
Section A-Project Introduction	A - 133	When the follow-up monitoring program identifies issues requiring mitigation, Benga will undertake maintenance activities such as erosion control and in-fill planting of areas with selected species to enhance the reclamation process and the movement of wildlife into the area. An **adaptive management** program will allow for specialized responses to specific issues that may arise.	
Section A-Project Introduction	A - 135	monitor changes in land use policies and initiatives and, through **adaptive management**, incorporate new requirements into the ongoing development, operation, and reclamation plans.	
Section A-Project Introduction	A - 135	When the follow-up monitoring program identifies issues requiring mitigation, Benga will undertake maintenance activities such as erosion control and in-fill planting of areas with selected species to enhance the reclamation process and the suitability of landscapes for targeted end land and resource uses. An **adaptive management** program will allow for specialized responses to specific issues that may arise	

Part of EIA	Page Number	Reference	Topic
Section A- Project Introduction	A - 147	**adaptive management** of the C&R and Closure Plans will be pursued through the incorporation of the results of the site wide environmental monitoring programs.	
Section A- Project Introduction	A - 149	Reclamation will begin as soon as practical after mining activities are completed in areas where no additional mining, dumping, or stockpiling is required. Progressive reclamation will be optimized though the mine planning process to take advantage of all opportunities for progressive reclamation. Benga's **adaptive management** approach will involve establishing end land use; monitoring reclamation, soils, revegetation, and wildlife to allow objectives and end point to be reviewed, and, if necessary, develop modified mitigations and site expectations according to changing conditions.	
Section C- Project Description	C -131	C.7.4 Regulatory Compliance and Adaptive Management Benga will commit to ensuring that its activities and operations comply with all relevant laws and regulations. This commitment is attained in numerous ways: • designated Benga employees to be kept informed of relevant laws, regulations and operating guidelines through training programs; • continual review and updating of emergency preparedness procedures; and • continual review and updating of operating procedures including responsible handling, use and disposal of products and materials. Environmental and Occupational Health and Safety Inspectors will routinely monitor Benga's site operations and regulatory compliance. Benga will continue carrying out its environmental and operating programs in the Project area using an **adaptive management** approach.	Regulatory Compliance
Section C- Project Description	C -131	C.7.6 Environmental Protection Program The purpose of the Environmental Protection Program at the Benga is to first prevent and second to minimize adverse environmental impacts resulting from mine related operations. The program will be implemented in the Project area through the following on-site mechanisms: **adaptive management** approach to environmental risk assessment .... (this section continues)	
Section C- Project Description	C -132	C.7.6.1 Adaptive Management and Environmental Risk Assessment [this whole subsection is about adaptive management)	
Section D- Environmental Impact Assessment Methodology	D-19	how results of the follow-up or monitoring program will be applied, including consideration of an **adaptive management** approach.	

Part of EIA	Page Number	Reference	Topic
Section E- Environmental Assessment	E - 95	Given the potential for sulphate concentrations in Blairmore Creek to reach levels above a published no-effect-threshold in low-flow winter months late in mine life (i.e., 2030s) before returning to below this threshold on mine closure, monitoring and **adaptive management** for sulphate should include development of a site-specific water quality for sulphate for Blairmore Creek. Development of this objective during early mine life would allow this process to include toxicity testing of process waters with ionic composition reflective of actual mine operations.	
Section E- Environmental Assessment	E -135	based on monitoring results of reclaimed landscapes, **adaptive management** will be incorporated by Benga in order to allow for continual improvement of erosion control processes;	
Section E- Environmental Assessment	E - 199	improving Benga's understanding of the effects of Project construction and operation on wildlife within the WLSA and surrounding area to enable the implementation of **adaptive management** practices when required; and	
Section E- Environmental Assessment	E - 211	Reclamation activities will be undertaken throughout the life of the mine as mining in each pit is competed. During this process Benga will ensure that end land use objectives are developed in consultation with stakeholders, building on the existing consultation process and **adaptive management** of the Conservation & Reclamation and Closure plan will be pursued through the incorporation of the results of the site wide environmental monitoring programs and through regional research initiatives. The details of the reclamation plan are provided in Section F of the application.	
Section E- Environmental Assessment	E - 216	monitor changes in land use policies and initiatives and, through **adaptive managemen**t, incorporate new requirements into the ongoing development, operation, and reclamation plans.	
Section F- Conservation and Reclamation Plan	F - 8	**adaptive management** of the C&R and Closure Plans will be pursued through the incorporation of the results of the site wide environmental monitoring programs.	
Section F- Conservation and Reclamation Plan	F - 32	monitor changes in land use policies and initiatives and, through **adaptive management,** incorporate new requirements into the ongoing reclamation plans.	

Part of EIA	Page Number	Reference	Topic
Section F- Conservation and Reclamation Plan	F - 38	F.2.3 **Adaptive Management** for Reclamation Benga's **adaptive management** approach will involve establishing end land use objectives according to pre-development land use capability, site-specific conditions, improved practices based on research and monitoring results, and input from the public engagement and aboriginal consultation programs. As reclamation proceeds, monitoring of reclamation and revegetation performance will allow land use objectives to be reviewed and, if necessary, modifications can be made to site expectations according to natural revegetation processes. Adaptive management is intended to respond to changes and advances in technology, such as reclamation material replacement and revegetation, to meet specific objectives. Benga will incorporate **adaptive management** techniques as routine components in all of its environmental management activities. These techniques provide the opportunity to develop and fine-tune the reclamation program using data collected on-site and from other regional operators. **Adaptive management** may be used at any point throughout the project life cycle, but will have the greatest benefit in the early planning stages when the location and compositions of landforms are still to be decided. When landforms are designed or constructed, their intended end use will facilitate the decision-making process on surface contouring measures and corrective initiatives that could improve surface drainage, decrease erosion or enhance vegetation performance. Benga will use the experience gained during the development of the Project, and other successes by the regional coal operators over the next 24 years, to manage and implement an effective reclamation program. Benga will work with other operators of coalmines, AEP, AER and local stakeholders, to further develop criteria and monitoring programs that clearly demonstrate progress toward reclaiming environmentally sound sustainable ecosystems.	

Part of EIA	Page Number	Reference	Topic
Section F- Conservation and Reclamation Plan	F - 39	uncertainties in landscape performance and technology will be resolved through use of the principles of **adaptive management**, and knowledge gaps are to be resolved through research programs;	
Section F- Conservation and Reclamation Plan	F - 40	an adaptive revegetation strategy to take advantage of opportunities for establishment of a variety of target vegetation communities and wetlands (closed conifer forests, moderate mixed forests, native herbaceous grasslands and treed wetlands); or other vegetation communities that may become more appropriate with knowledge gained from **adaptive management;**	Reclamation - revegetation
Section F- Conservation and Reclamation Plan	F - 53	Development of the mine will require clearing existing vegetation from the Project Footprint. The Project Footprint has been developed recognizing Benga's commitment to minimizing the amount of disturbance that is required for Project development. There may be opportunities to reduce the mine disturbance area through an **adaptive management** program.	Mine disturbance area
Section F- Conservation and Reclamation Plan	F - 63	As the mine reaches maximum disturbance in Year 15, approximately 4.0 ha of reclaimed landscape will be selected to seed monocultures of foothills rough fescue as recommended by Sherritt (2012) in Lancaster, et al. (2016) as shown in Figure F.3.6-4. Once seeded, monitoring programs will be implemented that will assess the success of foothills rough fescue establishment so that corrective actions can be recommended. The early development of rangeland communities will benefit from the remaining years of reclamation schedule and will utilize the **adaptive management** program to ensure that healthy rangeland communities are established. Following Year 15, additional landscape areas will be selected based on the results of the previously targeted foothills rough fescue dominated areas.	Reclamation - revegetation
Section F- Conservation and Reclamation Plan	F - 75	Lands will be progressively reclaimed and **adaptive managemen**t techniques will be incorporated when selecting the appropriate revegetation techniques.	Reclamation

Part of EIA	Page Number	Reference	Topic
Section F- Conservation and Reclamation Plan	F - 79	These conceptual seed mixes have been discussed with the local Alberta Environment and Parks land manager and comply with the expectations of the Operating Ground Rules for the C5 FMU (ASRD, 2012). The mixes are considered conceptual and, through the mine **adaptive management** and continuous improvement processes, may require substitutions resulting from species availability and as new species (native and agronomic) are developed. These seed mixes will therefore be reviewed and approved with the local land managers in advance of seeding.	Reclamation - revegetation
Section F- Conservation and Reclamation Plan	F - 83	When the monitoring program identifies issues requiring mitigation, Benga will undertake maintenance activities such as erosion control and in-fill planting of areas with selected species to increase biodiversity, structural diversity, and stocking requirements. The **adaptive management** program will allow for specialized responses to specific issues that may arise.	Reclamation - biodiversity
Section F- Conservation and Reclamation Plan	F - 85	An important component of the reclamation program will be the monitoring of the biophysical aspects of the program. The identification of successes and limitations early in the reclamation process will allow modifications to be made through the **adaptive management** program to be used at the Project. In addition to providing important feedback on the effectiveness of reclamation techniques, it will also provide data to use in planning the certification of reclaimed lands and the release of lands back to the Crown.	Reclamation
Section F- Conservation and Reclamation Plan	F - 87	The basis of the reclamation material salvage practices for the Project is discussed in detail in Section F.3.4 of the reclamation plan. During the development and operations of the Project, **adaptive managemen**t and continual improvement programs may introduce changes to the salvage practices.	Reclamation

Part of EIA	Page Number	Reference	Topic
Section F- Conservation and Reclamation Plan	F - 88	At closure, there will be approximately 1,462.6 ha of recontoured area that will have had an average of 20 cm of reclamation material replacement. Reclamation material replacement practices are discussed in detail in Section F.3.6.2. During the development and operations of the Project, the **adaptive management** program may introduce changes to the replacement practices. All salvaged reclamation material will be replaced on the recontoured areas.	Reclamation
Section F- Conservation and Reclamation Plan	F - 88	Upon closure, much of the reclaimed landscape will be in various stages of development because of the progressive reclamation program. The revegetation techniques in use at closure will be a continuation of practices employed during development and progressive reclamation of the mine. These practices may be modified by **adaptive management** and continuous improvement programs at the mine.	Reclamation - revegetation
Section H - Aboriginal Groups Consultation and Assessment	H - 47	Section E.8.3 characterizes residual effects as local in geographic extent, long-term in duration, continuous in frequency, reversible, and high magnitude. The Project will have a neutral contribution with respect to valued species and communities. The reclaimed land will support a range of communities with equivalent capabilities to those of the surrounding lands and that existed prior to development. The Project will not result in the loss of the resource to the communities, the region or the province. The confidence rating is high. The effect of the project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring. The probability of occurrence is high given the type of project and method of coal extraction.	Reclamation - revegetation

Part of EIA	Page Number	Reference	Topic
Section H - Aboriginal Groups Consultation and Assessment	H - 92	Section E.8.3 characterizes residual vegetation effects as local in geographic extent, long-term in duration, continuous in frequency, reversible, and high magnitude. The Project will have a neutral contribution with respect to TK species and communities. The reclaimed land will support a range of communities with equivalent capabilities to those of the surrounding lands and that existed prior to development. The Project will not result in the loss of the resource to the communities, the region, or the province. The confidence rating is high. The effect of the Project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring. The probability of occurrence is high given the type of project and method of coal extraction	Reclamation - revegetation
Section H - Aboriginal Groups Consultation and Assessment	H - 129	Section E.8.3 characterizes residual effects as local in geographic extent, long-term in duration, continuous in frequency, reversible, and high magnitude. The Project will have a neutral contribution with respect to TK species and communities. The reclaimed land will support a range of communities with equivalent capabilities to those of the surrounding lands and that existed prior to development. The Project will not result in the loss of the resource to the communities, the region or the province. The confidence rating is high. The effect of the Project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring. The probability of occurrence is high given the type of project and method of coal extraction.	Reclamation - revegetation

Part of EIA	Page Number	Reference	Topic
Section H - Aboriginal Groups Consultation and Assessment	H - 160	Section E.8.3 characterizes residual effects as local in geographic extent, long-term in duration, continuous in frequency, reversible, and high magnitude. The Project will have a neutral contribution with respect to TK species and communities. The reclaimed land will support a range of communities with equivalent capabilities to those of the surrounding lands and that existed prior to development. The Project will not result in the loss of the resource to the communities, the region or the province. The confidence rating is high. The effect of the project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring. The probability of occurrence is high given the type of project and method of coal extraction.	Reclamation - revegetation
Section H - Aboriginal Groups Consultation and Assessment	H - 190	Section E.8.3 characterizes residual effects as local in geographic extent, long-term in duration, continuous in frequency, reversible, and high magnitude. The Project will have a neutral contribution with respect to TK species and communities. The reclaimed land will support a range of communities with equivalent capabilities to those of the surrounding lands and that existed prior to development. The Project will not result in the loss of the resource to the communities, the region or the province. The confidence rating is high. The effect of the project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring. The probability of occurrence is high given the type of project and method of coal extraction.	Reclamation - revegetation

Part of EIA	Page Number	Reference	Topic
Section H - Aboriginal Groups Consultation and Assessment	H - 225	CR #8 characterizes residual effects as local in geographic extent, long-term in duration, continuous in frequency, reversible, and high magnitude. The Project will have a neutral contribution with respect to valued species and communities. The reclaimed land will support a range of communities with equivalent capabilities to those of the surrounding lands and that existed prior to development. The Project will not result in the loss of the resource to the communities, the region, or the province. The confidence rating is high. The effect of the Project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring. The probability of occurrence is high given the type of project and method of coal extraction	Reclamation - revegetation
Section H - Aboriginal Groups Consultation and Assessment	H 252	Section E.8.3 characterizes residual effects as local in geographic extent, long-term in duration, continuous in frequency, reversible, and high magnitude. The Project will have a neutral contribution with respect to valued species and communities. The reclaimed land will support a range of communities with equivalent capabilities to those of the surrounding lands and that existed prior to development. The Project will not result in the loss of the resource to the communities, the region or the province. The confidence rating is high. The effect of the project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring. The probability of occurrence is high given the type of project and method of coal extraction.	Reclamation - revegetation

Part of EIA	Page Number	Reference	Topic
Appendix 2 - Canadian Environmental Assessment Agency Terms of Reference and Concordance Tables	Appendix 2a- 71 "Table 2A CEAA Guidelines for the Preparation of Environmental Impact Statement for Benga Mining Limited Proposed Grassy Mountain Coal Project"	"**Adaptive management** is not considered as a mitigation measure, but, if the follow-up program (refer to section 9) indicates that corrective action is required, the proposed approach for managing the action should be identified"	
Appendix 2 - Canadian Environmental Assessment Agency Terms of Reference and Concordance Tables	Appendix 2a -6 "Table 2D-1 Key Mitigations and Monitoring Commitments for all Project Valued Components"	"• based on monitoring results of reclaimed landscapes, **adaptive management** will be incorporated by Benga in order to allow for continual improvement of erosion control processes;"	Erosion
Appendix 2 - Canadian Environmental Assessment Agency Terms of Reference and Concordance Tables	Appendix 2d-12 "Table 2D-1"	improving Benga's understanding of the effects of Project construction and operation on wildlife within the WLSA and surrounding area to enable the implementation of **adaptive management** practices when required;	Wildlife-birds

Part of EIA	Page Number	Reference	Topic
Consultant Report #7 - Terrain & Soils	Page 61	4.5.2 Reclaimed Ratings The main goal for the reclamation program is to achieve land capability equivalent or higher than predisturbance conditions. The reclaimed ratings are estimated based on construction and reclamation procedure outlined in the C&R Plan for the Project (Section F) in Sections F.2.2 Reclamation Schedule, F.2.3 **Adaptive Management** for Reclamation, F.3.4 Soil Conservation Program, F.3.6 Mine Reclamation and F.4.2 Soil Management, predicted composition of the reclaimed profile, projected drainage and projected landform model created post reclamation.	Reclamation - soil
Consultant Report #7 - Terrain & Soils	page 91	"Mitigation and monitoring measures are detailed in the C&R Plan provided in Section F in Sections F.2.2 Reclamation Schedule, F.2.3 **Adaptive Management** for Reclamation, F.3.6 Mine Reclamation and F.3.9 Research and Monitoring to ensure soil quality is maintained throughout the life of the Project"	Reclamation - soil
Consultant Report #7 - Terrain & Soils	Page 92	• based on monitoring results of reclaimed landscapes, **adaptive management** will be incorporated by Benga in order to allow for continual improvement of erosion control processes.	Reclamation - soil
Consultant Report #7 - Terrain & Soils	Page 101	Monitoring of post reclamation landscapes for stability, drainage, and the interaction of the vegetation communities in the reclaimed landscapes will be completed after reclamation and revegetation. Areas of concern would be addressed as necessary to mitigate terrain conditions undesirable for end land use and reclaimed vegetation communities. Monitoring will allow for **adaptive management** of the re-contouring, soil placement and re-vegetation activities throughout the life of the Project.	Reclamation - soil

Part of EIA	Page Number	Reference	Topic
Consultant Report #7 - Terrain & Soils	Page 106	Mitigation Project disturbance will result in reclaimed landscapes that will provide a range of capabilities that will be spatially unique to pre-disturbance conditions. Reducing the length of time to achieve equivalent land capability is based largely on the success of reclamation. It is expected that Benga will reclaim disturbed areas to meet all regulatory requirements related to soil salvage, storage and replacement. In addition, Benga will utilize best management practices currently used in the industry as well as **adaptive management** to ensure that reclamation practices are effective.	Reclamation - soil
Consultant Report #8 - Vegetation	Page 128	An **adaptive management** approach, including non-native invasive species control and monitoring, and re-vegetation establishment assessments will be used to ensure that sites have been re-vegetated to meet target vegetation communities.	Reclamation - revegetation
Consultant Report #8 - Vegetation	Page 129	Monitoring should provide the information required for **adaptive management.** Information from early phases of reclamation to determine survival and growth should be used to revise and provide direction for reclamation and future closure monitoring.	Reclamation - revegetation
Consultant Report #8 - Vegetation	Page 130	Confidence Rating: The confidence rating is high. The effect of the project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring	Reclamation - revegetation

Part of EIA	Page Number	Reference	Topic
Consultant Report #8 - Vegetation	Page 156-157	Ability for Recovery: Reclaimed terrain and soils will support establishment of native communities and include slope and aspect conditions suitable for rough fescue. Present reclamation techniques for native rough fescue grassland communities have met with limited success; however, the Project has an expected reclamation period of approximately 26 years from when approximately Project reclamation begins and is expected to end, and will include **adaptive management** (Application, Section F, Conservation and Reclamation Plan (Benga 2016)) which may allow for improved reclamation techniques to be developed. Based on this, the impacts to the rough fescue grasslands communities are anticipated to be reversible in the long term with the planned mitigation.	Reclamation - revegetation
Consultant Report #8 - Vegetation	Page 169	• Confidence Rating: The confidence rating is high. The effect of the project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring.	Reclamation - revegetation
Consultant Report #8 - Vegetation	Page 175	• Confidence Rating: Confidence rating is high and based on good understanding of cause effect relationships and data pertinent to study. Wetlands have been successfully created on other mountain mines in Alberta and mitigation will be supported by **adaptive management** and monitoring.	Reclamation - revegetation
Consultant Report #8 - Vegetation	Page 217-218	an adaptive re-vegetation strategy to take advantage of opportunities present on the re-contoured lands for establishment of a variety target vegetation communities and wetlands as outlined in the reclamation plan (closed conifer forests, grassland open forests, mixed forests, and treed wetlands); or other vegetation communities that may become more appropriate with knowledge gained from **adaptive management.**	Reclamation - revegetation

Part of EIA	Page Number	Reference	Topic
Consultant Report #8 - Vegetation	Page 218	• complete surveys early in the life of the re-vegetation program, to assess the level of biodiversity success and allow for **adaptive management** of subsequent stages of revegetation	Reclamation - revegetation
Consultant Report #8 - Vegetation	Page 220	Confidence Rating: The confidence rating is moderate due to the uncertainties in individual rare species designations and regional distributions. The effect of the Project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring	Reclamation - revegetation
Consultant Report #8 - Vegetation	page 221	Confidence Rating: The confidence rating is high. The effect of the Project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring	Reclamation - revegetation
Consultant Report #9 - Wildlife 5.0 Application Case Assessment	Page 253	Working in consultation with the olive-side flycatcher recovery team to monitor olive-sided flycatcher presence, abundance, habitat use, fidelity to breeding sites, and factors affecting survival and reproductive output within the WLSA would provide valuable information required for the conservation of this species in both the short-term and long-term and at the local and regional scales. A monitoring program such as this, which includes a Beneficial Management Practices guide, would assist with **adaptive management**, improving breeding and foraging habitats and reducing risks to the species in the WLSA and the broader regional scale.	olive-side flycatcher

Part of EIA	Page Number	Reference	Topic
Consultant Report #9 - Wildlife 7.0 Wildlife Mitigation and Monitoring	Page 328	The Project has the potential to affect wildlife through a number of effects mechanisms such as direct and indirect habitat loss, habitat fragmentation/connectivity, and changes in movement patterns, and increased mortality risk. The proposed mitigation measures and wildlife monitoring program described in this section were designed to reduce or minimize the effects of the Project on wildlife and to monitor the effects of the Project to allow for effective **adaptive management** of mitigation measures over time to ensure that the Project-related effects on wildlife are avoided or minimized.	Wildlife monitoring
Consultant Report #9 - Wildlife 7.0 Wildlife Mitigation and Monitoring	page 336	improving Benga's understanding of the effects of Project construction and operation on wildlife within the WLSA and surrounding area to enable the implementation of **adaptive management** practices when required; and	Wildlife monitoring
Consultant Report #10 - Land & Resource Use	Page 42	Reclamation activities will be undertaken throughout the life of the mine as mining in each pit is competed. During this process, Benga will ensure that end land use objectives are developed in consultation with stakeholders, building on the existing consultation process and **adaptive management** of the Conservation & Reclamation and Closure plan will be pursued through the incorporation of the results of the site wide environmental monitoring programs and through regional research initiatives. The details of the reclamation plan are provided in Section F of the application	Reclamation - land
Consultant Report #10 - Land & Resource Use	Page 45	Benga will continue to keep up to date with the implementation of the SSRP and, through their **adaptive management** program, will incorporate changes to their development and operation as the need is identified.	Reclamation - land

Part of EIA	Page Number	Reference	Topic
Consultant Report #10 - Land & Resource Use	page 64	MITIGATION & MONITORING RECOMMENDATIONS …. monitor changes in land use policies and initiatives and, through **adaptive management**, incorporate new requirements into the ongoing development, operation, and reclamation plans	Reclamation - land
Addendum One - Aquatic Ecology Summary	Page E-6 - 20	Benga is committed to achieving continual improvement in environmental performance. The development and implementation of all monitoring and mitigation (including offsetting) identified for the Project and housed in the monitoring and follow up programs will be tracked in relevant management plans. As site conditions and monitoring dictate, or as new technology emerges, we will **adaptively manage** our site practices and monitoring program to meet the defined objectives. For some programs this would involve regular evaluation of predictive models; which would be clearly defined in each applicable management plan.	https://iaac-aeic.gc.ca/050/documents/p80101/117248E.pdf

Part of EIA	Page Number	Reference	Topic
Addendum One - Aquatic Ecology Effects Assessment Addendum Report #6	Page 98	Header 6.1.1 "Adaptive Management" Benga is committed to achieving continual improvement in environmental performance. The development and implementation of all monitoring and mitigation (including offsetting) identified for the Project and housed in the monitoring and follow up programs will be tracked in relevant management plans. As site conditions and monitoring dictate, or as new technology emerges, we will adaptively manage our site practices and monitoring program to meet the defined objectives. For some programs this would involve regular evaluation of predictive models; which would be clearly defined in each applicable management plan. If a monitoring and follow-up program identifies that adverse environmental effects are greater than predicted, then Benga will evaluate whether they result in changes to the conclusions presented in this effects assessment. If changes are confirmed, then Benga will evaluate the need for revised mitigation actions and management practices to manage effects. Where the need for revised mitigations is identified, they will be developed and implemented.	Aquatic Ecology

Part of EIA	Page Number	Reference	Topic
Addendum Four - Attachment 2	Attachment 2 -32	Benga proposes to plant a minimum of three times the number of trees removed due to operation of the Project (estimated at 1,000 trees thus 3,000 trees planted). Establishing limber pine by planting seedlings is feasible. According to Pigot and Moody (2013), “limber pine seeds germinate readily, and it is possible to produce good quality seedlings for outplanting in one growing season. Survival after planting appears to be high and planting is one of the more productive restoration activities…” As summarised in the Alberta Limber Pine Recovery plan, limber pine seed has been collected many times in the past in Alberta, and trees have been successfully established. Planting a minimum of three times the number of trees removed has been selected to account for mortality during planting, subsequent natural losses, uncertainty in long term survival, and to provide a buffer to ensure a net increase in the number of trees. **Adaptive management** (Section F.2.3) will be implemented throughout the reclamation period to reduce mortality from planting and to increase long-term survival.	Limber Pine
Addendum Four - Attachment 2	Attachment 2 -80	As stated in Section C.9, Benga is committed to developing an ERP in relation to water management for a dam failure as well as implementing site-specific Standard Operating Policies and Procedures (SOPPs) to prevent a failure. The ERP will provide the emergency responses to be implemented by Benga during the construction and operation of the dams in the event of a failure. The ERP will be reviewed and updated as needed throughout the construction and operations phases of the Project to incorporate changes in site conditions, continual environmental improvement and **adaptive management** based on monitoring results, if necessary.	Water management emergency response

Part of EIA	Page Number	Reference	Topic
Addendum Four - Attachment 2	Attachment 2 -91	The potential effects of changes in fire regime (reduced frequency, increased area burned) in relation to the historical fire on VCs and Benga's proposed mitigation and reclamation plans are summarized in Table 25-2. These changes are based on Boulanger et al. (2014) as they provide the most recently available site-specific predictions. Benga is aware that climate changes may be different than those indicated and will use **adaptive management** strategies to tailor its mitigation and monitoring plans to the conditions that prevail.	Forest fires
Addendum Four - Attachment 3	Attachment 3 -6	The Aquatic Effects Monitoring Program (AEMP) (CR#6, Section 6), is proposed to test the predictions regarding potential Project effects on stream flows, water quality, sediment quality, and fish and fish habitat during operations, closure, and early-post closure phases. As site conditions and monitoring dictate, and as new technology emerges, **adaptive management** will be implemented to adjust site practices and the monitoring program as needed. If the monitoring and follow-up program identify unexpected adverse effects to the aquatic environment, the effects assessment will be reevaluated and revised, addressing any needed development and implementation of new mitigation and management practices	https://iaac-aeic.gc.ca/050/documents/p80101/121164E.pdf
Addendum Four - Attachment 3	Table 4-1 "Approaches and Strategies from the Alberta Westslope Cutthroat Trout Recovery Plan 2012-2017 that were and/or will be applied to identify potential threats from the Project"; Attachment 3-8	Aquatic Resources Management Plan, Aquatic Effects Monitoring Program, compliance and effectiveness monitoring for Fisheries Act Authorization include evaluation of mitigation and **adaptive management** approach to address any changes required due to mitigation not functioning as intended or changes in the management and/or regulation framework (CR#6, Section 6.1.1).	Westslope Cutthroat Trout

Part of EIA	Page Number	Reference	Topic
Addendum five	Page 11	Benga will have an extensive monitoring program involving a wide range of environmental values including air and water quality, fisheries, soils, wildlife and revegetation as part of the Project's overall monitoring requirements. Benga has proposed to finalize these monitoring programs and submit them to the regulatory authorities at the appropriate time prior to construction, operation or reclamation. Benga has committed to an **adaptive management** philosophy through the life of the project that would see the monitoring plans modified as required as mining progresses to improve performance relative to environmental values	
Addendum five	Page 13	As the reclamation process is progressive, it lends itself to **adaptive management** through the incorporation of the results of the site wide environmental monitoring programs and experiences from earlier reclamation activities.	Reclamation

Part of EIA	Page Number	Reference	Topic
Addendum five	Page 88	The saturated zones in the mine-out open pits do not have sufficient capacity to store all the waste rock produced during production; therefore, inundation is not a viable source control method. The installation of low-permeability covers was evaluated but rejected due to the slope angles of the waste rock areas as discussed in SIR 93a. As such, pure source control methods are not feasible for the Grassy Mountain Project; however, options for creating “anoxic barriers” at the base of the waste rock dumps have been discussed and will continue to be explored during detailed design. These barriers would be permeable zones enriched with organic material. As waste rock seepage passes through these zones, anaerobic conditions would develop and nitrate and selenium would be come attenuated. The concept is similar to permeable reactive barriers, which are often used for remediation of contaminated groundwater. However, rather than intercepting groundwater flow along a horizontal flow path, the anoxic barrier would intercept seepage as it flows downward within the waste rock mass toward the base of the dump. Geotechnical implications of such a design must be carefully considered to ensure that such an anoxic barrier would not cause instabilities. This concept was not presented as part of the Environmental Impact Assessment, but is being considered as an **adaptive management**, continuous refinement of the Selenium Management Plan.	Selenium mitigation

Part of EIA	Page Number	Reference	Topic
Addendum five	Page 125-126	Based on this study, vegetation establishment in the shallow portions of the EPL should occur along the fringe of the EPL five years after the lake elevation achieves a sustainable water elevation. Through **adaptive management**, if after five years the establishment of macrophyte communities has not occurred, the conservation and reclamation plan will be re-evaluated to assist in the development of vegetative communities in the EPL. Hatfield (2014) recommended that if manual planting is undertaken in should occur in shallow sheltered areas of the EPLs.	Selenium mitigation
Addendum five	Page 136	minimize the overall disturbance footprint through the mine planning process. There may be opportunities to reduce the mine disturbance area through an **adaptive management** program; … based on monitoring results of reclaimed landscapes, adaptive management will be incorporated by Benga in order to allow for continual improvement of erosion control processes.	
Addendum five	Page 141	Through Benga's **adaptive management** strategy, Benga can incorporate input from public engagement and aboriginal consultation programs, along with data from monitoring or reclamation and revegetation performance to modify their plans to continual to enhance the revegetation process.	Reclamation - revegetation
Addendum five	Page 141	As described in response 128b, Benga will utilise **adaptive management** and consultation with aboriginal groups. Where wet conditions are present within the reclaimed areas, such as ponds, it may be possible to establish dwarf birch by planting, transplanting or seeding. Opportunity to establish dwarf birch may be limited by regulated seed zones and limits on transport distance and elevation changes for woody vegetation. These opportunities and limitations will form part of the ongoing consultations.	Dwarf Birch

Part of EIA	Page Number	Reference	Topic
Addendum five	Page 141- 142	The estimate of 21,000 whitebark pine (WBP) trees within the footprint is intentionally conservative and includes estimates of juvenile trees and seedlings. Benga is committed to planting three times the number of trees removed from mining and to support establishment of disease resistant trees wherever possible as this is the key component of recovery. Tree plantation success will be assured by application of **adaptive management**, active participation/engagement with recovery plans and groups, and use of best management practices as they evolve over time	Whitebark Pine
Addendum five	Page 157	Both WBP and fescue grasslands are considered high sensitivity to disturbance and high risk for reclamation and therefore require specific modifications to the typical mine reclamation procedures. Details on the methods to establish WBP and limber pine are in Section F, Section F.3.2.2 and Foothills Rough Fescue in Section F, Section F.3.2.4. Benga is committed to engagement and use of best management practises for the establishment of WBP, limber pine and fescue. Benga is also committed to undertaking maintenance (Section F.3.8) on reclaimed lands and application of **adaptive management** to reduce the risk to reclamation.	

Addendum five	** There are specific mentions of adaptive management that have been recorded in this table. Unfortunately, there are no corresponding page numbers. The different responses from this table are spread out in the next few columns.	"Section E.8 of the August 2016 Environmental Impact Assessment (EIA) document assessed the potential for invasive species (with technical detail in Consultant Report # 8 - Vegetation). Proposed mitigation measures related to invasive species are outlined in Section 4.9.4 of Consultant Report #8. An **adaptive management** approach, including non-native invasive species control and monitoring, and monitoring of postreclamation revegetation establishment will be used to manage the risk of non-native and invasive	The potential for invasive species is assessed in the Environmental Impact Assessment (EIA) Update (August 2016) (with technical detail in Consultant Report # 8 - Vegetation). Proposed mitigation measures related to invasive species are outlined in Section 4.9.4 (Consultant Report #8). An **adaptive management** approach, including non-native invasive species control and monitoring, and revegetation establishment assessments will be used to ensure that sites have	Section F in the August 2016 Environmental Impact Assessment (EIA) document provides the proposed Conservation and Reclamation (C&R) Plan for the Project. This was provided to Piikani Nation in August 2016. Section F.1.5 describes the reclamation goals and principles that were incorporated in the C&R and closure plans. Section F.1.6 describes proposed End Land Use goals and includes a commitment that end land use decisions will be made in consultation	"How can we develop more detailed monitoring and **adaptive management** programs." … "Benga supports an **adaptive management** approach to its monitoring and environmental programs and will try to incorporate this approach into its environmental management plans. Benga will be developing specific environmental monitoring and management plans that comply with its regulatory requirements. Benga will provide Piikani Nation the opportunity to participate in the development and	The assessment of potential effects to wildlife includes potential effects to migration and movement with a discussion of proposed mitigation measures in Section E.9.5 of the Environmental Impact Assessment. No eagle nesting sites were identified during the baseline field surveys. As part of the **adaptive environmental management** of the site, should monitoring identify sites in the future appropriate mitigation measures will be undertaken to protect the eagles	No eagle nesting sites were identified during the baseline field surveys. As part of the **adaptive environmental management** of the site, should monitoring identify sites in the future appropriate mitigation measures will be undertaken to protect the eagles including avoidance of the nesting site during the breeding season and relocation, if feasible, in the off season.	Consultant Report #8 provides an assessment of potential effects to vegetation including sensitivity of plant community biodiversity to disturbance. The removal of vegetation within the Project footprint will initially reduce species habitat and increase habitat fragmentation. Mitigation and monitoring are described in Section 4.8.4 of the report including reclamation which will reduce present fragmentation from existing disturbances (primarily previous mining	No eagle nesting sites were identified during the baseline field surveys. As part of the **adaptive environmental management** of the site, should monitoring identify sites in the future appropriate mitigation measures will be undertaken to protect the eagles including avoidance of the nesting site during the breeding season and relocation, if feasible, in the off season.	Siksika Nation did not identify plant species in the Traditional Use study provided. Benga requests Siksika Nation to identify plant species in the Project area that may not be available throughout Siksika Nation territory. Consultant Report #8 provides an assessment of potential effects to vegetation including sensitivity of plant community biodiversity to disturbance. Mitigation measures for biodiversity include an **adaptive re-vegetation strategy** and

		species to help ensure that reclaimed sites meet target vegetation communities and reclamation certification requirements. "	been revegetated to meet target vegetation communities.	with Piikani Nation. Benga has committed to progressive reclamation of sites as they no longer part of the mining operations. Reclamation of some areas may begin as early as year 7. Monitoring of reclaimed sites will provide a measure of reclamation success and enable measures to be implemented in a timely manner as part of Benga's **adaptive managemen**t strategy to resolve issues as they arise.	implementation of it's environmental programs on site"	including avoidance of the nesting site during the breeding season and relocation, if feasible, in the		operations). Mitigation measures for biodiversity include an **adaptive re-vegetation strategy** and reestablishing native species		reestablishing native species.

Part of EIA	Page Number	Reference	Topic
Addendum five	Page A-2-4 "Table H.3.2-1 "Chronology of Key Consultation Activities with the Kainai Nation"	Main discussion items were the EIA project presentation which included a review of timelines, project components, overview of construction, operations, reclamation and closure phases and status of Project applications, including federal and provincial approvals; and the development of the monitoring program and **adaptive management** plans.	
Addendum Six	Page 69	If any additional adverse effects resulting from changes in allochthonous input, increase in streamflow, or water quality (i.e., nutrient loading, changes in stream temperature, elevated sediment load) are detected, Benga will evaluate the opportunity for additional mitigation to reduce the spatial scale, duration or intensity of the effects. As described in CR#6 Section 6.1.1 **Adaptive Management**, Benga is committed to achieving continual improvement in environmental performance by applying an **adaptive management** approach to monitoring and follow-up programs. If residual serious harm to fish remains after mitigation, additional offsetting measures will be evaluated to counterbalance the effect, if required. The detailed Habitat Offsetting Plan will include contingency measures to address additional residual effects to fish and fish habitat.	
Repeated from earlier entry, also included in Addendum Six	Page 81 "Table DFO 8-4 Record of Communication Regarding Fish Monitoring Mitigation, or Offsetting Feedback with the Kainai First Nation (Blood Tribe)"	Main discussion items included: 1) EIA project presentation which included a review of timelines, project components, overview of construction, operations, reclamation and closure phases and status of Project applications, including federal and provincial approvals 2) the development of the monitoring program and **adaptive management** plans.	

Part of EIA	Page Number	Reference	Topic
Addendum Six	Page 89	The fluvial geomorphology analysis was conducted to estimate sediment mobility at critical fish habitat sites (as identified in the Instream Flow Assessment), which indicates that the streambeds of Blairmore and Gold creeks are expected to become more stable through the life of the project. To test the predictions and the uncertainties associated with the assessment, monitoring is proposed as part of the project's Aquatic Monitoring Plan to confirm changes through time that may occur in the sediment grain size. For example, the monitoring program could include a spawning sediment survey to further characterize sample bed grain size in key locations that provide high spawning habitat value and track those areas over time. An **adaptive management** strategy would also be developed to mitigate identified changes.	
Addendum Six	Page 94	The risk of increased mobilization of sand is thought to be unlikely due to the minor changes in base flows in Blairmore Creek. However, to test the predictions and the uncertainties associated with the assessment, a monitoring program is proposed as part of the project's Aquatic Effects Monitoring Plan (AEMP) to confirm whether changes in the sediment grain size materialize with predicted/confirmed alterations in flow noting specific focus on identified high quality spawning habitats. As described in CR#6 Section 6.1.1 Adaptive Management, Benga is committed to achieving continual improvement in environmental performance by applying an **adaptive management** approach to monitoring and follow-up programs, where required.	

Part of EIA	Page Number	Reference	Topic
Addendum Six	Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components" [Land Capacity Effects] A3-10	Effects to reclaimed overburden materials will be mitigated through: • implementing appropriate soil salvage activities such that sufficient volumes of reclamation material are salvaged for placement • sufficient suitable overburden material will be available for placement over unsuitable overburden • upon backfilling and re-contouring of mine blocks, unsuitable overburden will be identified to ensure that sufficient reclamation material is replaced to meet regulatory requirements over all reclaimed lands Reducing the length of time to achieve equivalent land capability is based largely on the success of reclamation. Benga will: • reclaim disturbed areas to meet all regulatory requirements related to soil salvage, storage and replacement • utilize best management practices currently used in the industry as well as **adaptive management** to promote effective reclamation practices	
Addendum Six	Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components" [Land Capacity Effects] A3--11	Effects will be mitigated with a C&R Plan (Section F) that will result in reclaimed landscapes providing a range of capabilities that will be spatially unique to pre-disturbance conditions Reducing the length of time to achieve equivalent land capability is based largely on the success of reclamation. Benga will: • reclaim disturbed areas to meet all regulatory requirements related to soil salvage, storage and replacement • utilize best management practices currently used in the industry as well as **adaptive managemen**t to promote effective reclamation practices	

Part of EIA	Page Number	Reference	Topic
Addendum Six	Appendix A-3 Potential Effects, Mitigations, and Impact Ratings for Project Valued Components" [Biodiversity] A3--13	Mitigation measures for biodiversity will include: • direct placement of soil salvaged (with propagules) from new mining areas as much as is practicable • re-establishing native species by planting native trees, native shrubs, and native graminoids to provide structural diversity, wildlife habitat. and wildlife browse • implementing an **adaptive re-vegetation strategy** to take advantage of opportunities present on the re-contoured lands for establishment of a variety of target vegetation communities and wetlands as outlined in the reclamation plan or other vegetation communities that may become more appropriate with knowledge gained from **adaptive management**	
Addendum Six	Appendix C; Appendix C-1-1 table concerning document references: "EIS Review 35"	t Water treatment for total suspended solids is very well tested technology and Benga does not anticipate a difficulty achieving required water quality objectives. Any periodic or incident based deviations will be dealt with through the **adaptive management** process and would include addition of water treatment technologies to ensure consistent water quality is achieved.	
Addendum Seven	** PDF does not have proper page numbers. The mention is on page 121 of 306, in reference to the PDF, not Benga's page numbers **	Interim: Lands will be progressively reclaimed and **adaptive management** techniques will be incorporated when selecting the appropriate revegetation techniques. Interim reclamation for the proposed MSL area will be limited to errosion control measures.	
Addendum Eight	Page 77	A detailed geomorphologic monitoring plan will be developed to verify the predictions and inform **adaptive management** initiatives, where necessary. At a minimum, monitoring could include monumented cross-sections, detailed grain-size estimates (i.e., pebble counts with N>100 particles), and visual/photo assessment records. Reaches where Westslope Cutthroat spawning has been observed will be monitored for changes in geomorphology that may affect spawning habitat.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Page 107	Benga are committed to investigating alternative blasting agent formulations that reduce NOx emissions during blasting as part of their **adaptive management** strategy during the life of the operations phase.	
Addendum Eight	Page 166	As part of the Project's C&R Plan, Benga is committed to planting three times the number of trees removed from mining and to support establishment of disease resistant trees wherever possible as this is the key component of recovery for the species. Tree plantation success will be assured by application of **adaptive management**, active participation/engagement with recovery plans and groups, and use of best management practices as they evolve.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Page 183 - 184- This was a request for more information	In response to requests to revise impact assessments as a result of predicted elevated selenium and sulphate levels in the receiving environment, Benga re-iterated their confidence in the development of site-specific objectives/guidelines for both substances. It is recognized that if the project is approved as currently designed, project activities would result in increased concentrations of selenium, sulphate, calcium carbonate, some metals and potentially other substances within the receiving environment. Given that these receiving environments contain populations of Westslope cutthroat trout (WSCT), a recognized species at risk, it is important an **adaptive monitoring** and mitigation plan for the aquatic receiving environment intended to monitor and mitigate for both planned and unplanned impacts be implemented. Benga's application and SIR responses refer to future monitoring and mitigation in different sections, but defer the development of a comprehensive monitoring, mitigation and **adaptive management** plan until after approval for the project is received. Given the sensitivities within the aquatic receiving environment and the uncertainties associated with predicted effects and effectiveness of mitigation measures, additional detail is required to assess the feasibility of monitoring, mitigation and **adaptive management** strategies to address potential impacts to the receiving environment. Provide a draft aquatics monitoring, mitigation and **adaptive management** plan to ensure effective mitigation of project effects to the aquatic environment in the streams affected by mine development can be achieved. Specifically, the draft plan should include: .... (ii) a description of the uncertainities that necessitate the use of **adaptive managemen**t...	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Page 184 - 185 (Response to the Above Question)	The Aquatics Monitoring Plan (AMP) will target a suite of key components that are essential to: (1) further characterize existing conditions of Gold and Blairmore creeks; (2) test and verify effect predictions made during the environmental assessment, (3) confirm mitigation measures implemented are working as intended and approved thresholds are achieved and maintained, and (4) ensure an **adaptive management** approach/strategy is in place to effectively counter any noncompliance that are encountered. To achieve the above monitoring objectives of the AMP, survey components will include (but not limited to) the following: .... **Adaptive Management ...**	
Addendum Eight	Page 185	With respect to **Adaptive Management**, Benga is committed to achieving continual improvement in environmental performance. The development and implementation of all monitoring and mitigation (including fisheries offsetting) identified for the Project and housed in the monitoring and follow-up programs will be tracked in relevant management plans. As site conditions and monitoring dictate, or as new technology emerges, Benga will **adaptively manage** our site practices and monitoring program to meet the defined objectives. For some programs this would involve regular evaluation of predictive models; which would be clearly defined in each applicable management plan.	
Addendum Eight	Page 188	Additional strategies not indicated in Section 4.7.4.1 that could be utilized to revegetate the wetlands in lieu of utilizing existing propagules include planting of locally sourced trees and shrubs that are representative of wetland communities, or inclusion of this mitigation in combination with the above strategies. Future proven effective revegetation strategies that are developed during the operating life of the mine but are not developed at this time would also be considered for revegetation as part of Benga's **adaptive management.**	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Page 188 - Request for Response	…) Discuss how calcite precipitation will be prevented, monitored and **adaptively managed** should proposed plans prove ineffective at preventing the formation of concretions within Gold and Blairmore Creek watersheds, including the Crowsnest River;	
Addendum Eight	Page 188 Response to Above	The mitigation measures to prevent calcite precipitation were provided in the response to AER-R2-23. As part of the mitigation, monitoring of calcite precipitation will be incorporated into a site-wide water quality monitoring program. Benga would use monitoring methodology and **adaptive management** techniques similar to those used by other established coal mines within Alberta and/or British Columbia	
Addendum Eight	Page 194 - Request for Response	Given the potential for calcite precipitation in both Gold Creek and Blairmore Creek, a detailed monitoring plan should be submitted along with mitigation measures should calcite precipitation be detected and how the proponent will **adaptively manage** this issue. Monitoring and management of calcite will need to be extended into the closure phase until calcium carbonate levels reach background due to the potential impacts to fish habitat productivity from watercourse concretion.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Page 208	TLU studies, and the information, concerns, and issues expressed during consultation up to the submission of the EIS have been described in the Conservation and Reclamation Plan (C&R Plan) (EIS Section F). Section F.18 of the C&R Plan provides an overview of the public engagement and Aboriginal group values and issues related to closure and C&R planning. Section F.19 provides an overview of how Traditional Ecological Knowledge (TEK) and Land Use was incorporated into the C&R Plan. Any feedback that is received on the C&R Plan as part of ongoing consultation with the Aboriginal groups, since the original was submitted as part of the EIS, will be incorporated into any subsequent versions of the C&R Plan. The C&R Plan will be a document that Benga will exercise **adaptive management** with to ensure new technologies, results from site specific monitoring, and input from the public and Aboriginal groups is incorporated to ensure the long-term viable success of the plan.	
Addendum Eight	Page 218	For clarification, where Aboriginal groups provided recommendations for mitigations through TK/TU studies, those were considered and incorporated into the EIA. As part of the on-going consultation, Aboriginal groups have not provided feedback regarding the effectiveness of proposed mitigations. If and/or when an Aboriginal group will provide this type if feedback, Benga would consider the information as part of an **adaptive management** process.	
Addendum Eight	Page 224	As discussed in AER SIR Round 1 responses, Section A.1.1, SIR 20, Page 13, the C&R Plan in Section F of the EIS is conceptual and will be finalized and continuously refined as the Project progresses through engineering, construction, site-specific monitoring, public engagement and Aboriginal group consultation as part of an **adaptive management** process. Input that is received through on-going discussions with Aboriginal groups will be incorporated in future iterations of the plan.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Appendix A-1 -66	Benga is committed to investigating alternative blasting agent formulations that reduce NOx emissions during blasting as part of their **adaptive management** strategy during the life of the operations phase.	
Addendum Eight	Appendix A-1-111	In conclusion, water quality issues due to Project activities would be addressed by applying appropriate mitigation measures. After mitigation, effects of these water quality issues on receiving environment are assessed as not significant in both LSA and RSA. Development of a site-specific selenium and sulphate objectives in the LSA is recommended, and an **adaptive-management** approach to monitoring and assessment of any potential effects of sulphate in Blairmore Creek waters late in mine life should be adopted. Water quality model outputs should be considered as represent information for decision-making rather than representing absolute predictions of receiving water quality; monitoring vigilance is recommended to track and identify any trends in water quality and further refine model predictions.	
Addendum Eight	Appendix A-1 - 117	Given the potential for selenium and sulphate concentrations in Blairmore Creek to reach levels above a published no-effect-threshold in low-flow winter months, monitoring and **adaptive management** for selenium and sulphate should include development of a site-specific water quality for Blairmore Creek. Development of this objective during early mine life would allow this process to include toxicity testing of process waters with ionic composition reflective of actual mine operations. However, no such issues in the RSA are anticipated.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Appendix A-1 - 145	The AMP will serve two purposes: (1) to test the predictions of the EA and apply **adaptive management** in the event predictions are not verified and (2) evaluate the efficacy of mitigation measures proposed to protect fish and fish habitat during the construction phase. The AMP will include monitoring components such as: WSCT Population Monitoring (ongoing since 2016), Calcite Precipitation Verification, WSCT Bioenergetics monitoring, Instream Flow Assessment Verification, Geomorphological monitoring. With respect to on-site mitigation, one component that is directly relevant to WSCT will be salvage methods appropriate and the habitat being salvaged from the mine site. WSCT salvage during construction of the mine site on tributaries that were identified as fish bearing during the baseline investigations is one of the mitigation measures that will reduce direct fish mortality to WSCT. Live capture methods will be used to capture live WSCT. Appropriate standards and permit conditions will be followed for all live captures. All live specimens will be relocated to reaches in Gold Creek, or as approved by Regulators.	
Addendum Eight	Appendix A-1-116	based on monitoring results of reclaimed landscapes, **adaptive management** will be incorporated by Benga in order to allow for continual improvement of erosion control processes;	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Appendix A-1-197	For old growth forests, additional mitigation measures should include reclamation with tree species capable of achieving of old growth conditions. As a rare tree species with a specific conservation plan, whitebark pine mitigation will focus on the goals of introducing white pine blister rust resistant strains and conserving genetic diversity during reclamation. The estimate of 21,000 whitebark pine (WBP) trees within the footprint is intentionally conservative and includes estimates of juvenile trees and seedlings. Benga is committed to planting three times the number of trees removed from mining and to support establishment of disease resistant trees wherever possible as this is the key component of recovery. Tree plantation success will be assured by application of **adaptive management**, active participation/engagement with recovery plans and groups, and use of best management practices as they evolve over time.	
Addendum Eight	Appendix A-1-204	Confidence Rating: The confidence rating is high. The effect of the project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring.	
Addendum Eight	Appendix A-1 - 206	Ability for Recovery: Reclaimed terrain and soils will support establishment of native communities and include slope and aspect conditions suitable for rough fescue. Present reclamation techniques for native rough fescue grassland communities have met with limited success; however, the Project has an expected reclamation period of approximately 26 years and includes **adaptive management** (EIS, Section F, Conservation and Reclamation Plan (Benga 2016)) which may allow for improved reclamation techniques to be developed. Based on this, the impacts to the rough fescue grasslands communities are anticipated to be reversible in the long term with the planned mitigation	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Appendix A-1-210	• Confidence Rating: The confidence rating is high. The effect of the project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring	
Addendum Eight	Appendix A-1-211+A119A	Confidence Rating: Confidence rating is high and based on good understanding of cause effect relationships and data pertinent to study. Wetlands have been successfully created on other mountain mines in Alberta and mitigation will be supported by **adaptive management** and monitoring	
Addendum Eight	Appendix A-1-212	• Confidence Rating: The confidence rating is moderate due to the uncertainties in individual rare species designations and regional distributions. The effect of the Project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring.	
Addendum Eight	Appendix A-1-213	• Confidence Rating: The confidence rating is high. The effect of the Project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by a**daptive management** and monitoring.	
Addendum Eight	Appendix A-1 - 240	Working in consultation with the olive-side flycatcher recovery team to monitor olive-sided flycatcher presence, abundance, habitat use, fidelity to breeding sites, and factors affecting survival and reproductive output within the WLSA would provide valuable information required for the conservation of this species in both the short-term and long-term and at the local and regional scales. A monitoring program such as this, which includes a Beneficial Management Practices guide, would assist wit**h adaptive management**, improving breeding and foraging habitats and reducing risks to the species in the WLSA and the broader regional scale.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Appendix A-1-294	improving Benga's understanding of the effects of Project construction and operation on wildlife within the WLSA and surrounding area to enable the implementation of **adaptive management** practices when required; and	
Addendum Eight	Appendix A-1 324	monitor changes in land use policies and initiatives and, through **adaptive management**, incorporate new requirements into the ongoing development, operation, and reclamation plans.	
Addendum Eight	Appendix A-1 - 357	Management plans, monitoring, and **adaptive management** will be implemented to mitigate impacts of the Project on hunting and trapping opportunities. In particular, the following mitigation measures are planned to minimize the effects of the Project on wildlife and, by extension, effects on success for hunters and trappers:	
Addendum Eight	Appendix A-1-364	EIS, Section E.8.3 characterizes residual effects to vegetation as local in geographic extent, long-term in duration, continuous in frequency, reversible, and high magnitude. The Project will have a neutral contribution with respect to valued species and communities. The reclaimed land will support a range of communities with equivalent capabilities to those of the surrounding lands and that existed prior to Project development. The Project will not result in the loss of the resource to the communities, the region or the province. The confidence rating is high. The effect of the Project is well understood as are the techniques used for revegetation. Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring. The probability of occurrence is high given the type of Project and method of coal extraction.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	Appendix A-1-372	Management plans, monitoring, and **adaptive management** will be implemented to mitigate impacts of the Project on Aboriginal Physical and Cultural Heritage. In particular, the following mitigation measures are planned to minimize the effects of the Project on physical and cultural and by extension any effects on success for hunters and trappers:	
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 843 of 1567, in reference to the PDF, not Benga's page numbers **	This document builds on the preliminary offsetting options identified in the Grassy Mountain Coal Project Preliminary Habitat Offsetting Plan (Hatfield 2017a), and is structured as follows: …. Summary of monitoring requirements and the **Adaptive Management** strategy for the selected offsetting measures (Sections 11 and 12); and	
Addendum Eight	Table 1.2 ** PDF does not have proper page numbers. The mention is on page 850 of 1567, in reference to the PDF, not Benga's page numbers **	Effectiveness of applied mitigation will be monitored throughout Project construction and operations, which will inform the characterization of residual serious harm to fish. Offsetting Plan restoration measures (i.e., offsetting activities) will be monitored through the Offsetting Compliance Monitoring Plan and the Offsetting Effectiveness Monitoring Plan. Benga has committee to an **adaptive management** approach to allow for refinement of protocols as necessary	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	5.1 Confidence in Predictions ** PDF does not have proper page numbers. The mention is on page 880 of 1567, in reference to the PDF, not Benga's page numbers **	Like all scientific results and inference, residual effects predictions are subject to uncertainty. Uncertainty can stem from various factors. For example, uncertainty may be associated with various assumptions and limitations inherent in the data, the extent of current knowledge of the system under study, the collective biology of a species, and natural variability and resilience to change. Since as the degree of uncertainty increases about whether an activity would jeopardize the survival or recovery of WSCT, the likelihood decreases that a permit can be issued (Government of Canada 2016) all efforts will be taken to reduce the uncertainty in the predictions, through monitoring and the development of contingency measures, ready to instate if indicators show they are necessary. A**n adaptive management** approach will be integrated into the project offsetting activities and monitoring plan.	
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 893 of 1567, in reference to the PDF, not Benga's page numbers **	If the results of the eDNA surveys and physical habitat assessment determine suppression is not feasible, this offsetting activity will not be developed further. This outcome has been built into the **adaptive managemen**t approach employed for this FOP.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 894 of 1567, in reference to the PDF, not Benga's page numbers **	A phased-approach is proposed for implementing the priority (enhancement/creation of aquatic and riparian habitat) offsetting measures as further information is necessary to assess feasibility and likelihood of success. Given the complex nature of the habitat and sensitivity of the species additional data collection and site investigations are required. Ecosystems are highly complex and dynamic, therefore monitoring, **adaptive management,** and contingency measures are an integral part of this Plan to ensure the effectiveness of the selected offsets. Contingency measures have been built into this approach, to allow for the discontinuance of offsetting activities if they are deemed non-beneficial or ineffective.	
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 903 of 1567, in reference to the PDF, not Benga's page numbers **	This habitat is designed to be self-sustaining and does not require any scheduled maintenance. Monitoring will ensure the design is functioning as intended (Section 11.0). If monitoring detects the need to initiate contingency measures, the **adaptive management** plan will be implemented.	
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 908 of 1567, in reference to the PDF, not Benga's page numbers **	This habitat is designed to be self-sustaining and does not require any scheduled maintenance. Monitoring will ensure the design is functioning as intended (Section 11.0). If monitoring detects the need to initiate contingency measures, the **adaptive management** plan will be implemented.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 925 of 1567, in reference to the PDF, not Benga's page numbers **	The proposed **Adaptive Management** Plan (Section 12.0) will be an additional means for addressing uncertainty that will allow for adjustment of offsetting requirements and measures based on the measured residual effects of the project and the results offset monitoring. The effectiveness monitoring plan and a commitment to respond to monitoring results will further reduce uncertainty (Bradford 2017). This will form part of Benga's plan to ensure the offsetting measures perform successfully	
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 925/26 of 1567, in reference to the PDF, not Benga's page numbers **	The uncertainty associated with the prediction in losses is described in Section 5.1 of this report. The uncertainty of predicted Project effects will be minimized by implementing the Grassy Mountain Coal Project: Aquatics Monitoring Plan to target characterization of natural variation in the existing conditions prior to Project construction and confirmation that predicted residual effects are accurate during the life of the Project. This program will include key performance indicators, contingency measures, and a**n adaptive management** strategy in the event offsetting measures are not achieving targets. Further detail on the proposed monitoring is provided in Section 11.0.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	12.0 Adaptative Management ** PDF does not have proper page numbers. The mention is on page 929 of 1567, in reference to the PDF, not Benga's page numbers **	**Adaptive Management** will play a key role in ensuring greater certainty in the performance and success of the offsetting measures selected. It will allow for adjustment of offsetting requirements and measures based on the measured residual effects of the project and the results offset monitoring. The effectiveness monitoring plan and a commitment to respond to monitoring results will further reduce uncertainty (Bradford 2017). The **adaptive management** approach will be further developed to respond to the performance of offset objectives, indicators (metrics) of effectiveness, and project (species) offsetting targets. The FOP and Effectiveness Monitoring Plan will be closely linked to the Project's Aquatics Monitoring Plan that will continue to gather site-specific metric data (e.g., WSCT relative abundance, seasonal habitat use, food supply etc.) generated from ongoing baseline WSCT population and trend monitoring and will be used to refine the design of priority offset measures (where necessary) and be used to evaluate results from effectiveness monitoring. If offsetting metrics do not align with baseline trends, adaptive action may be necessary. Specific triggers will be defined in the final FOP to allow for sufficient time to act prior to any offset underperforming.	
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 929 of 1567, in reference to the PDF, not Benga's page numbers **	Finalization of the Fisheries Offsetting Plan **Adaptive Management** Strategy.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 929 of 1567, in reference to the PDF, not Benga's page numbers **	Upon issuance of all required permits, the target is to commence the implementation of the FOP prior to Project construction to limit lag time between functional offsets and project residual effects. The Fisheries Offsetting Plan is an iterative process between the monitoring of predicted effects, compliance with the plan, and the effectiveness of the designed offsetting activities. The identified contingency measures will be implemented where necessary, likely through the **Adaptive Management Strategy.**	
Addendum Eight	5.0 Adaptive Management ** PDF does not have proper page numbers. The mention is on page 964 of 1567, in reference to the PDF, not Benga's page numbers **	Monitoring and evaluating the effectiveness of the offsetting measures is an important part of the **adaptive management** process, whereby monitoring results are used to review the design goals and objectives, evaluate project implementation and assess the final on-the-ground results. By compiling and reviewing this monitoring information, immediate problems can be identified, and mitigative actions can be taken where necessary. The process for determining whether mitigation should be initiated, and if so, what level of effort should be expended to achieve measurable results, will be dictated by the natural progression of the Project offset habitats. The timing of any mitigative actions will utilize an adaptive approach that is informed by the annual monitoring activities. The **adaptive management** approach will be further developed to respond to the performance of offset objectives, indicators (metrics) of effectiveness, and project (species) offsetting targets. The FOP and Monitoring Plan will be closely linked to the Project's Aquatics Monitoring Plan that will continue to gather site-specific metric data (e.g., WSCT relative abundance, seasonal habitat use, food supply etc.) generated from ongoing baseline WSCT population and trend monitoring and will be used to refine the design of priority offset measures (where necessary) and be used to evaluate results from effectiveness monitoring. If offsetting metrics do not align with baseline trends, adaptive action may be necessary. Specific triggers will be defined in the final FOP to allow for sufficient time to act prior to any offset underperforming.	

Part of EIA	Page Number	Reference	Topic
Addendum Eight	** PDF does not have proper page numbers. The mention is on page 965 of 1567, in reference to the PDF, not Benga's page numbers **	Proponents are responsible for implementing offsetting plans and monitoring their effectiveness, which includes reporting on the implementation and the results of monitoring. A standardized reporting schedule and format will be established, structured around the conditions of the FAA. The annual monitoring report will be submitted within each year of the monitoring program prior to the commencement of the next field season to allow for adjustment **(Adaptive Management)**, if required. A proposed schedule of monitoring and reporting is illustrated in Table 4.1. A standardized reporting format on the monitoring program will be established and followed, including the following components as recommended by Smokorowski et al. (2015):	

Repeated from earlier entry, also included in Addendum 5 Addendum Eight - Eight Addendum to the Environmental Impact Assessment	** There are specific mentions of adaptive management that have been recorded in this table. Unfortunately, there are no corresponding page numbers. The different responses from this table are spread out in the following columns.	**An adaptive management** approach, including non-native invasive species control and monitoring, and revegetation establishment assessments will be used to ensure that sites have been revegetated to meet target vegetation communities. This information has been provided to Blood Tribe	Section E.8 of the August 2016 Environmental Impact Assessment (EIA) document assessed the potential for invasive species (with technical detail in Consultant Report # 8 - Vegetation). Proposed mitigation measures related to invasive species are outlined in Section 4.9.4 of Consultant Report #8**. An adaptive management approach**, including non-native invasive species control and monitoring, and monitoring of postreclamation revegetation establishment will be used to manage the risk of non-native and invasive species to help ensure that reclaimed sites meet target	The potential for invasive species is assessed in the Environmental Impact Assessment (EIA) Update (August 2016) (with technical detail in Consultant Report # 8 - Vegetation). Proposed mitigation measures related to invasive species are outlined in Section 4.9.4 (Consultant Report #8). **An adaptive management approach,** including non-native invasive species control and monitoring, and revegetation establishment assessments will be used to ensure that sites have been revegetated to meet target vegetation communities	Section F in the August 2016 Environmental Impact Assessment (EIA) document provides the proposed Conservation and Reclamation (C&R) Plan for the Project. This was provided to Piikani Nation in August 2016. Section F.1.5 describes the reclamation goals and principles that were incorporated in the C&R and closure plans. Section F.1.6 describes proposed End Land Use goals and includes a commitment that end land use decisions will be made in consultation with Piikani Nation. Benga has committed to progressive reclamation of sites as they no longer part of the mining operations.	"How can we develop more detailed monitoring and adaptive management programs." " Benga supports an **adaptive management** approach to its monitoring and environmental programs and will try to incorporate this approach into its environmental management plans. Benga will be developing specific environmental monitoring and management plans that comply with its regulatory requirements. Benga will provide Piikani Nation the opportunity to participate in the development and implementation of it's environmental programs on site.	The assessment of potential effects to wildlife includes potential effects to migration and movement with a discussion of proposed mitigation measures in Section E.9.5 of the Environmental Impact Assessment. No eagle nesting sites were identified during the baseline field surveys. As part of the **adaptive environmental management** of the site, should monitoring identify sites in the future appropriate mitigation measures will be undertaken to protect the eagles including avoidance of the nesting site during the breeding season and relocation, if feasible, in the off season.	No eagle nesting sites were identified during the baseline field surveys. As part of the **adaptive environmental management** of the site, should monitoring identify sites in the future appropriate mitigation measures will be undertaken to protect the eagles including avoidance of the nesting site during the breeding season and relocation, if feasible, in the off season	No eagle nesting sites were identified during the baseline field surveys. As part of the **adaptive environmental management**t of the site, should monitoring identify sites in the future appropriate mitigation measures will be undertaken to protect the eagles including avoidance of the nesting site during the breeding season and relocation, if feasible, in the off season.

			vegetation communities and reclamation certification requirements.		Reclamation of some areas may begin as early as year 7. Monitoring of reclaimed sites will provide a measure of reclamation success and enable measures to be implemented in a timely manner as part of Benga’**s adaptive management strategy** to resolve issues as they arise.				

Part of EIA	Page Number	Reference	
Repeated from earlier entry, also included in Addendum Eight - Eight Addendum to the Environmental Impact Assessment	Table H.3.2-1 Chronology of Key Consultations with Kainai Tribe	Main discussion items were the EIA project presentation which included a review of timelines, project components, overview of construction, operations, reclamation and closure phases and status of Project applications, including federal and provincial approvals; and the development of the monitoring program and **adaptive management** plans.	
Repeated from earlier entry, also included in Addendum Eight - Eight Addendum to the Environmental Impact Assessment	** PDF does not have proper page numbers. The mention is on page 1483 of 1567, in reference to the PDF, not Benga's page numbers **	Interim: Lands will be progressively reclaimed and **adaptive management** techniques will be incorporated when selecting the appropriate revegetation techniques. Interim reclamation for the proposed MSL area will be limited to errosion control measures.	
Repeated from earlier entry, also included in Addendum Eight - Eight Addendum to the Environmental Impact Assessment	** PDF does not have proper page numbers. The mention is on page 1484 of 1567, in reference to the PDF, not Benga's page numbers **	Interim: Lands will be progressively reclaimed, and **adaptive management** techniques will be incorporated when selecting the appropriate revegetation techniques.	
Addendum Nine	Page 11 -Table 4-1 Chronology of Key Consultation Activities with Kainai Nation	the development of the monitoring program and adaptive management plans.	

Part of EIA	Page Number	Reference	
Addendum Nine	** PDF does not have proper page numbers. The mention is on page 305 of 507, in reference to the PDF, not Benga's page numbers **	Piikani Nation requests that Benga develops a detailed, long-term, community-based SEIA monitoring program. The program would analyze programs and policies that are developed to address social and economic concerns for Piikani Nation members. The monitoring would allow for an adaptive **management** approach to be used, with adjustments being made to programs and policies based on actual performance.	
Addendum Nine	** PDF does not have proper page numbers. The mention is on page 368 of 507, in reference to the PDF, not Benga's page numbers **	Piikani Nation requests that Benga discusses how it will use best available technology economically achievable (BATEA), best practices, continuous improvement, **adaptive management** and consider community input in design and implementation considerations of mitigation measures of all potential Project effects.	
Addendum Nine	** PDF does not have proper page numbers. The mention is on page 373 of 507, in reference to the PDF, not Benga's page numbers **	Water treatment for total suspended solids is very well tested technology and Benga does not anticipate a difficulty achievi ng required water quality objectives. ny periodic or incident based deviations will be dealt with through the **adaptive mana gement** process and would include addition of water treatment technologies to ensure consistent water quality is achieved.	
Addendum Nine	** PDF does not have proper page numbers. The mention is on page 375 of 507, in reference to the PDF, not Benga's page numbers **	The details requested are not available at the current project stage of development. Benga will develop more precise Cons ervation and Reclamation Plans during the detailed engineering phase and will use **adaptive management** throughout the mine operation to improve those plans. Benga will communicate with Piikani Nation as the Conservation and Reclamation Plans are finalized.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 1: Air Quality and Noise	Page 26	The approach to managing NO2 emission and concentration uncertainties will be to implement the **adaptive management** portion of the Project's air quality mitigation and monitoring plan (please see response to JRP IR-1.3). Monitoring will provide an indication of the contribution of current community, Highway 3 and rail sources. Measurements will be compared to Baseline predictions in Table 1.6-1. Based on the measurements, the need for mitigation beyond the current planned will be assessed	https://iaac-aeic.gc.ca/050/documents/p80101/132604E.pdf
Addendum Ten - Package 1: Air Quality and Noise	page 1 (PDF Page 91 out of 118)	The following draft Air Quality Monitoring and **Adaptive Management** Plan (the Plan) has been developed for the Grassy Mountain Coal Project (the Project) to address the Joint Review Panel (JRP) information request (IR) 1.3, which requested the following information:	
Addendum Ten - Package 1: Air Quality and Noise	page 1 (PDF Page 91 out of 118)	This draft Plan has been prepared using the most current information available to date regarding air quality mitigation, monitoring and **adaptive management** related to the Project. Finalization of the draft Plan will occur following additional consultation with regulators, Aboriginal communities and stakeholders and is an anticipated requirement of the Environmental Protection and Enhancement Act (EPEA) approval condition, should the Project be approved. It is anticipated that this draft Plan will be periodically updated and reviewed as per expected EPEA approval conditions	
Addendum Ten - Package 1: Air Quality and Noise	Page 3 (PDF page 93 out of 118)	The goals of the draft Plan link potential Project effects to mitigation, mitigation objectives to monitoring and monitoring results to **adaptive management** actions. The specific goals and objectives of this Plan are summarized in Table 3.0-1.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 1: Air Quality and Noise	page 11 (PDF page 101 out of 118)	**ADAPTIVE MANAGEMENT** PROGRAM **Adaptive management** is a planned and systematic process for continuously improving environmental management practices by learning about their outcomes. **Adaptive management** provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project. As per Figure 7.0-1, Benga's adaptive management program is organized into four main components, which are re-evaluated and reassessed in a feedback loop.	
Addendum Ten - Package 1: Air Quality and Noise	page 11 (PDF page 101 out of 118)	Figure 7.0-1 Benga's **Adaptive Management** Process **Adaptive management** is intended to respond to changes and advances in technology to meet specific objectives. Benga will incorporate **adaptive management** techniques as routine components in all of its environmental management activities. These techniques provide the opportunity to develop and fine-tune the monitoring program using data collected on-site and from other regional operators. Benga will use the experience gained during the development of the Project, and other successes by the regional coal operators over the next 24 years, to manage and implement an effective monitoring program. Benga will work with other operators of coalmines, AEP, AER and local stakeholders, to further develop criteria and monitoring programs that clearly demonstrate progress toward managing and reducing Project-related air emissions	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 1: Air Quality and Noise	Page 12 (PDF page 102 out of 118)	With respect to **Adaptive Management,** Benga is committed to achieving continual improvement in environmental performance. The development and implementation of all monitoring and mitigation identified for the Project and housed in the monitoring and follow-up programs will be tracked in relevant management plans. As site conditions and monitoring dictate, or as new technology emerges, Benga will **adaptively manage** our site practices and monitoring program to meet the defined objectives. For some programs this would involve regular evaluation of predictive models; which would be clearly defined in each applicable management plan.	
Addendum Ten - Package 1: Air Quality and Noise	Page 13 (PDF page 103 out of 118)	**Adaptive Management** Process Design Once the problem has been identified and assessed, the design of the **adaptive management** program can commence, beginning with determining the best approach to **adaptive management.** The following are design considerations for the **adaptive management** program: • data analysis methods and frequency; • predicted trajectories for indicators; and • triggers for action and potential adaptations. Benga is confident in the mitigation measures selected but acknowledges that a formal process is warranted to optimize the measures, as opportunities to refine aspects of the management strategies are available. This formal process includes the following points: • Indicators of mitigation effectiveness. • Predicted trajectories through time for the indicators of mitigation effectiveness. • A monitoring program designed to allow observed trends to be compared to predicted trajectories. • Triggers for action, should predicted trajectories and observed trends not align, and a plan of action if and when triggers are pulled. A summary of the **adaptive management** program for the Project is provided in Table 7.2-1.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 1: Air Quality and Noise	Page 14 (PDF page 104 out of 118)	If mitigation adjustments are determined to be required, then they will be implemented with careful consideration to proper planning, approvals, notifications and/ or consultation. In this step of the **adaptive management** process, the work plan will be implemented. Any required notifications and/or approvals will be obtained before acting to confirm that all interested/affected parties are properly informed. If adjustments to mitigation measures are required, Section 5.0 of this Plan will be updated to reflect the adapted mitigation for the Project. Table 7.2-1 outlines some **adaptive managemen**t adjustments that could be implemented if monitoring indicates that air quality targets are not being met. Since the monitoring plan has not been implemented, nor monitoring conducted, these are options for consideration.	
Addendum Ten - Package 1: Air Quality and Noise	Page 15 (PDF 105 out of 118)	**Table 7.2.1 "Adaptive Management Program"**	
Addendum Ten - Package 1: Air Quality and Noise	Page 16(PDF 106 out of 118)	Information Management and Reporting This section will outline how the monitoring results and **adaptive management** actions will be recorded, stored, tracked and made available to interested stakeholders. Accurate record keeping will be necessary to assess the implementation of the Plan, to measure the effectiveness of management and to develop and implement any necessary improvements. This section will outline the process for altering any part of this Plan, which may be required due to changes resulting from ongoing **adaptive management.**	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 1: Air Quality and Noise	Page 7 (PDF page 117 out of 118)	Information Management and Reporting Effective monitoring and record keeping is required to review the implementation of the plan, to measure the effectiveness of management and to develop and implement improvements as required. The Information Management and Reporting section will outline how the monitoring results and **adaptive management** actions will be recorded, stored, tracked and made available to interested parties. 7.3 Change Management The Change Management section will outline the process for changing any part of this plan. Changes might be required as part of ongoing **adaptive managemen**t, or for other reasons. Any significant proposed amendments to the plan will be presented to interested parties before the plan is formally updated.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 3	Response: As stated in the Conservation and Reclamation Plan (updated as part of JRP IR-2.6), reclamation will begin as soon as practical after mining activities are completed in areas where no additional mining, dumping or stockpiling is required. Progressive reclamation would be optimized through the mine planning process through ongoing monitoring and **adaptive managemen**t. Monitoring (assessing success of reclamation) and applying **adaptive managemen**t techniques (as outlined in JRP IR-2.6) would allow Benga to take advantage of all the potential opportunities that would exist with a progressive reclamation approach, rather than reclamation only being initiated at Closure. The progressive reclamation that will be undertaken in sequential steps as mining operations are completed are illustrated in the updated C&R Plan (JRP IR-2.6 Table F.2.2-1).	https://iaac-aeic.gc.ca/050/documents/p80101/132603E.pdf

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 5 - Request for Information	Benga has estimated that the proposed Project would disturb approximately 21,000 whitebark pine and 1,000 limber pine trees. Benga concluded that, with mitigation, the Project will result in Project effects and cumulative effects on these species that are not significant. In support of this conclusion, Benga stated that, as part of the closure and reclamation plan, it committed to planting three times the number of trees removed from mining and to support establishment of disease resistant trees. Tree planting success would further be assured by application of **adaptive management**, active participation and engagement with recovery plans and groups, and use of best management practices as they evolve (CEAR #42).	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 8	Any of the example sites conducting WBP work, especially similar mining operations, will help build the pool of knowledge about reclamation of WBP and provide the basis for **adaptive management** adjustments for the Grassy Mountain Coal Project. New findings from other mines or from trials can be incorporated into future reclamation planning.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 10 - Request for Information	Describe how Benga will apply **adaptive management** to ensure successful reforestation of whitebark pine and limber pine stands, and how Traditional Ecological Knowledge will be integrated in the adaptive management approach.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 10 - Response to Above	See the updated conceptual Conservation and Reclamation (C&R) Plan Section F.3.10 on **Adaptive Management,** as provided in the response to JRP IR-2.6. Table F.3.10-1 in the C&R plan outlines examples of adaptive management that can be implemented for whitebark and limber pine should monitoring demonstrate results not achieving desired targets or trajectories. Results from new research studies, reclamation on other sites, and updated recovery strategies can also help inform potential adaptive management adjustments.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 15	As the mine reaches maximum disturbance in Year 15, approximately 4.0 ha of reclaimed landscape will be selected to seed monocultures of foothills rough fescue as recommended by Sherritt (2012) in Lancaster, et al. (2016). Once seeded, monitoring programs will be implemented that will assess the success of foothills rough fescue establishment so that corrective actions can be recommended. The early development of rangeland communities will benefit from the remaining years of reclamation schedule and will utilize the **adaptive management** program to ensure that healthy rangeland communities are established. Following Year 15, additional landscape areas will be selected based on the results of the previously targeted foothills rough fescue dominated areas.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 20 - Request for Information	…. Additionally, the Closure and Reclamation Plan mentions Benga will develop in further detail several management plans and mitigation plans, and use **adaptive management.** … Provides additional details on how reclamation success will be monitored and how **adaptive managemen**t will be used to address reclamation outcomes that do not meet expectations.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 20 - Response to above	incorporate any pertinent information from previously requested information from the Project's regulatory review, and provides additional clarification on how reclamation success will be monitored (Section F.3.9) and how **adaptive managemen**t will be used to address reclamation outcomes that do not meet expectations (Section F.3.10).	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 20 - Request for Information	Explains, in quantitative terms, how specific measures in the plan, as well as monitoring and **adaptive management,** will contribute to mitigation of the potential adverse effects on each valued component.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 20 - 21 Response to Above	At the request of the JRP, Benga has provided an Updated C&R Plan (Appendix 2.6-1). Table F.2.8-1, Section F.2.8, in the Updated C&R Plan shows how specific reclamation measures from the Plan will be applied to mitigate potential adverse effects on VCs. The VCs included in the table are those that listed reclamation as a mitigation, as outlined in the EIA in each consultant report (CEAR #42). Many quantitative details were already included in the C&R plan related to VCs, and for ease of review, these reclamation specific mitigation measures have been summarized in tabular format to show with more clarity how they relate to each VC. Monitoring and **adaptive management** as they related to those VCs, are presented in Tables F.3.9-1 and F.3.10-1, respectively. Together, mitigation associated with reclamation, monitoring of reclamation mitigation, and **adaptive managemen**t of reclamation plans are some of the key measures that will be used on the Project to mitigate potential adverse effects.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F-1	a more detailed discussion of **adaptive management** (Section F.3.10) to address JRP IR-2.6 a);	
Addendum Ten - Package 2: Vegetation and Reclamation	Page f-8	an Indigenous monitoring plan is developed in coordination with nearby Indigenous groups and provides important feedback to guide decisions and **adaptive management;**	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F-8	**adaptive management** of the C&R and Closure Plans will be pursued through the incorporation of the results of the site wide environmental monitoring programs.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page f-15	the Project has a robust Conservation & Reclamation plan that incorporates monitoring and **adaptive** m**anagement** strategies, on topics including biodiversity and watersheds;	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F-33	monitor changes in land use policies and initiatives and, through **adaptive management,** incorporate new requirements into the ongoing reclamation plans.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F -39	uncertainties in landscape performance and technology will be resolved through use of the principles of **adaptive management**, and knowledge gaps are to be resolved through research programs;	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F-40	an adaptive revegetation strategy to take advantage of opportunities for establishment of a variety of target vegetation communities and wetlands (closed conifer forests, moderate mixed forests, native herbaceous grasslands and treed wetlands); or other vegetation communities that may become more appropriate with knowledge gained from a**daptive management;**	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F -54	[Land Capability Effects (Reclaimed overburden materials)] Utilize best management practices currently used in the industry as well as **adaptive management** to promote effective reclamation practices	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F-54	[Land Capability effects] utilize best management practices currently used in the industry as well as **adaptive management** to promote effective reclamation practices	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F-60	[Biodiversity] implementing an adaptive re-vegetation strategy to take advantage of opportunities present on the re-contoured lands for establishment of a variety of target vegetation communities and wetlands as outlined in the reclamation plan or other vegetation communities that may become more appropriate with knowledge gained from **adaptive management**	
Addendum Ten - Package 2: Vegetation and Reclamation	F-66	Development of the mine will require clearing existing vegetation from the Project Footprint. The Project Footprint has been developed recognizing Benga's commitment to minimizing the amount of disturbance that is required for Project development. There may be opportunities to reduce the mine disturbance area through an **adaptive management program.**	
Addendum Ten - Package 2: Vegetation and Reclamation	F-76	As the mine reaches maximum disturbance in Year 15, approximately 4.0 ha of reclaimed landscape will be selected to seed monocultures of foothills rough fescue as recommended by Sherritt (2012) in Lancaster, et al. (2016) as shown in Figure F.3.6-4. Once seeded, monitoring programs will be implemented that will assess the success of foothills rough fescue establishment so that corrective actions can be recommended. The early development of rangeland communities will benefit from the remaining years of reclamation schedule and will utilize the **adaptive management** program to ensure that healthy rangeland communities are established. Following Year 15, additional landscape areas will be selected based on the results of the previously targeted foothills rough fescue dominated areas.	
Addendum Ten - Package 2: Vegetation and Reclamation	F-89	Lands will be progressively reclaimed and **adaptive management** techniques will be incorporated when selecting the appropriate revegetation techniques	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	F-92	These conceptual seed mixes have been discussed with the local Alberta Environment and Parks land manager and comply with the expectations of the Operating Ground Rules for the C5 FMU (ASRD, 2012). The mixes are considered conceptual and, through the mine **adaptive management** and continuous improvement processes, may require substitutions resulting from species availability and as new species (native and agronomic) are developed. These seed mixes will therefore be reviewed and approved with the local land managers in advance of seeding.	
Addendum Ten - Package 2: Vegetation and Reclamation	F-97	When the monitoring program identifies issues requiring mitigation, Benga will undertake maintenance activities such as erosion control and in-fill planting of areas with selected species to increase biodiversity, structural diversity, and stocking requirements. The **adaptive management** program will allow for specialized responses to specific issues that may arise.	
Addendum Ten - Package 2: Vegetation and Reclamation	F-98	An important component of the reclamation program will be the monitoring of the biophysical aspects of the program. The identification of successes and limitations early in the reclamation process will allow modifications to be made through the **adaptive management** program to be used at the Project. In addition to providing important feedback on the effectiveness of reclamation techniques, it will also provide data to use in planning the certification of reclaimed lands and the release of lands back to the Crown.	
Addendum Ten - Package 2: Vegetation and Reclamation	Table F.3.9-1 Monitoring Plans related to VCs; Page F-100	[Soil] based on monitoring results of reclaimed landscapes, a**daptive management** will be incorporated by Benga in order to allow for continual improvement of erosion control processes;	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Table F.3.9-1 Monitoring Plans related to VCs; Page F-102	[Biodiversity] complete surveys early in the life of the re-vegetation program, to assess the level of biodiversity success and allow for **adaptive management** of subsequent stages of revegetation	
Repeated from earlier entry also included here: Addendum Ten - Vegetation and Reclamation	Page f-104	F.3.10 **Adaptive Management Adaptive management** is a planned and systematic process for continuously improving environmental management practices by learning about their outcomes. **Adaptive management** provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project. As per Figure F.3.10, Benga's **adaptive management** program is organized into to four main components, which are reevaluated and reassessed in feedback loop. Figure F.3.10 Benga's Adaptive Management Process. Benga's **adaptive management** approach will involve establishing end land use objectives according to pre-development land use capability, site-specific conditions, improved practices based on research and monitoring results, and input from the public engagement and Indigenous consultation programs. As reclamation proceeds, monitoring of reclamation and revegetation performance will allow land use objectives to be reviewed and, if necessary, modifications can be made to site expectations according to natural revegetation processes.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F-105	**Adaptive management** is intended to respond to changes and advances in technology, such as reclamation material replacement and revegetation, to meet specific objectives. Benga will incorporate **adaptive management** techniques as routine components in all of its environmental management activities. These techniques provide the opportunity to develop and fine-tune the reclamation program using data collected on-site and from other regional operators.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F -105	With respect to **Adaptive Management**, Benga is committed to achieving continual improvement in environmental performance. The development and implementation of all monitoring and mitigation (including fisheries offsetting) identified for the Project and housed in the monitoring and follow-up programs will be tracked in relevant management plans. As site conditions and monitoring dictate, or as new technology emerges, Benga will **adaptively manage** our site practices and monitoring program to meet the defined objectives. For some programs this would involve regular evaluation of predictive models; which would be clearly defined in each applicable management plan	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F -106	F.3.10.2 **Adaptive Management** Process Design Once the problem has been identified and assessed, the design of the **adaptive management** program can commence, beginning with determining the best approach to a**daptive management**. The following are design considerations for the **adaptive management** program: .... A summary of the **adaptive management** program for the Project is provided in Table F.3.10-1.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F -107	If mitigation adjustments are determined to be required, then they will be implemented with careful consideration to proper planning, approvals, notifications and/ or consultation. In this step of the **adaptive management p**rocess, the work plan will be implemented. Any required notifications and/or approvals will be obtained before acting to confirm that all interested/affected parties are properly informed. Reclamation activities and plans will be updated regularly as part of the mine reclamation plan updates, under EPEA, and will also reflect these **adaptive management** actions. Table F.3.10-1 outlines examples of adaptive management adjustments that could be implemented if monitoring indicates that reclamation success is not meeting targets. The original mitigation plans that may be changed through **adaptive management** strategies are detailed in Table F.2.8-1. As the monitoring plan has not been implemented, nor monitoring conducted, these are options for consideration	
Addendum Ten - Package 2: Vegetation and Reclamation	Table F.3.10-1 Adaptive Management Strategies; Page F-108	A full table with Potential Adaptive Management Strategies	
Addendum Ten - Package 2: Vegetation and Reclamation	Table F.3.10-1 Adaptive Management Strategies; Page F-109	The seed mixes are considered conceptual and, through the mine **adaptive management** and continuous improvement processes, may require substitutions resulting from species availability and as new species (native and agronomic) are developed, or if reclamation monitoring indicates the vegetation community is not trending towards the desired community and adaptions to the seed mixes are required. These seed mixes will therefore be reviewed and approved with the local land managers in advance of seeding.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Table F.3.10-1 Adaptive Management Strategies; Page F-111	C&R plan adaptive management	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F - 112	F.3.10.5 Incorporating TEK into **Adaptive Management** Benga has and will continue to incorporate TEK into C&R planning and implementation. Benga has committed to consulting and involving nearby Indigenous communities in the ongoing development of C&R plans and C&R related monitoring as the Project advances through the construction, operations, and progressive reclamation phases. The intent is to ensure that habitat and vegetation selections align with traditional land use interests.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 113	The basis of the reclamation material salvage practices for the Project is discussed in detail in Section F.3.4 of the reclamation plan. During the development and operations of the Project, **adaptive management** and continual improvement programs may introduce changes to the salvage practices.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 114	At closure, there will be approximately 1,462.6 ha of recontoured area that will have had an average of 20 cm of reclamation material replacement. Reclamation material replacement practices are discussed in detail in Section F.3.6.2. During the development and operations of the Project, the **adaptive management** program may introduce changes to the replacement practices. All salvaged reclamation material will be replaced on the recontoured areas.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 114	Upon closure, much of the reclaimed landscape will be in various stages of development because of the progressive reclamation program. The revegetation techniques in use at closure will be a continuation of practices employed during development and progressive reclamation of the mine. These practices may be modified by **adaptive management** and continuous improvement programs at the mine	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 125	By assessing the potential impacts of climate change on the Project, Benga is able to better understand the potential effects of climate change on reclamation success. Climate change has been evaluated for potential effects on this Project and potential effects and uncertainty can be adequately managed using **adaptive management** and/or other strategies (further discussed in Section F.5.3 of this document).	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 125	Monitoring, Follow-up and **Adaptive Management** • monitor status of project and effectiveness of mitigation measures • implement remedial action as necessary • incorporate “lessons learned” into normal procedures • address evolving project and climate change knowledge, technology, policy and legislation. During the monitoring, follow-up and adaptive management phase, the responsible federal, provincial or territorial authority may monitor the status of the project and the effectiveness of the mitigation measures that have been implemented. An **adaptive management** process may be employed by the proponent to implement any remedial actions identified as necessary during the follow-up program, as well as incorporate any new lessons learned into normal procedures. The **adaptive management** plan would also be implemented during the follow-up phase. **Adaptive management** can serve as an important learning tool for climate change action, as uncertainty about vulnerabilities and risks can be reduced by experience only if that experience is identified and passed on (to others) to benefit other projects	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 126	Steps 1 and 2 ([1] Preliminary Scoping and [2] Identify Impacts) were evaluated in the Section C. 10 of the EIA (CEAR #42). Steps 3 and 4 ([3] Assess Impacts and [4] Management) were evaluated in detail in IR 113 (Addendum 5, CEAA Registry #69) and IR 25 (Addendum 4, Attachment 2, CEAA Registry #55) which have been carried forward and included again in Section F.5.2 (Effects of Climate Change on Reclamation) for ease of reference. Step 5 is addressed in Sections F.3.9.3 (Reclamation Monitoring Program) and **F.3.10 (Adaptive Management).**	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page 129	The potential effects of changes in fire regime (reduced frequency, increased area burned) in relation to the historical fire on VCs and Benga's proposed mitigation and reclamation plans are summarized in Table F.5.2-2. These changes are based on Boulanger et al. (2014) as they provide the most recently available site-specific predictions. Benga is aware that climate changes may be different than those indicated and would use **adaptive management** strategies to tailor its mitigation and monitoring plans to the conditions that prevail.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F - 154	Risks to the environment attributed to climate change effects can be **adaptively managed** and mitigated for the Project. While climate change has the potential to affect reclamation outcomes, it is important to recognize that the reclamation plans in the C&R plan for the Project represent a variety of ecosites, vegetation species, over a variety of topographic conditions, implemented in phases over several years. Successful reclamation involves establishing a land capability equivalent (including previously disturbed un-reclaimed lands from mining and oil and gas developments in the Project Footprint) to that which existed prior to disturbance, such that the land can support uses that are similar to but not necessarily the same as those present at Baseline	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F -155	According to the Technical Guidance on Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects Under the CEAA, 2012, uncertainty often influences the prediction of the likelihood of a significant adverse effect (Section 4). **Adaptive management** may be used to address uncertainty. **Adaptive management** provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project (Section 5).	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F -157	• incorporate **adaptive management** to reduce risks associated with climate change; and	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F -157	**Adaptive management: • Adaptive management** can serve as an important learning tool for climate change action and addressing uncertainty. The modification of reclamation plans as necessary will be implemented should monitoring indicate that reclamation targets are not being met (Section F.3.10);	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F 158	• Reclamation monitoring is expected to be an EPEA approval condition and is discussed in Section F.3.9. The results of the monitoring results will be reviewed with regulators and Indigenous communities on an ongoing basis as prescribed in EPEA conditions. The continual review of monitoring data will allow for **adaptive management** where results do not meet expectations.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F 158	The potential effects of climate change on reclamation success will occur over a gradual timeline, allowing Benga time to adaptively manage changes that are outside the expected variability. Progressive reclamation allows for the implementation of the reclamation plan over many years, as sites become available, which facilitates the ability to incorporate new information or findings. For example, if climate conditions push characteristic vegetation species (i.e., those necessary for reclamation success) beyond their range of tolerance, then Benga will **adaptively manage** revegetation prescriptions in accordance with the proposed site type characteristics.	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F 159	These anticipated requirements for monitoring and reclamation plans and results will provide an ongoing dialogue with provincial regulators and stakeholders under which to **adaptively manage** the plan as required.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 2: Vegetation and Reclamation	Page F 160	• incorporate **adaptive management strategy** into all development activities.	
Addendum Ten - Package 3: Geotechnical and Dam Safety, Land Use and Land Management	Page 14	the Project has a robust Conservation & Reclamation plan that incorporates monitoring and **adaptive management** strategies, on topics including biodiversity and watersheds;	
Addendum Ten - Package 3: Geotechnical and Dam Safety, Land Use and Land Management	** PDF does not have proper numbers. It is PDF page 68 out of 84.	monitor changes in land use policies and initiatives and, through **adaptive management**, incorporate new requirements into the ongoing reclamation plans.	
Addendum Ten - Package 3: Geotechnical and Dam Safety, Land Use and Land Management	** PDF does not have proper numbers. It is PDF page 73 out of 84.	As the mine reaches maximum disturbance in Year 15, approximately 4.0 ha of reclaimed landscape will be selected to seed monocultures of foothills rough fescue as recommended by Sherritt (2012) in Lancaster, et al. (2016). Once seeded, monitoring programs will be implemented that will assess the success of foothills rough fescue establishment so that corrective actions can be recommended. The early development of rangeland communities will benefit from the remaining years of reclamation schedule and will utilize the **adaptive management** program to ensure that healthy rangeland communities are established. Following Year 15, additional landscape areas will be selected based on the results of the previously targeted foothills rough fescue dominated areas.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 3: Geotechnical and Dam Safety, Land Use and Land Management	** PDF does not have proper numbers. It is PDF page 75 out of 84.	monitor changes in land use policies and initiatives and, through **adaptive management,** incorporate new requirements into the ongoing reclamation plans.	
Addendum Ten - Package 3: Geotechnical and Dam Safety, Land Use and Land Management	** PDF does not have proper numbers. It is PDF page 79 out of 84.	monitor changes in land use policies and initiatives and, through adaptive management, incorporate new requirements into the ongoing reclamation plans.	
Addendum Ten - Package 3: Geotechnical and Dam Safety, Land Use and Land Management	** PDF does not have proper numbers. It is PDF page 81 out of 84.	monitor changes in land use policies and initiatives and, through **adaptive management**, incorporate new requirements into the ongoing reclamation plans.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 9	Benga will continue to consult with Indigenous groups regarding mitigation and monitoring throughout the life of the Project in keeping with an **adaptive management** approach and a commitment to meaningful interweaving of TK into reclamation and closure (e.g., monitoring) planning.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 12	Determining which VCs are included in the discussion of cumulative effects is based on input from Indigenous groups and the residual effects assessment for associated VCs. Identifying the spatial and temporal overlap of the residual effects with those of other projects or activities is focused on interactions with other projects and activities that are in proximity to the Project. These activities are described and shown in corresponding figures. The discussion of whether there is a reasonable expectation for the occurrence of a cumulative effect is based on a qualitative interpretation of how cumulative effects may affect Indigenous people. Cumulative effects may be minimized through the implementation of Project-specific mitigation measures and regional level management by government. Indigenous led community-based monitoring will likely play an additional role in cumulative effects monitoring, mitigation and **adaptive management.**	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	Page 12	The purpose of follow-up and monitoring programs is to verify the accuracy of the effects assessment, determine the effectiveness of mitigation measures identified for the Project and implement **adaptive management** as required. Follow-up and monitoring programs related to Indigenous VCs are described in Section 19 of this Information Request response. Residual effects are likely, and the effectiveness of proposed mitigation measures is uncertain. The focus of follow-up and monitoring programs is on VCs that are characterized as not resilient. In addition, views provided by Indigenous groups on monitoring and reclamation are presented and discussed.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 35	In totality, the changes to hunting by the Káínai Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. Further, the implementation of an Indigenous Environmental Stewardship Committee and an Indigenous monitoring program will function to address issues related to traditional use, wildlife and hunting throughout the life of the Project. It will also provide a mechanism by which community members can actively contribute to and participate in on-going reclamation and conservation planning.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 36	The Project residual effects to fishing by the Káínai Nation are not considered significant. In totality, the changes to fishing are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 38	In totality, the changes to trails and travelways used by the Káínai Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 39	In totality, the residual effects of changes to physical and cultural heritage of the Káínai Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. In addition, Benga will implement the following:	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 67	In totality, the changes to hunting by the Piikani Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive managemen**t where appropriate will be part of ensuring the measures are successful. Further, the implementation of an Indigenous Environmental Stewardship Committee and an Indigenous monitoring program will function to address issues related to traditional use, wildlife and hunting throughout the life of the Project. It will also provide a mechanism by which community members can actively contribute to and participate in on-going reclamation and conservation planning.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 68	In totality, the changes to fishing by the Piikani Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 69	In totality, the changes to plant gathering by the Piikani Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 71	In totality, the changes to trails and travelways used by the Piikani Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 72	Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. In addition, Benga will implement the following:	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 75	In totality, the changes to Physical and Cultural Heritage of the Piikani Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 94	In totality, the changes to hunting by the Siksika Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. Further, the implementation of an Indigenous Environmental Stewardship Committee and an Indigenous monitoring program will function to address issues related to traditional use, wildlife and hunting throughout the life of the Project. It will also provide a mechanism by which community members can actively contribute to and participate in on-going reclamation and conservation planning.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 95	The Project residual effects to fishing by the Siksika Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 96	Monitoring and implementing **adaptive management** techniques will be part of ensuring mitigation measures are effective. With the implementation of mitigation measures, including an AMP, the Project is expected to have a residual effect on the Siksika Nation trails and travelways; however, the effect is predicted to be not significant.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 97	In totality, the changes to trails and travelways used by the Siksika Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 97	In totality, the changes to cultural and spiritual values of the Siksika Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. In addition, Benga will implement the following:	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 102	In totality, the residual effects of changes to physical and cultural heritage of the Siksika Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. In addition, Benga will implement the following:	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 188-119	In totality, the changes to hunting by the Stoney Nakoda Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. Further, the implementation of an Indigenous Environmental Stewardship Committee and an Indigenous monitoring program will function to address issues related to traditional use, wildlife and hunting throughout the life of the Project. It will also provide a mechanism by which community members can actively contribute to and participate in on-going reclamation and conservation planning.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 122	Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 122	In totality, the changes to cultural and spiritual values of the Stoney Nakoda Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. In addition, Benga will implement the following:	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 125	In totality, the residual effects of changes to physical and cultural heritage of the Stoney Nakoda Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. In addition, Benga will implement the following:	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 142	In totality, the changes to hunting by the Tsuut'ina Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. Further, the implementation of an Indigenous Environmental Stewardship Committee and an Indigenous monitoring program will function to address issues related to traditional use, wildlife and hunting throughout the life of the Project. It will also provide a mechanism by which community members can actively contribute to and participate in on-going reclamation and conservation planning.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 143	In totality, the changes to fishing by the Tsuut'ina Nation are not considered significant. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 144	In totality, the changes to plant gathering by the Tsuut'ina Nation are not considered significant, providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 145	In totality, the changes to trails and travelways used by the Tsuut'ina Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 146	In totality, the changes to cultural and spiritual values of the Tsuut'ina Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. In addition, Benga will implement the following:	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 148	In totality, the residual effects of changes to physical and cultural heritage of the Tsuut'ina Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. In addition, Benga will implement the following:	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 172	In totality, the changes to hunting by the Ktunaxa Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 173	In totality, the changes to fishing by the Ktunaxa Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 173	In totality, the changes to plant gathering by the Ktunaxa Nation are not considered significant, providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 174	Use of proven techniques for revegetation will be supported by **adaptive management** and monitoring. The probability of occurrence is high given the type of Project and method of coal extraction.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 176	In totality, the changes to trails and travelways used by the Ktunaxa Nation are not considered significant, providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 177	The changes to cultural and spiritual values of the Ktunaxa Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 179	In totality, the residual effects of changes to physical and cultural heritage of the Ktunaxa Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful. In addition, Benga will implement the following:	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 193	The changes to hunting by the Samson Cree Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 194	The Project residual effects to fishing by the Samson Cree Nation are not considered significant Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 195	The residual effects to plant gathering are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 196	The changes to trails and travelways used by the Samson Cree Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 196	In totality, the changes to cultural and spiritual values used by the Samson Cree Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 198	The changes to Physical and Cultural Heritage of the Samson Cree Nation are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 217	The changes to hunting by the Métis Nation of Alberta are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 218	The Project residual effects to fishing by the Métis Nation of Alberta are not considered significant. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 219	In totality, the residual effects to plant gathering are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 220	The changes to trails and travelways used by the Métis Nation of Alberta are not considered significant providing mitigation measures are implemented and successful. Monitoring and adaptive management where appropriate will be part of ensuring the measures are successful.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 221	The changes to cultural and spiritual values of the Métis Nation of Alberta are not considered significant providing mitigation measures are implemented and successful. Monitoring and **adaptive management** where appropriate will be part of ensuring the measures are successful.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	page 258	The prediction of residual cumulative effects to plant gathering is made with medium to high confidence given the effects on vegetation are well understood and reclamation methods proposed are proven to be effective at re-establishing conditions that ensure tradition use plants. Reclamation will be supported by **adaptive management** and monitoring. However, there was limited information received from Indigenous groups regarding the locations of sites that overlap the Project footprint and the current extent and quality of experience of plant gathering within the LSA.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	** Pages do not properly line up -PDF Page 431 out of 1011	Should the Project be approved, Riversdale would consolidate its private land holdings and surface rights granted through mineral surface leases (MSL) into a contiguous footprint for the purposes of developing the Project. In order to ensure minimum impact to Indigenous access and use of adjacent lands Riversdale has committed to developing an a**daptive Access Management Plan** (AMP, or the Plan). The AMP will also provide for access to portions of the Project footprint while they are not actively part of the mine when it is safe to do so. The details of this plan are intended to protect indigenous rights while also balancing operational considerations and worker safety.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	** Pages do not properly line up -PDF Page 431 out of 1011	This AMP presents Riversdale`s currently available information regarding the mitigation, monitoring, and **adaptive management** programs for managing the potential effects of access for traditional and recreational land use as it relates to the Project. The AMP may be amended by Riversdale following additional consultation with regulators, Indigenous communities, and stakeholders.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	** Pages do not properly line up -PDF Page 432 out of 1011	Goal 5: Utilize an **adaptive management** approach to maximizing access opportunities where feasible.	
Addendum Ten - Package 4: Indigenous Rights, Land Use and Culture and Human Health	** Pages do not properly line up -PDF Page 434 out of 1011	**Adaptive Management** Program **Adaptive management** is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Riversdale will use a Plan-Do-Check-Act management approach to optimize operational safety and access for traditional and recreational users. The findings of the AMP monitoring program will drive adaptive changes to the way Riversdale manages access requests, communicating access permitting requirements, and soliciting feedback from access users.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 9	Response: The site will be **adaptively managed** with the goal of achieving the provincial selenium guidelines. However, modelling of selenium concentrations in receiving waters indicate that the selenium guideline of 2 µg/L may be exceeded in the future. The site-specific selenium objective derived by Benga provides an initial assessment of whether the modelled waterborne selenium concentrations may pose a risk to fish, as represented by WSCT. If it becomes necessary to develop a site-specific selenium objective in the future, monitoring data available at that time may be used to update the site-specific objective currently developed, and those data may also be used to validate the present model. The approach involved site-specific studies and the best available science were used to reduce uncertainty, while ongoing monitoring and **adaptive managemen**t will be used to validate the model, or update it as necessary, to help mitigate against unacceptable selenium risk	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	Page 11 - 12	Application of the Golder (2014) model for Elk Valley, including a version “calibrated” to the baseline relationship between periphyton and water selenium in Blairmore Creek, result in predicted WSCT egg selenium concentrations that fall within the range of concentrations predicted by Benga in evaluating a site-specific selenium guideline. The Golder (2014) model did not include a sulphate as a modifying factor, but any influence of sulphate would have been implicitly captured in the empirical periphyton data. We believe this separate comparison provides further evidence that predicted water selenium concentrations in Blairmore Creek will not pose an unacceptable risk to WSCT, as predicted egg selenium concentrations fall between an effects level of 0 and 2% effects for this species. Again, however, it is noted that ongoing monitoring, and **adaptive management** if necessary, will be used to validate the model and mitigate against potential risks.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	Page 19 - 20 - Request for Response	In response to a request for submission of a draft aquatic monitoring, mitigation and **adaptive management** plan in AER-R2-24 in Addendum 8 (CEAR #89), Benga outlined what the contents of such a plan would contain and referenced the draft Fisheries Offset Plan, but did not provide the requested draft aquatic monitoring plan. In CEAR #191, Benga indicated that details such as final locations and endpoints were not provided in Addendum 8 since they are typically finalized with appropriate regulatory bodies as part of Project conditions. While the Panel does not expect that the aquatic monitoring plan would be finalized at this stage, the draft should demonstrate: ... planning for and availability of alternative mitigation measures to **a**daptively manage potential adverse effects. ... Furthermore, in its submission to the Panel (CEAR #167), ECCC reiterated, having a draft aquatic monitoring plan would allow the Panel to evaluate Benga's ability to: detect potential changes in water quality, validate assessment predictions, and evaluate **adaptive management** measures to mitigate potential effects. Canadian Parks and Wilderness Society Southern Alberta (CEAR #176) also indicated that the draft aquatic monitoring plan should be available to evaluate potential effects. Finally, Fisheries and Oceans Canada requested (CEAR #167), in consideration of the responses to information request DFO-R2-4 through DFO-R2-7 in Addendum 8 (CEAR #89) and Benga's commitment to produce monitoring plans in each of these responses, a draft monitoring plan that considers potential effects of changes to fluvial geomorphology on fish and fish habitat be prepared. a) Provide a draft aquatic monitoring, mitigation and **adaptive management** plan specifically addressing the following points: ... ii. uncertainties that necessitate the use of **adaptive management** including, supporting evidence on the efficacy of proposed **adaptive management** measures; ... vi. methods to be used to develop thresholds that would trigger implementation of mitigation measures or **adaptive management** measures (e.g., a series of risk-based thresholds ranging from triggering confirmation of exceedance of guidelines, to confirming cause/effect, to triggering deployment of alternate or additional mitigation).	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	Page 29	Opportunities for **Adaptive Management** of the SBZ Benga considers that the operation of the SBZ provides numerous opportunities for the application of **Adaptive Management** to improve the SBZ performance. As stated above, the SBZ will be implemented in 3 phases which in itself allows for lessons learned in the first phase to be applied to the phase 2 design. In addition, as mentioned, Benga has the opportunity to implement significant redundancy into the first phase SBZ to provide maximum operational flexibility and ability to adjust the operation if required.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 46	As part of the Project's Water Management Plan, the development of a metal's treatment plant would be determined through operational monitoring. Related, through continued research and development, implementation, monitoring, and **adaptive management**, it is unknown if or when a selenium treatment plan would be required for the Project. For either case, in the event one or both facilities are required, they would likely both be in place for a period of time during Closure, and then phased out and decommissioned as water treatment requirements allow. Based on the uncertainty of what treatment plants may be needed, and for what particular parameters, it is difficult to estimate capital and operating costs; however, JRP IR-5.33 b) speaks to the specifics of reclamation as such pertinent information is summarized here as well.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 64	Uncertainty in Project predictions can be managed according to the Technical Guidance on Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects Under the CEAA, 2012. **Adaptive management** may be used to address uncertainty. **Adaptive management** provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project. Water quality will be monitored to verify the accuracy of predictions and adaptive management strategies will be implemented in the event predictions are not achieved.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 99	The IFA results summarized above suggest that even drought-period average losses of up to 11% in upper or mid-reaches of Gold Creek, resulting in (hypothetical) losses of <11% at the mouth and would support the IFN values calculated at the mouth using the Alberta Desktop Method (in which flow losses at or below 15% must be maintained at or above the Q80 ecosystem base flow, and no flow losses are permitted below this Q80 ecosystem base flow). The assumption is made that below the ecosystem base flow (e.g., during droughts), one or more of the proposed **adaptive management** strategies would be implemented on the Project to conserve losses of flow and ultimately fish habitat.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 105 - 106	Uncertainties within the model and the modelled predictions will be addressed through the use of an **adaptive monitoring and management** plan. Results from the model were used to select monitoring locations and areas requiring monitoring to confirm the modelling predictions and ensure all of the associated receptors are effectively monitored prior to any impact associated with the mining activities. Results from the monitoring will be compared with the modelling predictions, and in context with the mining operations and the need for additional monitoring or the implementation of **adaptive management** re-assessed regularly	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	Page 110 - Request for Response	identify **adaptive management** actions that could be implemented in the event that concentrations of contaminants in groundwater are found to exceed triggers or guideline values.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	Page 118 - Request for Response	Discuss technically and economically feasible mitigation and **adaptive management** measures that can be implemented to prevent and/or minimize changes in stream temperatures in Gold Creek and Blairmore Creek as a result of discharges from the water management structures discussed above.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 121 - Request for Response	Discuss mitigation measures or **adaptive management** actions that will be undertaken to address water with low dissolved oxygen concentrations, prior to being discharged to Gold Creek or Blairmore Creek.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 125 - Request for Response	…. If Project-related uptake or effects exceed **adaptive management** targets or thresholds, mitigation measures would be triggered.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 134 - Request for Response	) Discuss technically and economically feasible mitigation and **adaptive management** measures that can be implemented to prevent and/or minimize changes in groundwater flux to Blairmore Creek as a result of developing the mine and reducing groundwater discharge to Blairmore Creek and its tributaries.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 135 - Request for Response	In Section 5 of the Instream Flow Assessment in Appendix A3 in Addendum 1 (CEAR #44), Benga stated that short-term mitigation measures have been proposed for supplementing flows during dry years, which are intended to alleviate any elevated risk of causing incremental residual effects to critical habitat. In response to concerns outlined by the Coalition (CEAR #191), Benga stated that flow supplementation, and other **adaptive water management** techniques, would be considered as part of the Water Management Plans developed during the permitting stage. Details regarding how flow augmentation of Gold Creek during periods of reduced flows will be implemented were not provided for consideration. Given the threatened status of WSCT, details regarding the proposed mitigation must be provided for the Panel's consideration, and not at a later time.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	Page 136	Flow augmentation has been proposed as an **adaptive management** technique should the flow reductions and/or changes in area weighted suitability (AWS) be greater than what was predicted in the Instream Flow Assessment (CR#6, Appendix A3: CEAR #44). Monitoring will be implemented to verify and validate the changes in surface flow predicted by the Instream Flow Assessment. Details on the flow monitoring frequency, methods, and data analysis are provided in Section 6.1 of the draft Fisheries and Aquatics Monitoring Program (response to JRP IR-5.4).	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	Page 137 - Request for Response	Provide a discussion of how water quality parameters from the source location will be analyzed and treated, as necessary, prior to discharging augmented flows into Gold Creek. Include an analysis of all Chemicals of Potential Concern from the source location, temperature of the source water and sediment load, and proposed mitigation measures and **adaptive management** actions that are economically and technically feasible to address issues with water quality, temperature or sediment prior to discharging augmented flows to Gold Creek.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	Page 139	An updated Recovery/Action Plan for the Alberta Populations of WSCT has been posted for 60-day public comment period (ending July 13, 2019) proposing to designate the Gold Creek watershed in its entirety as critical habitat, including a 30 m riparian area around the watercourses. At present, a 20 m buffer was applied to the non-fish bearing tributaries of Gold Creek (e.g., GCT06) and a 50 m buffer was applied to the mainstem of Gold Creek. Should the updated Recovery/Action Plan be implemented, the amount of riparian habitat affected by the Project will be re-evaluated to consider these potential changes. Given the conservative buffer applied to Gold Creek, changes are expected to be minimal. The draft Fisheries Offsetting Plan (Addendum 8, CEAR #89) has incorporated a number of methods to address uncertainty in potential effects including: 1) gain:loss ratio of 9:1 for aquatic habitat and 2.2:1 for riparian habitat (Section 9), 2) contingency measures (Section 7.1.4), and 3) a**n adaptive management a**pproach (Section 12).	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 143-144	Discuss technically and economically feasible mitigation and **adaptive management** measures that can be implemented to prevent and/or minimize avoidance responses of fish in Gold Creekand Blairmore Creek as a result of blasting activities, to prevent any impacts on fish populations, and to ensure fish have year round access to all habitats throughout Gold and Blairmore Creeks.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 188	improving Benga's understanding of the effects of Project construction and operation on wildlife within the WLSA and surrounding area to enable the implementation of **adaptive management** practices when required; and	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 199	improving Benga's understanding of the effects of Project construction and operation on wildlife within the WLSA and surrounding area to enable the implementation of **adaptive management** practices when required; and	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 232 - Request for Response	Proposed mitigation measures for wildlife are discussed in various sections throughout the updated EIA and referenced within the various addenda. In Consultant Report #9 (CEAR #42), Benga provides a Wildlife Mitigation and Monitoring Section in which Benga proposes mitigation measures and wildlife monitoring programs designed to reduce or minimize the effects of the Project on wildlife and to monitor the effects of the Project to allow for effective **adaptive management** of mitigation measure over time. Benga states that they will be implementing a number of best management practices, Project design features and other measures to avoid or minimize effects. Throughout the EIA, Benga also refers to, and depends on, the ability to reclaim the landscape at closure as a means to mitigate effects on wildlife. ... The Panel requires further information to better understand Benga's proposed mitigation measures for wildlife and to assess the effectiveness of these measures. The Panel also requires an understanding of the **adaptive management** measures that will be adopted if the proposed mitigation measures do not perform as anticipated.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	page 233 - Request for Response	vii. a description of uncertainties that may necessitate the use of **adaptive management;** viii. Thresholds that monitoring results will be compared to that will trigger implementation of **adaptive management** or alternative mitigation measures; ix. A description of the **adaptive management** approach that will be used to assess and improve the effectiveness of mitigations; and ...	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	*** Pages do not line up; PDF page 299 out of 1153	The following draft Fisheries and Aquatics Monitoring Program (the Program) has been developed for the Project aimed to verify predicted potential effects to WSCT in Consultant Report #5 (CEAR #42) and Consultant Report #6 (CEAR #44) as well as respond to the Joint Review Panel (JRP) information request (IR) 5.4 (JRP IR-5.4), which requested a draft aquatic monitoring, mitigation and **adaptive management plan**	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF pages 299-300	This draft Program has been prepared using the most current information available to date regarding mitigation, monitoring and a**daptive management** related to the Project. Finalization of the draft Program will occur following additional consultation with regulators, Indigenous communities and stakeholders and is an anticipated requirement of the EPEA approval condition, should the Project be approved. It is anticipated that this draft Program will be periodically updated and reviewed as per expected EPEA approval conditions.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF pages 317	This component of the Water Resources Monitoring Plan includes the detection of changes in WSCT Area Weighted Suitability (AWS) at established microhabitat transects (within mesohabitat units) during the Instream Flow Assessment (IFA) in key reaches of Gold and Blairmore creeks. The purpose of this component is to verify predictions made during the IFA, evaluate whether **adaptive mitigation** (i.e., flow augmentation) is required, and implement and monitor mitigation effectiveness, if necessary.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDG page 322	The main purpose of monitoring will be to confirm that predictions made during the effects assessment remain valid, and to trigger the implement **adaptive mitigation,** where necessary. Monitoring may also identify new effects that might not have been predicted. Monitoring may also inform our understanding of the efficacy of mitigation measures that could be implemented by Benga (e.g., flow augmentation), such as the effect of decreasing peak discharge and adding water at discrete nodes.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 324	determine the causes of any observed changes in food supply, individual condition, and/or population condition, to facilitate **adaptive management** and offsetting/mitigation programs;	

Part of EIA	**Page Number**	**Reference**	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 342	**7.0 ADAPTIVE MANAGEMENT** This Program has been developed to validate the predicted Project effects on WSCT. Benga recognizes there is an inherent uncertainty in these predictions given natural variation in the environment such as fluctuations in the WSCT population and climate change. Should monitoring detect Project effects that are different than those predicted, Benga is committed to implementing **adaptive management** measures such as additional mitigation or offsetting activities. Contemporary **adaptive management** science relies on monitoring and management of species that are being conserved and managed over the long-term. A key concept of **adaptive managemen**t is that	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF 343	Benga's **adaptive management** approach will involve establishing indicators and thresholds according to baseline characterization, improved practices based on research and monitoring results, and input from the public engagement and Indigenous consultation programs. As the Project proceeds, monitoring throughout all Project phases will allow WSCT targets to be reviewed and, if necessary, modifications can be made to site expectations. **Adaptive management** is intended to respond to changes and advances in technology to meet specific objectives. Benga will incorporate adaptive management techniques as routine components in all of its environmental management activities. These techniques provide the opportunity to develop and fine-tune the monitoring program using data collected on-site and from other regional operators.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 343	With respect to **Adaptive Management**, Benga is committed to achieving continual improvement in environmental performance. The development and implementation of all monitoring and mitigation identified for the Project and housed in the monitoring and follow-up programs will be tracked in relevant management plans. As site conditions and monitoring dictate, or as new technology emerges, Benga will **adaptively manage** its site practices and monitoring program to meet the defined objectives. For some programs this would involve regular evaluation of predictive models; which would be clearly defined in each applicable management plan.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 344	**7.1 Adaptive Management** Process Design Once the problem has been identified and assessed, the design of the adaptive **management** program can commence, beginning with determining the best approach to **adaptive management**. The following are design considerations for the adaptive management program: • data analysis methods and frequency; • predicted trajectories for indicators; and • triggers for action and potential adaptations.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 345 out of 1153	8.2 Information Management and Reporting This section will outline how the monitoring results and **adaptive management** actions will be recorded, stored, tracked and made available to interested stakeholders. Accurate record keeping will be necessary to assess the implementation of the Program, to measure the effectiveness of management and to develop and implement any necessary improvements.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF pages 345 out of 1153	8.3 Change Management This section will outline the process for altering any part of this Program, which may be required due to changes resulting from ongoing **adaptive management.**	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	**PDF page 582 out of 1153**	Adaptively managing implementation of the Plan to ensure that new data and information is continually assessed and considered, and actions taken when necessary to meet objectives	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	**PDF Page 585**	The Plan incorporates a process for ongoing monitoring of the ecological health in the Valley and the effectiveness of the water management options employed. An adaptive management approach will ensure that the Plan evolves in step with changing circumstances, monitoring results, and the outcomes of Teck's research and development program, as well as advances in the science and technology available to manage water quality.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	**PDF page 588**	"11. Adaptive Management Describes the framework that the Elk Valley Water Quality Plan will be implemented within, and outlines the tiered decision-making to allow for refinements of the initial implementation plan Allows the Plan to adapt through the incorporation of key learnings during implementation"	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	**PDF page 594**	Additional water treatment is also contemplated in the Plan, and will be assessed through the Adaptive Management Process as new technologies emerge and monitoring results are analyzed.	

Part of EIA	**Page Number**	**Reference**	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	**PDF page 596**	"Results of these evaluations will be summarized and made available at www.teck.com/ElkValley. Analysis of the results will be used to inform the adaptive management component of the Plan."	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 597	"Adaptive Management Adapting to Monitoring Teck will be responsive to monitoring data and, as necessary, will adapt the Plan to continue to meet targets and objectives. Adaptive management is a systematic process for reviewing the Plan to ensure that objectives set in the Plan are being met, and to adjust and improve management actions as required to achieve those objectives. Monitoring of water quality, ecosystem health, periphyton, ecotoxicology and groundwater will provide the necessary information to assess results of the initial implementation and to make changes as necessary."	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 613	The process for developing the Plan, called the Elk Valley Water Quality Plan, is based on extensive research and study into aquatic health in the Valley. The Plan takes into account the effect of mining activity, the scientific advice provided by the independent Technical Advisory Committee, and broad consultations. The Plan incorporates a process for ongoing monitoring of water, and ecosystem health in the Valley and the effectiveness of water management. An adaptive management approach will ensure that the Plan evolves in step with monitoring results, technology advances, and the outcomes of Teck's research and development program. As such, the Plan is considered a living document and a process to consider adjustments to target and management actions for example, will be considered during implementation.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 635	Consultation to continue: Teck will continue to undertake consultation at key milestones during implementation of the Plan. Inputs will be considered in the adaptive management of the Plan.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 638	Phase 2 (April 9-May 5, 2014): During the second round, Teck provided an update on progress made in developing the Plan, including information about research into ecologically protective levels for the substances of concern. Input was sought regarding the short-, medium- and long-term approaches to be included in the Plan, and how communities and the public would like to be consulted about adaptive management of the Plan after it has been implemented.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 640	A high proportion of participants who provided feedback in the Phase 2 consultation period were supportive of the short-, medium- and long-term water quality approaches proposed by Teck. Participants were asked how they would prefer to be notified and consulted about ongoing monitoring and adaptive management of the Plan. Most respondents preferred to obtain information and provide feedback via a website (76.7%), direct notification (62.8%), and by attending a community information session (55.5%).	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 645	Input received through consultation will be considered, along with environmental, technical and financial information, in the adaptive management and implementation of the Plan.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 736	Calcite targets, in terms of both levels of calcite and the timing of remedial actions, will be adaptively managed as implementation of the Plan proceeds. The long-term Calcite Index target will be reviewed as more data become available, and should be viewed as an interim target.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 736	Adaptive management. As more data are collected, the calcite management plan will be adapted and adjusted.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 748	Concretion Score of ≥0.50 was used to identify priority streams to be managed in the medium term. Although management measures will begin immediately, achieving medium-term targets will take up to 10 years, and 15 years will be required to meet the long-term targets. This timing reflects ongoing evaluations associated with development of calcite control and remediation technologies discussed in Section 7.6. Furthermore, calcite targets (levels and timing) will be adaptively managed as outlined in Section 7.7. Medium- and long-term targets are summarized below.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 751	Step 6: Adaptive Management. Teck will monitor, conduct research, re-evaluate control methods, and refine targets (scores and timelines) if necessary.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 755	"7.7 **Adaptive Management** (Future Work) Calcite management plans outlined in this chapter are based on current knowledge of the levels of calcite deposition, as measured by the Calcite Index. As more data are collected, Teck will adapt and adjust the program to achieve the desired overall objective of managing mine-related calcite formation such that streambed substrates within the Designated Area support abundant and diverse communities of aquatic plants, benthic invertebrates, and fish, comparable to those in reference areas. The adaptive management framework for calcite is depicted in Figure 7-10. Ongoing monitoring, research and learning will provide the foundation for evaluating whether adjustments to the approach of calcite management are warranted. The monitoring, research, and learning components of adaptive management have specific objectives and desired outcomes relating to calcite.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 757	As detailed in Section 7.4, medium-term targets have been identified and selected based on a Calcite Concretion Score of 0.50. This score was selected based on the TAC's advice and associated hypothesis that it may represent a level at which physical stress to stream-bed organisms are possible. As such, it represents an implementation trigger. At the time of writing, this hypothesis remains an uncertainty and as such, will be adaptively managed.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 757	When the analysis trigger is reached, Teck will initiate an evaluation of the stream conditions. Following a careful review of the data, if it is determined that Calcite Index levels are in fact trending upward due to increased concretion scores, a root-cause analysis will be conducted to determine if the results are due to coal mining or to other outside factors. Identification of the root cause will guide the adaptive management decision-making process, help identify and evaluate solutions, and help to predict, using a balance of probabilities approach, if and when a Calcite Concretion Score >0.50 is likely to be reached. If it is determined that it is likely, Teck will implement management actions with the objective of keeping it <0.50 or at the value consistent with the overall objective.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 759	There will be two reporting cycles regarding calcite: 1) an annual calcite update; and 2) a three-year Plan report that corresponds to the reporting cycle for aquatic effects monitoring (see Chapters 10 and 11). The reports will include evaluation against relevant management triggers and any associated root cause analyses and adaptive management outcomes.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 759	A three-year Plan report will be completed on a cycle that corresponds to the aquatic effects monitoring. The first reporting cycle will be 2017. The anticipated scope of the three-year adaptive management report is fully described in Chapter 11.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 760	Started: Calcite monitoring has identified potential streams; additional technology advancements and research are ongoing - findings of which will inform decision-making; Adaptive Management Framework for Calcite (Section 7.7)	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 778	Sulphate concentrations at Order station FR4 in MU-1 are predicted to reach the B.C. WQG in 2030. The potential for sulphate to exceed the long-term target in MU-1 will be managed through monitoring and adaptive management (see Chapter 11). If required, sulphate treatment can be implemented (see Section 8.5). The long-term sulphate target for MU-1 at Order station FR4 was set to B.C. WQG (i.e., 429 mg/L) and an integrated assessment was completed to confirm that this target will protect aquatic health in MU-1.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 786	"Results of the integrated assessment for sulphate in the are presented in Table 8-14. In MU-1, most but not all integrated assessment criteria were met (Table 8-14). … However, only approximately 34% of the mainstem Fording River was predicted to be less than the Level 1 benchmark, although 100% of this area was below the Level 2 benchmark. A sulphate target level of 429 mg/L at FR4 is expected to be protective of aquatic health in MU-1 because integrated effect sizes were <10% for all receptors and 98% or more of the MU met Level 2 benchmarks for fish, amphibians and benthic invertebrates. Follow-up monitoring and toxicity testing will be used to verify this conclusion and updated the toxicity benchmarks as appropriate. Sulphate concentrations in the upper Fording River will be **adaptively managed** as described in Chapter 11, as will the sulphate targets and timeframes. If necessary, sulphate treatment can be implemented"	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 786	Predictions of cadmium concentrations are uncertain. Efforts are underway to improve the quantitative understanding of the geochemical release of cadmium from waste rock, allowing improvement of model predictions. This information will be used during implementation to adaptively manage cadmium concentrations if and as necessary.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 794	An evaluation of individual physical and chemical stressors is provided below, following by a qualitative evaluation of multiple stressors in MUs in the Elk and Fording River (MU-1 to MU-4). Based on this information, conclusions are rendered on how the findings of the constituent-specific analyses previously discussed may be affected, if at all, by multiple stressor considerations. Residual uncertainties inherent in multiple-stressor analysis will be addressed with through on-going monitoring and adaptive management, which are presented in Chapters 10 and 11 of the Plan.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 796	Based on this evaluation, mixture effects at target concentrations are considered unlikely. Uncertainties in potential mixture effects will be evaluated during Plan implementation through an ecotoxicology supporting study (see Chapter 10) and considered in adaptive management	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 797	Based on the above, the potential for multiple-stressor effects is considered unlikely. … Fish are the most sensitive receptor to selenium and sulphate. As concentrations of both constituents are close to (selenium) or over (sulphate) their respective Level 1 benchmarks, it is theoretically possible that response addition for these two constituents could yield a combined effect size of greater than 20%. Follow-up monitoring, additional toxicity testing with sulphate and **adaptive management** will, therefore, be used to address this residual uncertainty.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 799	An initial implementation plan was developed to meet short- and long-term water-quality targets at Order Stations for selenium, nitrate, sulphate and cadmium. Medium term targets were then identified based on the initial implementation plan to demonstrate progress from short to long term targets. AWTFs and diversions are identified as the technologies that can reliably and efficiently reduce concentrations of selenium and nitrate from mine sites (Chapter 6). Other options based on emerging technologies and management approaches will continue to be evaluated, with the intention of incorporating them through an adaptive management process when appropriate (Chapter 11).	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 800	Table 8-18 Planning basis, rationale, and adaptive management considerations **** this table has a full column on Adaptive Management *****	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 801	Based on lessons learned through the implementation and operation of treatment facilities, and as new treatment technology becomes available, facility up-time will be re-evaluated and fed into the adaptive management process to achieve the water-quality targets of the Plan.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 817	Cadmium was not modelled, but current concentrations are within targets and are expected to remain so (Chapter 4). Cadmium trends will continue to be monitored and adaptively managed during plan implementation. Technologies that remove these constituents will be evaluated and implemented if required.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 833	This chapter describes monitoring that will be undertaken, through the Regional Aquatic Effects Monitoring Program (RAEMP) and supporting studies, to assess environmental conditions, confirm that the objectives of the Plan are met, identify the need for adaptive management actions, and refine planning tools in the use of the Plan.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 833	Teck will implement ecosystem monitoring and ecotoxicology assessment programs to evaluate progress on meeting Plan objectives. The monitoring program will be used to confirm that the Plan is achieving its objectives of protecting aquatic ecosystem health, managing bioaccumulation of constituents, and protecting human health and groundwater. It will also be used to refine planning tools and inform adaptive management.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 835	The RAEMP entails a comprehensive evaluation of aquatic ecosystem health. It measures a broad range of constituents in environmental media, including those specified by the Order (selenium, cadmium, nitrate and sulphate) and also measures calcite formation and aquatic effects. The data collected, and reports developed, for the program to evaluate effects to aquatic ecosystem health will be used to meet both objectives of the Plan and Teck's existing permits. Specific to the Plan, monitoring results will be used to assess environmental conditions, confirm objectives are met, identify and inform the need for adaptive management actions, and refine the tools (e.g., the Elk Valley Water Quality Planning Model and selenium bioaccumulation model) used in development of the Plan.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 840	"Table 10-3: Relationship between conceptual site model and proposed monitoring: Initial trigger levels based on concentration scores. Combined calcite and benthic invertebrate monitoring will be undertaken as a supporting study in 2015 to update target and adaptive management trigger levels to account for calcite effects to EPT and E proportions and periphyton biomass (Chapter 7)."	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 845	The approach proposed above will directly assess potential eutrophication, and thereby contribute to the understanding of overall ecosystem health. For surface water quality, sufficient baseline data exist to characterize the baseline envelope, and thus can be incorporated into the adaptive management plan (Chapter 11); however, baseline data for primary productivity are limited, and further data collection will be an important component of aquatic ecosystem monitoring.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 849	The ground water synthesis report will evaluate regional groundwater conditions and protection objectives in the context of existing mitigation and management strategies. The report will also assess anticipated future groundwater conditions based on changes to mining activities and water quality improvements resulting from mitigation actions. This assessment will lead to identification of areas and/or aquifers that may require protection or consideration of **adaptive management** steps to achieve related water quality objectives. Where areas are identified as potentially requiring additional consideration, an evaluation of the appropriate management strategies will be performed. The report will incorporate information from groundwater programs implemented or in development at each Teck Elk Valley operation as well as baseline data captured as a component of Environmental Assessments and results from the well sampling program detailed in Chapter 5.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 849-850	The collective information gained from operational monitoring, applied R&D, well sampling program and Environmental Assessment baseline data evaluated through the groundwater synthesis report will provide the necessary information to develop the regional groundwater monitoring program and serve to assess and inform the effectiveness of mitigation measures implemented as part of the Plan. As such, supplemental management strategies will be developed as part the adaptive management process to ensure protection of groundwater is achieved.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 851	identify and help define the need for adaptive management actions	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 853	This chapter describes the adaptive management framework for the Elk Valley Water Quality Plan (the Plan) and outlines the tiered decision-making framework for adaptively managing the Plan during implementation.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 853	Teck will be responsive to monitoring data and supporting studies, applied R&D and changing circumstances, and will update the Plan as required to meet water-quality and calcite targets and environmental management objectives. Adaptive management is a systematic process for reviewing the Plan to ensure that objectives are being met, to adjust management actions as required to achieve its targets, and/or to review and adjust targets when appropriate. Monitoring of water quality, ecosystem health, periphyton, and groundwater and other supporting studies will enable modifications to take new information and changing circumstances into account.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 855	The approach in the Plan reflects Teck's current understanding of how best to manage water quality and calcite, and the targets established pursuant of the Order. Many factors will change over time, and will require adaptive management. The over-arching objective of adaptive management is to provide a structured but flexible process for evaluating and , when required, adjusting the Plan, in response to new information and changing circumstances, to allow the goals and environmental management objectives of the Plan to be achieved as circumstances change.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 855	"**Adaptive management** will address the following more specific objectives: Incorporate the results of monitoring the aquatic environment in the Designated Area, relative to meeting the environmental management objectives of the Plan. • Use the results of supporting studies that are developed to validate and inform the Plan and to address specific uncertainties (e.g., selenium bioaccumulation model). • Incorporate new mitigation measures developed by Teck's R&D program, to improve the long-term sustainability of the initial implementation plan and calcite management plan by enhancing cost-effectiveness, long-term operation and maintenance, and environmental performance. Take reclamation and closure issues into account in future updates of the initial implementation plan and calcite management plan, as reclamation research and monitoring address uncertainties and provide quantitative measures of how reclamation practices and plans at Teck operations influence water quality and calcite1. • Manage changes in resource evaluation and mine plans, and update the Plan accordingly. • Update the planning tools used during implementation, including the Elk Valley Water Quality Planning Model (the Model), selenium bioaccumulation models, and site-specific hydrologic and water balance models that support detailed design of mitigation measures. • Review and, if required, update water-quality and calcite targets and timeframes to reflect results of aquatic effects monitoring and advances in science (e.g., literature publications). • Re-evaluate the sustainable balancing of environmental, economic and social costs and benefits to reflect any changes to future mine plans by Teck or proposed development of new mines by other proponents. Depending on the circumstances, adaptive management could lead to lower or higher long-term target levels, and shorter or longer implementation timeframes."	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 856	"The overall **adaptive management** process is illustrated in Figure 11-1. Each **adaptive management** component incorporates periodic evaluation and reporting, and identifies trigger points that determine if additional root cause analysis is required to determine whether the plan must be adapted. … As Teck gains experience and knowledge during implementation, the **adaptive management** components will themselves evolve. Teck will also coordinate Plan implementation with other relevant management plans, … Plan evaluation and reporting is described in Section 11.9 and public reporting is described in Section 11.10. Adaptive management for calcite is presented in Chapter 7."	

Part of EIA	Page Number	Reference	
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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 857	"The primary effect pathway is associated with release of selenium, nitrate, sulphate and cadmium (Order constituents) from mine sources and advective transport in water. Water-quality monitoring data at Order stations will be collected monthly and assessed annually to determine if concentrations, loadings and trends of constituents are consistent with predictions and remain on track to meet water-quality targets and timeframes. Additional adaptive management triggers will be developed for monitoring locations located closer to source areas in mainstem river and tributary locations, including any monitoring locations specified in effluent permits issued under the B.C. Environmental Management Act."	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 858	"The root-cause analysis will identify need for adaptive management actions that could include one or more of the following: • further investigations or more frequent evaluation, if the cause is not sufficiently well- understood to make a management decision • adjustment of triggers, targets or timeframes • improving performance of existing mitigation projects • increasing or decreasing the level of future mitigation • revising the scope or frequency of monitoring programs • continued monitoring, and re-evaluation after the next cycle."	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 859	"As described in Chapter 10, the regional aquatic effects monitoring program (RAEMP) will measure and integrate multiple types of data to assess the health of the aquatic ecosystem throughout the Designated Area. The RAEMP provides an integrated assessment of pathways for release, transport and fate of Order constituents in water, sediment and biota, as well as the combined effects of all stressors on sensitive biota. RAEMP components that will be used to adaptively manage the Plan for selenium, nitrate, sulphate, cadmium and calcite include:"	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 859	The RAEMP will use a three-year integrated evaluation and reporting cycle for all components. The second cycle of regional aquatic effects monitoring is 2013 to 2016, with an interpretative report in 2017. Adaptive management triggers related to monitoring will be developed and evaluated in a three-year Plan report, which will be developed in parallel with the second cycle of the RAEMP interpretive report (see Section 11.9). The RAEMP assessment and measurement endpoints that will be used to develop and evaluate adaptive management triggers for the Plan are listed in Table 11-1.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 861	**Adaptive management** triggers will incorporate: • water quality guidelines (WQGs), benchmarks and targets for selenium, nitrate, sulphate and cadmium • effects to benthic invertebrate community structure • B.C. WQGs for nutrients and algae, including periphyton chlorophyll-a guidelines for streams and total phosphorus concentrations in water for lakes • selenium tissue guidelines and site-specific benchmarks for the protection of aquatic life • sediment quality guidelines for selenium and cadmium • calcite targets, based on an evaluation of effects of calcite on benthic invertebrates, periphyton and physical and chemical measures of stream-bed habitat • status of juvenile and adult WCT in the upper Fording River. Monitoring of selenium in water and tissue will also be used to validate and update the selenium bioaccumulation models discussed in Section 11.6. Adaptive management triggers, associated root-cause analyses and potential adaptive management actions will be fully developed as part the first cycle of the three-year Plan reporting (see Section 11.9).	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 862	Teck is also updating the Model to provide improved resolution for predicting future increases in total phosphorus concentrations in the Elk and Fording rivers. The model will be used to assist with **adaptive management** of phosphorus.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 863	As part of existing EMA and Mines Act Permits, groundwater monitoring programs have been implemented or are in development for each of Teck's coal operations in the Elk Valley. The objective of programs is to better understand the influence of mine operations on groundwater and potential interactions with surface water. Results will be used to assess the potential influence of Teck operations on groundwater wells and support adaptive management of groundwater. If concentrations in wells remain above drinking water guidelines for Order constituents, additional monitoring will be considered. The adaptive management trigger would be an increasing trend in groundwater well concentrations. Should the data indicate that concentrations are increasing, a root-cause analysis will be conducted to guide the adaptive management decision-making process. A root-cause analysis could, for example, include a supporting study to better understand groundwater-to-surface-water connections in a particular area.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 863	"The focus of Teck's R&D is to investigate and implement more effective and efficient solutions for managing constituents of interest in mine-affected watersheds. Active water treatment technology R&D and source control R&D are the two components of this initiative, and guided the selection of the management options described in Chapter 6. As R&D continues, new technologies and management approaches may be used in adaptive management of the Plan implementation. As stated in Section 6.3.1, the steps for advancing technologies to a stage where they can be considered for full deployment are: 1. Identify basic knowledge and technology. 2. Identify sites for full-scale implementation. 3. Bound the risks. 4. Prioritize implementation technologies and sites. 5. Implement at full scale. 6. Monitor and improve first implementation. 7. Consider broader technology applications within mine plans."	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 866	"There will be two adaptive management evaluation and Plan reporting cycles: 1) an annual water quality and calcite update; and 2) a three-year Plan report that corresponds to the reporting cycle for aquatic effects monitoring (see Chapter 10). The reports will include evaluation against relevant management triggers and any associated root-cause analyses and adaptive management outcomes. Adaptive management triggers, associated root-cause analyses and potential adaptive management actions described in earlier sections of the chapter will be fully developed as part the first cycle of Plan reporting. The annual water quality and calcite report will provide an update of monitoring and management activities for the previous year and progress towards meeting water quality and calcite targets and timelines. The first annual adaptive management update report will be prepared in 2016 for monitoring and management activities completed to the end of 2015. The anticipated scope of the annual water quality and calcite update includes: • an update of water quality and calcite mitigation measures for the previous year • water quality monitoring and modelling results for Order stations, any compliance locations that may be specified in effluent permits and other monitoring locations for which adaptive management triggers are defined"	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA - Methodology. **The following references are from an included document created by Teck Coal outlining their plans regarding water quality in the Elk Valley. It starts on PDF page 582 out of 1153 and ends on PDF page 869 out of 1153**	PDF page 867	Inputs received from consultation will be considered as part of adaptive management of the Plan.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 877	5. A**daptive Management:** Multi-decade plan, adapting implementation based on new information and learnings An Environmental Monitoring Committee (EMC) was established to advise on the implementation of the plan. The EMC consists of experts from the Ministry of Environment, Ministry of Energy and Mines, the Interior Health Authority, the Ktunaxa Nation Council, an independent scientist and Teck. The EMC reviews and provides input and advice to all monitoring reports and study designs. The EMC publishes an annual public report at www.teck.com/elkvalley	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1105	vi. identification and discussion of any Project-specific mitigation measures that may have a positive impact on wildlife including any details of proposed conservation offsets. vii. a description of uncertainties that may necessitate the use of **adaptive management**; viii. thresholds that monitoring results will be compared to that will trigger implementation of **adaptive management** or alternative mitigation measures; ix. a description of the adaptive management approach that will be used to assess and improve the effectiveness of mitigations; and x. to the extent possible, a description of how, when and where mitigation measures will be implemented including details on leading methodologies used and their supporting literature or research.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1106	This draft Plan has been prepared using the most current information available regarding mitigation, monitoring and **adaptive management** related to the Project. Finalization of the draft Plan will occur following additional consultation with regulators, Aboriginal communities and stakeholders and is an anticipated requirement of the Environmental Protection and Enhancement Act (EPEA) approval condition, should the Project be approved. It is anticipated that this draft Plan will be periodically updated and reviewed as per expected EPEA approval conditions.	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1108	The goals of the draft Plan link potential Project effects to mitigation, mitigation objectives to monitoring, and monitoring results to **adaptive management** actions. The specific goals and objectives of this Plan are summarized in Table 3.0-1.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1113	The Project has the potential to affect wildlife through a number of effects mechanisms such as direct and indirect habitat loss, habitat fragmentation/connectivity, and changes in movement patterns, and increased mortality risk. The proposed mitigation measures described in this section were designed to reduce or minimize the effects of the Project on wildlife and to monitor the effects of the Project to allow for effective **adaptive management** of mitigation measures over time to ensure that the Project related effects on wildlife are avoided or minimized (Goal #1, Table 3.0-1). Benga has already committed to these mitigation measures and expects that they would become part of the anticipated EPEA approval for the Project. Table 5.0-1 summarizes the objectives and planned mitigation of the mitigation program, which are further described in Section 5.1. General wildlife mitigations apply to all VCs with additional species-specific mitigation as noted (Table 5.0-1).	

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Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1139-1140	7**.0 ADAPTIVE MANAGEMENT** PROGRAM **Adaptive management** is a planned and systematic process for continuously improving environmental management practices by learning about their outcomes. **Adaptive management** provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project. As with the mitigation program, the mitigation monitoring program is viewed as adaptive and is expected to change as understanding of wildlife responses to Project development and operations increases. Benga's **adaptive management** program is organized into four main components, which are reevaluated and reassessed in a feedback loop (Figure 7.0-1).	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1140	Figure 7.0-1 Benga's Adaptive Management Process Benga's **adaptive management** approach will involve establishing end land use objectives according to pre-development land use capability, site-specific conditions, improved practices based on research and monitoring results, and input from the public engagement and Indigenous consultation programs. As reclamation proceeds, monitoring of reclamation and revegetation performance in conjunction with the wildlife mitigation and monitoring programs will allow land use objectives to be reviewed and, if necessary, modifications can be made to site expectations according to natural revegetation processes and wildlife and wildlife habitat goals. **Adaptive management** is intended to respond to changes and advances in technology to meet specific objectives. Benga will incorporate **adaptive management** techniques as routine components in all of its environmental management activities. These techniques provide the opportunity to develop and fine-tune the monitoring program using data collected on-site and from other regional operators.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1141	With respect to Adaptive Management, Benga is committed to achieving continual improvement in environmental performance. The development and implementation of all monitoring and mitigation identified for the Project and housed in the monitoring and follow-up programs will be tracked in relevant management plans. As site conditions and monitoring dictate, or as new technology emerges, Benga will **adaptively manage** site practices and monitoring programs to meet the defined objectives. For some programs this would involve regular evaluation of predictive models; which would be clearly defined in each applicable management plan.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1141	Benga recognizes that there is a large degree of natural variation and complexity inherent within ecosystems and that predicting the effects of Project development (construction and operations) on wildlife and wildlife habitat use can result in uncertainties regarding the effectiveness of proposed mitigation measures. An important first step in Benga's **Adaptive Management** Process is assessing the problem. From a wildlife perspective, this step reflects the uncertainty that may be associated with the effectiveness of specific mitigation measures, the likelihood that the uncertainty associated with specific mitigation measures can be reduced, and/or the potential to adjust or modify best practices.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1142	**7.2 Adaptive Management** Process Design Once the problem has been identified and assessed, the design of the **adaptive management** program can commence, beginning with determining the best approach to adaptive management. The following are design considerations for the **adaptive management** program: • data analysis methods and frequency; • predicted trajectories for indicators; and • triggers for action and potential adaptations.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1143	To design the **adaptive management** process, Benga will develop a desired trajectory or performance objectives through time for each wildlife metric (e.g., species composition and abundance), so that trends observed through monitoring can be evaluated against desired objectives. The desired performance objectives can be used to define a trigger to indicate when observed wildlife metrics vary substantially from the objectives. These triggers and thresholds will be developed in conjunction with regulators, Indigenous community consultation, and EPEA approval conditions. They may change over time, as they are also informed by documents that continue to evolve, such as species recovery strategies, or regional frameworks and targets. They are also informed by the monitoring data collected on reference sites, and species general presence in the region. As such, triggers will be determined with stakeholders and regulators upon receipt of regulatory approvals when the final wildlife monitoring plan is required under the EPEA approval. Some triggers and thresholds are appropriate to set at this time. These include triggers associated mainly with Project infrastructure-human interactions, such as vehicle collisions or bird collisions with buildings. As indicated in Table 6.0-1, targets for these interactions are zero. Anything above zero will trigger an evaluation of the incident and mitigation to determine if modifications are required under the **adaptive management** process.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1143	To evaluate wildlife use of reclaimed habitats, wildlife use trajectories and associated management triggers would be developed from baseline reference data collected and from control sites established in undisturbed habitats outside of the Project footprint. If the composition or relative abundance of indicator species in reclaimed areas are not approaching the values in natural habitats with similar site type conditions and structural stages, then **adaptive management** can be implemented.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1143	A summary of the **adaptive management** program for the Project is provided in Table 7.2-1.	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1144	If mitigation adjustments are determined to be required, then they will be implemented with careful consideration to proper planning, approvals, notifications and/or consultation. In this step of the **adaptive management** process, a work plan may be developed and implemented. Any required notifications and/or approvals will be obtained before acting to confirm that all interested/affected parties are properly informed. If adjustments to mitigation measures are required, the Wildlife Mitigation and Monitoring Plan will be updated as appropriate to reflect the adapted mitigation for the Project. Table 7.2-1 outlines some **adaptive management** adjustments that could be implemented if monitoring indicates that wildlife use of the Project area is not meeting targets. Since the monitoring plan has not been implemented, nor monitoring conducted, these are options for consideration.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1145	Table 7.2-1 Wildlife **Adaptive Management** Program [Under the Options for Adaptions column: See C&R plan for soil and vegetation related reclamation **adaptive managemen**t strategies. • Development or implement appropriate setback or timing procedures for sensitive wildlife habitat features. • Consulting with ECCC and AEP should hibernacula, fall swarming sites, or maternity roosts be observed during operations.... See C&R plan **adaptive management** for changes that could be made to reclamation plans]	

Part of EIA	Page Number	Reference	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1150	This section will outline how the monitoring results and **adaptive management** actions will be recorded, stored, tracked and made available to interested stakeholders. Accurate record keeping will be necessary to assess the implementation of the Plan, to measure the effectiveness of management and to develop and implement any necessary improvements.	
Addendum Ten - Package 5: Surface Water Quality, Hydrology, Fish and Fish Habitat, Cumulative Effects, Geotechnical, Reclamation, Wildlife, Land Use and EA Methodology	PDF page 1150	This section will outline the process for altering any part of this Plan, which may be required due to changes resulting from ongoing **adaptive management.**	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 8	**Adaptative Management** for Dust Mitigation The above discussion on wind-blown dust generation is based on air quality and climate model predictions, and on regional Environment Canada wind measurements. Benga has also committed to monitoring airborne particulate associated with its operations and has developed a draft Air Quality Monitoring and **Adaptive Management** Plan (as provided in Addendum 10, JRP IR-1.3, CIAR#251). The specific mitigation measures in Section 5 of that plan that apply to wind-blown dust in all phases of operation are:	
Addendum Eleven	Page 9	Section 7 of the Plan (Addendum 10, JRP IR-1.3, Appendix 1.3-1, CIAR#251) identifies the factors that will be considered as part of **adaptive management,** based on the success of the proposed mitigation measures. The factors that directly affect wind-blown dust include varying water rates, alternative dust suppressants, and planting additional vegetation	
Addendum Eleven	page 28	Monitoring and **adaptive management** will be an important part of ensuring that mitigation measures are effective. Indigenous groups have provided Benga with recommendations on mitigation measures that could address potential effects on Indigenous Rights (e.g., hunting or fishing); these were summarized in response to Addendum 10, JRP IR-4.6 (CIAR#251) and in Addendum 10, Appendix 4.1-1, Section 18.3 (CIAR#251).	
Addendum Eleven	page 31 - Table 6.5-2 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Hunting and trapping	Utilize an **adaptive management** approach to maximizing access opportunities where feasible.	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 32 Table 6.5-2 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Hunting and trapping	Implementation of the mitigation measures for hunting and trapping, as it relates to air quality, will occur through the development and implementation of Project specific policies, procedures, training and management plans and through the commitments contained within agreements with the Indigenous groups, as well as expected conditions of regulatory approvals. Mitigation will be implemented, monitored and verified through their inclusion in the Draft Air Quality Monitoring and **Adaptive Management Plan.** The mitigation is expected to reduce or minimize the adverse effects of the Project on air quality and will be monitored through the implementation of the air monitoring plans to verify the effectiveness of mitigation measures over time to ensure that the Project related effects on air quality are avoided or minimized.	
Addendum Eleven	Page 33 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Fishing	Implementation of an on-demand and **adaptive light management** strategy (i.e., activated when needed) at the rail loadout during times a train set is not onsite for loading during nighttime hours.	
Addendum Eleven	Page36 Mitigation Measures and Commitments for Current Use of Lands and Resources for	Utilize an **adaptive management** approach to maximizing access opportunities where feasible.	

Part of EIA	Page Number	Reference	
	Traditional Purposes for Fishing		
Addendum Eleven	Page 37 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Plant Gathering	Implementation of the mitigation measures for fishing, as it relates to air quality, will occur through the development and implementation of Project-specific policies, procedures, training and management plans and through the commitments contained within agreements with the Indigenous groups, as well as expected conditions of regulatory approvals. Mitigation will be implemented, monitored and verified through their inclusion in the Draft Air Quality Monitoring and **Adaptive Management Plan**. The mitigation is expected to reduce or minimize the adverse effects of the Project on air quality and will be monitored through the implementation of the air monitoring plans to verify the effectiveness of mitigation measures over time to ensure that the Project related effects on air quality are avoided or minimized.	
Addendum Eleven	page 38 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Plant Gathering	Implementation of an on-demand and **adaptive light managemen**t strategy (i.e., activated when needed) at the rail loadout during times a train set is not onsite for loading during nighttime hours	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 40 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Plant Gathering	An important component of the reclamation program will be the monitoring of the biophysical aspects of the program. The identification of successes and limitations early in the reclamation process will allow modifications to be made through the **adaptive management** program to be used at the Project. In addition to providing important feedback on the effectiveness of reclamation techniques, it will also provide data to use in planning the certification of reclaimed lands and the release of lands back to the Crown. The details of this program are outlined in Section F.3.9.3 of the Updated C&R Plan. Benga has committed to developing an Indigenous monitoring program in cooperation with nearby Indigenous groups to work in parallel with other western science-based monitoring plans. In addition, Benga will consult with Indigenous groups in developing the monitoring programs through a series of workshops. Benga has committed to providing Annual Reporting documents to Indigenous groups highlighting the results from the monitoring programs and seeking any input that would help Benga improve monitoring and the effectiveness of mitigation measures.	
Addendum Eleven	Page 42 Mitigation Measure and Commitments for Current Use of Lands and Resources for Traditional Plant Gathering	• Utilize an **adaptive management** approach to maximizing access opportunities where feasible	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 42 - Page 43 Mitigation Measure and Commitments for Current Use of Lands and Resources for Traditional Plant Gathering	Mitigation will be implemented, monitored and verified through their inclusion in the Draft Air Quality Monitoring and **Adaptive Management Plan**. The mitigation is expected to reduce or minimize the adverse effects of the Project on air quality and will be monitored through the implementation of the air monitoring plans to verify the effectiveness of mitigation measures over time to ensure that the Project related effects on air quality are avoided or minimized.	
Addendum Eleven	Page 43 Mitigation Measure and Commitments for Current Use of Lands and Resources for Traditional Plant Gathering	Implementation of an on-demand and **adaptive light management strategy** (i.e., activated when needed) at the rail loadout during times a train set is not onsite for loading during night time hours.	
Addendum Eleven	page 44 Table 6.5-5 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Trails and Travelways	• Utilize an **adaptive management** approach to maximizing access opportunities where feasible.	

Part of EIA	Page Number	Reference	
Addendum Eleven	page 45 Table 6.5-5 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Trails and Travelways	s. Mitigation will be implemented, monitored and verified through their inclusion in the Draft Air Quality Monitoring and **Adaptive Management Plan.** The mitigation is expected to reduce or minimize the adverse effects of the Project on air quality and will be monitored through the implementation of the air monitoring plans to verify the effectiveness of mitigation measures over time to ensure that the Project related effects on air quality are avoided or minimized.	
Addendum Eleven	page 46 Table 6.5-5 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Trails and Travelways	• Implementation of an on-demand and **adaptive light management** strategy (i.e., activated when needed) at the rail loadout during times a train set is not onsite for loading during night time hours.	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 47 Table 6.5-6 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Spiritual and Cultural Values	Implementation and effectiveness of mitigation for each of historical resources, trails and travelways, land and resource use, hunting, trapping, fishing and plant gathering, and mitigation for linked VCs is discussed in Tables 6.5-2 through 6.5-5. Implementation of mitigation and monitoring for mitigation effectiveness will be in large part through: • Approval conditions • Agreements with Indigenous groups • Indigenous Environmental Stewardship Committee • Wildlife Mitigation and Monitoring Plan • Detailed Fisheries Offsetting Plan • Offsetting Effectiveness Monitoring Plan • Aquatic Monitoring Plan • Updated C&R Plan • Air Quality Monitoring and **Adaptive Management Plan** • Access Management Plan • Cultural Site Discovery Contingency Plan	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 49 Table 6.5-6 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Spiritual and Cultural Values	Mitigation will be implemented, monitored and verified through their inclusion in the Draft Air Quality Monitoring and **Adaptive Management Plan.** The mitigation is expected to reduce or minimize the adverse effects of the Project on air quality and will be monitored through the implementation of the air monitoring plans to verify the effectiveness of mitigation measures over time to ensure that the Project related effects on air quality are avoided or minimized.	
Addendum Eleven	Page 49 Table 6.5-6 Mitigation Measures and Commitments for Current Use of Lands and Resources for Traditional Purposes for Spiritual and Cultural Values	• Implementation of an on-demand and **adaptive light management strategy** (i.e., activated when needed) at the rail loadout during times a train set is not onsite for loading during night time hours.	
Addendum Eleven	page 51 Table 6.5-7 Mitigation Measures and Commitments for Indigenous Physical and Cultural Heritage	Utilize an **adaptive management** approach to maximizing access opportunities where feasible.	

Part of EIA	Page Number	Reference	
Addendum Eleven	page 52 Table 6.5-7 Mitigation Measures and Commitments for Indigenous Physical and Cultural Heritage	Mitigation will be implemented, monitored and verified through their inclusion in the Draft Air Quality Monitoring and **Adaptive Management Plan**. The mitigation is expected to reduce or minimize the adverse effects of the Project on air quality and will be monitored through the implementation of the air monitoring plans to verify the effectiveness of mitigation measures over time to ensure that the Project related effects on air quality are avoided or minimized.	
Addendum Eleven	page 52 Table 6.5-7 Mitigation Measures and Commitments for Indigenous Physical and Cultural Heritage	Implementation of an on-demand and **adaptive light management strategy** (i.e., activated when needed) at the rail loadout during times a train set is not onsite for loading during nighttime hours	
Addendum Eleven	page 54 Table 6.5-7 Mitigation Measures and Commitments for Indigenous Physical and Cultural Heritage	Implementation and effectiveness of mitigation for each of hunting, trapping, fishing, plant gathering, noise and air quality, and mitigation for linked VCs is discussed in Table 6.5-2 to 6.5-4. Implementation of mitigation and monitoring for mitigation effectiveness will be in large part through: • Approval conditions • Agreements with Indigenous groups • Indigenous Environmental Stewardship Committee • Wildlife Mitigation and Monitoring Plan • Detailed Fisheries Offsetting Plan • Offsetting Effectiveness Monitoring Plan • Aquatic Monitoring Plan • Updated C&R Plan • Air Quality Monitoring an**d Adaptive Management Plan** • Access Management Plan	

Part of EIA	Page Number	Reference	
Addendum Eleven	page 146	The wildlife monitoring program will serve a number of important functions including: • verifying impact predictions and monitoring the effectiveness of mitigation measures; improving Benga’s understanding of the effects of Project construction and operation; • on wildlife within the WLSA and surrounding area to enable the implementation of **adaptive;** • **management** practices when required; and • ensuring compliance with the terms and conditions of the Operating Approval and Project environmental standards once the Project has been approved by AER and CEAA.	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 165 - Request for Information	Given the depth of the saturated backfill zones, the size of the waste rock disposal areas, and the complex geology and large uncertainties associated with shallow and deep groundwater flow paths, the Panel requires additional information to assess the economic and technical feasibility of Benga's proposed mitigation measures and **adaptive management** approach; this includes how Benga intends to monitor both shallow and deeper groundwater for effects, and mitigation measures that can be implemented if effects are detected. Benga's response to IR 5.19 (CIAR #251) indicated that the installation of liners is unfeasible, and not technically achievable due to ground slopes. However, Benga did not substantiate this conclusion with the requested case studies of other mines with similar characteristics, where liners either failed, or were also deemed technically and economically unfeasible. Benga has suggested four other technically and economically feasible seepage capture options, however limited evidence has been provided to support these options as technically effective at monitoring and capturing contaminated groundwater. Tsuut'ina Nation notes that Benga has not provided adequate information to support the assertion that collection wells will collect all seepage water (CIAR #220). The Panel requires Benga to provide additional details on proposed seepage capture options, including how monitoring downgradient from potential contamination sources will be an effective and technically achievab**le adaptive management** measure, given the lack of a thorough hydrogeological understanding of the site	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 169-170 Request for Information	Provide details on how monitoring downgradient from potential contamination sources will be an effective and technically achievable **adaptive management** measure , by providing the following with sufficient technical details including assumptions, justifications of assumptions, and all required details for decision making: ...	
Addendum Eleven	Page 194 - Request for Information	Discuss technically and economically feasible mitigation and **adaptive management** measures that can be implemented to prevent and/or minimize changes in stream temperatures in Gold Creek and Blairmore Creek as a result of discharges from the water management structures discussed above	
Addendum Eleven	Page 229	If monitoring indicates that all the planned SBZ zones will not be effective in treating the anticipated life of mine water balance, Benga has committed to implementing contingency measures including initiating an interim gravel bed reactor (JRP IR-6.18), looking for alternative sites to construct additional SBZ's, and constructing an active treatment facility. This will be part of the **adaptive management** process (Addendum 10, JRP IR-5.5, CIAR#251) initiated at the site to continuously monitor and assess the effectiveness of treatment zones and when adjustments may need to be made in the overall mine plan or schedule	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 232 - Request for Information	Information Request 5.4 (CIAR #215) outlined the requirements for a draft aquatic monitoring plan relating to monitoring, mitigation**, adaptive management,** and overall study design and analysis. Benga's response to IR 5.4 (CIAR #251) did not provide all of the information requested. Fisheries and Oceans Canada and Environment and Climate Change Canada (CIAR #283) also noted that the response was in. Specifically, the following deficiencies were noted: • IR 5.4 a): a lack of details on **adaptive management,** instead outlining general concepts in an **adaptive management pla**n (CIAR #283); • IR 5.4 a): no description of past **successful application of adaptive management** and no response to parts a) i, ii, iii, iv and vi (CIAR #284); • IR 5.4 c): no information on baseline monitoring provided. The Fisheries and Aquatic Monitoring Plan (Section 6.5, Appendix 5.4-1) did not contain details on the establishment of an accurate baseline assessment for water quality (CIAR #283); and • IR 5.4 d): while mention is made of monitoring the population trends in Westslope Cutthroat Trout (Section 6.6 of Appendix 5.4-1) there is no discussion provided on how long-term trends will be evaluated and adverse effects mitigated for other aquatic components (water quality, algae, benthic invertebrates and fish health; (CIAR #283).	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 233 - Request for Response	) Provide project-specific details on **adaptive management a**nd mitigation specifically addressing the following points (as requested in IR 5.4 a): i. potential effects of the project that require mitigation;	
Addendum Eleven	Page 233 - Request for Response	ii. uncertainties that necessitate the use of a**daptive management** including, supporting evidence on the efficacy of proposed **adaptive management** measures;	
Addendum Eleven	Page 233	Uncertainties that necessitate the use of **adaptive management** are described in Section 7.1 of the AMP (Appendix 6.23-1) and are related to the following elements of the EIA analysis that have led to the current assessment that the effects of the Project on the aquatic environment are not significant:	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 234	With respect to the efficacy of proposed **adaptive management** measures, all of the uncertainties listed above will lead to a deviation from baseline data or a deviation from the results predicted in the EIA. The AMP's mitigation effectiveness evaluation and **adaptive management** approach will focus on establishing indicators and thresholds according to baseline characterization, improved practices based on research and monitoring results, and input from the public engagement and Indigenous consultation programs. As the Project proceeds, monitoring throughout all Project phases will allow water quality targets to be reviewed and, if necessary, modifications can be made to site expectations. Mitigation effectiveness evaluation and **adaptive management is** a planned and systematic process for continuously improving environmental management practices by learning about their outcomes. Mitigation effectiveness evaluation and **adaptive management** provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project. Benga's program is organized into four main components, which are reevaluated and reassessed in a feedback loop: • Assess the Problem • **Adaptive Management** Process Design • Implement, Monitor, and Evaluate • Adjust the Mitigation as Required	
Addendum Eleven	page 235	Additional information on efficacy of the proposed mitigation measures are provided in Table 5.0-1 of the updated AMP (Appendix 6.23-1). Contingency measures o**r adaptive management** options for each of the proposed mitigation measures, should the planned mitigations prove to be ineffective, are provided in Table 7.5-1 of the updated AMP (Appendix 6.23-1).	

Part of EIA	Page Number	Reference	
Addendum Eleven	page 235 - Request for Information	vi. methods to be used to develop thresholds that would trigger implementation of mitigation measures or **adaptive management** measures (e.g., a series of risk- based thresholds ranging from triggering confirmation of exceedance of guidelines, to confirming cause/effect, to triggering deployment of alternate or additional mitigation).	
Addendum Eleven	Page 235	Additional information on efficacy of the proposed mitigation measures are provided in Table 5.0-1 of the updated AMP (Appendix 6.23-1). Contingency measures or a**daptive management** options for each of the proposed mitigation measures, should the planned mitigations prove to be ineffective, are provided in Table 7.5-1 of the updated AMP (Appendix 6.23-1). Supporting evidence on the efficacy of the saturated backfill zone-specific and gravel bed reactor-specific mitigation measures are provided in Addendum 10, JRP IR-5.5, CIAR#251 and in the response to JRP IR-6.18, respectively.	
Addendum Eleven	page 235	Methods to be used to develop thresholds that would trigger implementation of mitigation measures or **adaptive management** measures are provided in the updated AMP (Appendix 6.23-1) in Section 6.1.2.6 (for water quality) and in Section 7.0, which presents the Project's draft Mitigation Effectiveness Evaluation and **Adaptive Management** approach.	
Addendum Eleven	Page 236 - Request for Information	b) Discuss Benga's application of **adaptive management** to mitigate unanticipated environmental effects during project construction, operation, decommissioning and/or reclamation, using examples from past mining, or other mining projects, to demonstrate Benga's understanding and ability to effectively implement **adaptive management**	

Part of EIA	Page Number	Reference	
Addendum Eleven	Page 236	As indicated in the updated AMP in Section 7.0 (Appendix 6.23-1), Benga will incorporate **adaptive management** techniques as routine components in all of its environmental management activities. These techniques provide the opportunity to develop and fine-tune the monitoring program using data collected on-site and from other regional operators.... With respect to Project mitigation effectiveness evaluation and **adaptive management**, Benga is committed to achieving continual improvement in environmental performance. The development and implementation of all monitoring and mitigation identified for the Project and housed in the monitoring and follow-up programs will be tracked in relevant management plans. As site conditions and monitoring dictate, or as new technology emerges, Benga will **adaptively manage** its site practices and monitoring program to meet the defined objectives. For some programs this would involve regular evaluation of predictive models; which would be clearly defined in each applicable management plan.	

Part of EIA	Page Number	Reference	
Addendum Eleven	page 245	In Blairmore Creek, the concentration of selenium would rise above the proposed site-specific water quality objective for selenium around end of mining for capture rate sensitivities and for selenium attenuation of 95%. If selenium attenuation is only 90%, the site-specific objective would be surpassed in year 10. As indicated above, Benga will monitor selenium concentrations in the creeks as well as the SBZ discharge and in upstream ponds to have an early indication if there is an issue with capture percentage or attenuation rate in the SBZ. If early indications point to a long-term selenium concentration of concern, Benga will implement its **adaptive management** plan which may include additional treatment for selenium in a plant or through a GBR in order to achieve the objective	
Addendum Eleven	page 268	A Project level follow-up monitoring plan has been developed: Aquatic Monitoring Plan (Appendix 6.23-1). As the Project's contribution to selenium related cumulative effects in the Oldman Reservoir are low, no further mitigation is proposed beyond the mitigation measures planned to manage selenium at the Project level. **Adaptive management** is a key part of the Aquatic Monitoring Plan, and as such, the monitoring program for selenium will be modified as necessary based on monitoring results observed over time.	

Part of EIA	Page Number	Reference	
Addendum Eleven	There are more mentions of Adaptive Management in Addendum 11, but many of these fall within an attached Appendix of Teck's Environmental Monitoring Report - for that reason, I have chosen to skip those over		
Addendum Eleven	PDF page 1121 of 1344	This preliminary draft AMP has been prepared using the most current information available regarding mitigation, monitoring, and **potential adaptive management** options related to the Project. Finalization of the AMP will occur shortly after Project approval; however, Benga recognizes for the purposes of the regulatory approval process regulators require a sufficient amount of information regarding the AMP to reduce uncertainty as part of a final decision process. The intent of this preliminary draft is to provide the foundations of the Project's AMP, with recognition that an agreement on sampling locations, parameters, and reporting frequency with provincial and federal regulators will be required, as well as additional logistics, which will be developed in the detailed design phase such as standard operating procedures, and alignment with pending construction and operations schedules.	

Part of EIA	Page Number	Reference	
Addendum Eleven	PDF page 1132 out of 1344	WQG or SSWQO exceedance results in specified actions and identified adaptive management responses. The protection goal and level of scientific rigor inherent in the WQGs and SSWQO informs the specific actions or **adaptive management** in the event that they are exceeded; briefly the basis for WQGs and SSWQOs includes: • WQGs are established by governments for various water protection purposes. Exceeding WQGs triggers investigation and implementation of solutions (where warranted) on an expedited timeline. Where a WQG is exceeded, the AMP's response would be to conduct a reevaluation of the WQG and if appropriate, develop a science, and aquatic risk based SSWQO on an accelerated timeline (Figure 6.1-2). • SSWQOs represent guidelines that have undergone considerable refinement through site-specific analysis and testing or other rigorous scientific review, such as the site-specific objectives for selenium and sulphate proposed for Blairmore Creek. Exceeding SSWQOs triggers specific actions, and SSWQOs are not normally subject to a re-evaluation step (Figure 6.1-3).	

Part of EIA	Page Number	Reference	
Addendum Eleven	PDF page 1145 out of 1344	This component of the AMP includes the detection of changes in WSCT Area Weighted Suitability (AWS) at established microhabitat transects (within mesohabitat units) during the Instream Flow Assessment (IFA) in key reaches of Gold and Blairmore creeks. The purpose of this component is to verify predictions made during the IFA, evaluate whether **adaptive mitigation** is required, and implement and monitor mitigation effectiveness, if necessary.	
Addendum Eleven	PDF page 1149 out of 1344	The overall goal of this program is to monitor potential changes in aquatic habitat required for the survival and persistence of WSCT in Blairmore and Gold creeks. This program will provide baseline information regarding food availability and fish condition, as well as a comprehensive methodology for monitoring fish condition in the LSA. The implementation of the bioenergetics monitoring will help the Project better understand potential effects to WSCT caused by up-land mine disturbance. The objectives of this plan will be to:….determine the causes of any observed changes in food supply, individual condition, and/or population condition, to facilitate **adaptive management** and offsetting/mitigation programs; and	
Addendum Eleven	PDF page 1153 out of 1344	7.0 MITIGATION EFFECTIVENESS EVALUATION AND **ADAPTIVE MANAGEMENT**	

Part of EIA	Page Number	Reference	
Addendum Eleven	PDF page 1153 out of 1344	The AMP's mitigation effectiveness evaluation and **adaptive management** approach will involve establishing indicators and thresholds according to baseline characterization, improved practices based on research and monitoring results, and input from the public engagement and Indigenous consultation programs. As the Project proceeds, monitoring throughout all Project phases will allow water quality targets to be reviewed and, if necessary, modifications can be made to site expectations.	
Addendum Eleven	PDF page 1154 out of 1344	Mitigation effectiveness evaluation and **adaptive management** is a planned and systematic process for continuously improving environmental management practices by learning about their outcomes. Mitigation effectiveness evaluation and **adaptive managemen**t provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project. As per Figure 7.1-1, Benga's program is organized into four main components, which are reevaluated and reassessed in a feedback loop.	
Addendum Eleven	PDF page 1154 out of 1344	**Adaptive management** itself, is intended to respond to changes and advances in technology or to react to measured outcomes that are different from those predicted during the EIA. Benga understands that outcomes that are different from modelled predictions may result from areas of uncertainty including:	

Part of EIA	Page Number	Reference	
Addendum Eleven	PDF page 1155	With respect to Project mitigation effectiveness evaluation and **adaptive management**, Benga is committed to achieving continual improvement in environmental performance. The development and implementation of all monitoring and mitigation identified for the Project and housed in the monitoring and follow-up programs will be tracked in relevant management plans. As site conditions and monitoring dictate, or as new technology emerges, Benga will adaptively manage its site practices and monitoring program to meet the defined objectives. For some programs this would involve regular evaluation of predictive models; which would be clearly defined in each applicable management plan.	
Addendum Eleven	PDF page 1155	7.3 **Adaptive Managemen**t Process Design Once the problem has been identified and assessed, the design of the a**daptive management program c**an commence, beginning with determining the best approach to **adaptive management.** The following are design considerations for the **adaptive management** program: • data analysis methods and frequency; • predicted trajectories for indicators; and • triggers for action and potential adaptations.	

Part of EIA	Page Number	Reference	
Addendum Eleven	PDF page 1156	7.4 Implement, Monitor and Evaluate The mitigation described throughout the EIA will be incorporated into monitoring plans for the Project. Final monitoring protocols will be established and baseline data will be collected soon after the Project is approved so that trends and progress can be evaluated. If indicators meet targets or align with desired trends, no **adaptive management** is required although continuing assessment of new technology and best practices may reveal an opportunity for improvement. Should indicators not meet targets or trends diverge from the desired trajectory, a sequence of Project-specific actions will be triggered. Prior to adjusting any mitigation, steps will be taken to investigate the observations, as necessary. If required, the following sequence will be followed: • Monitoring results will be verified and investigated. • Possible adaptations to mitigation will be identified and evaluated based on monitoring results. • A work plan will be developed to adapt mitigation or monitoring, if required.	

Part of EIA	Page Number	Reference	
Addendum Eleven	PDF page 1156	7.5 Adjust the Mitigation as Required If mitigation adjustments are determined to be required, then they will be implemented with careful consideration to proper planning, approvals, notifications and consultation. In this step of the **adaptive management** process, the work plan will be implemented. Any required notifications or approvals will be obtained before acting to confirm that all interested or affected parties are properly informed. If adjustments to mitigation measures are required, Section 5.0 of this Plan will be updated to reflect the **adapted mitigation** for the Project. Table 7.5-1 outlines **adaptive management** adjustments that could be implemented if monitoring indicates that aquatic parameters are not meeting targets. Since the monitoring plan has not been implemented, nor monitoring conducted, these are options for consideration.	
Addendum Eleven	PDG page 1157 "Potential Project Effects, Adaptive Management Options and Effectiveness"	Table 7.5-1 Potential Project Effects, **Adaptive Management** Options and Effectiveness	
Addendum Eleven	PDF Page 1159	This section will outline how the monitoring results and **adaptive management** actions will be recorded, stored, tracked and made available to interested stakeholders. Accurate record keeping will be necessary to assess the implementation of the Program, to measure the effectiveness of management and to develop and implement any necessary improvements.	

Part of EIA	Page Number	Reference	
Addendum Eleven	PDF page 1275	Air quality monitoring (as described in CR #1a, Section 6.6, CIAR #42; and Addendum 10, Appendix 1.3-1: Draft Air Quality Monitoring and **Adaptive Management Plan,** CIAR #251) should be undertaken to validate the predicted air concentrations and confirm the conclusion that Project emissions do not pose any risk of adverse health effect. Surface water concentrations within the EPL should be assessed and monitored as a component of the mine closure strategy to assure measured concentrations are not of human health concern.	
Addendum Twelve	page 5	The wildlife results indicate a low potential for adverse effect for piscivorous mammals on Gold Creek; piscivorous birds in the EPL and Gold and Blairmore creeks. The magnitude of predicted risk is slightly higher in the EPL for insectivorous and omnivorous birds. Due to slim margins for exposure that could result in adverse effect, particularly with selenium, focused data collection to refine risk predictions and efforts to limit metal mass migration through surface water and **adaptive management** are warranted.	

Part of EIA	Page Number	Reference	
Addendum Twelve	page 12	While the magnitude of the predicted exposure ratios is higher for selenium, the overall change to conclusions remains the same. Risk assessment is a tool to indicate potential for impact, it is meant to over-estimate exposure so that if predicted risk is below acceptable thresholds practitioners can have confidence that the potential for impact is negligible. Conversely, predicted risk above acceptable thresholds indicates i) risk assessment methodologies may require increased site-specific precision (e.g., measured tissue data), and ii) it helps highlight where monitoring and potentially **adaptive management** may be required. As such, reliance on the specific exposure ratio metric rather than overall magnitude and range against baseline is not intended.	
Addendum Twelve	page 81 - Table 2-1 Air Quality (AQ) Mitigation and Commitments Summary Table	An on-demand and **adaptive light management** strategy will be implemented at the rail loadout during times a train is not onsite for loading during nighttime hours.	
Addendum Twelve	Page 91 - Table 2-6 Aquatic Ecology (AE) Mitigation and Commitments Summary Table	1. Flow monitoring in Gold Creek will be incorporated into the Aquatic Monitoring Plan to validate the predicted outputs of the Project's water balance model to determine if flow augmentation is required during any phase of the Project. If required, Benga will implement flow augmentation in Gold Creek as an **adaptive management** mitigation should the flow reductions and/or changes in area weighted suitability (AWS) be greater than what was predicted in the Instream Flow Assessment.	

Part of EIA	Page Number	Reference	
Addendum Twelve	Page 92 Table 2-6 Aquatic Ecology (AE) Mitigation and Commitments Summary Table	4. Benga has committed to the finalization of the draft Aquatic Monitoring Plan (AMP) that was prepared using the most current information available regarding mitigation, monitoring, and potential **adaptive management** options related to the Project. Finalization of the AMP will occur once Project is approved. The AMP will include bioenergetics monitoring, which will be aimed at quantifying the food energy provided to fish and fish condition.	
Addendum Twelve	Page 93 - Table 2-6 Aquatic Ecology (AE) Mitigation and Commitments Summary Table	2. Benga has committed to the finalization of the draft Aquatic Monitoring Plan (AMP) that was prepared using the most current information available regarding mitigation, monitoring, and potential **adaptive management** options related to the Project. The AMP will include calcite precipitation monitoring, which will be aimed at verifying the effectiveness of the calcite mitigations.	
Addendum Twelve	Page 98 Table 2-8 Vegetation and Wetlands (VW) Mitigation and Commitments Summary Table	• an adaptive re-vegetation strategy to take advantage of opportunities present on the re-contoured lands for establishment of a variety target vegetation communities and wetlands as outlined in the reclamation plan (closed conifer forests, grassland open forests, mixed forests, and treed wetlands); or other vegetation communities that may become more appropriate with knowledge gained from **adaptive management.**	
Addendum Twelve	Page 104 Table 2-10 Land Use and Historical Resources (LU/HR)	7. Benga will monitor changes in land use policies and initiatives, and through **adaptive management** incorporate new requirements into the ongoing development, operation, and reclamation plans	

EXHIBIT D

PUBLIC INTEREST LAW CLINIC
FACULTY OF LAW
UNIVERSITY OF CALGARY

Memorandum

Date: August 20th, 2020

To: Drew Yewchuk

From: Daniella Marchand

Project: Grassy Mountain Coal Project

Re: Mentions of Adaptive Management in Benga's EA materials

You asked me to write a short paragraph describing how I made the table of adaptive management references.

MENTIONS OF ADAPTIVE MANAGEMENT

1. In order to create the table of adaptive management mentions in Benga's environment assessment materials I used the 'Control F' ("find") function to locate any use of the term "adaptive" in the EIA, including the original environmental assessment materials, the consultant reports, and the addendums. Once located, I would read the surrounding material and determine whether it was applicable – as in, it was being used in a sense that gave adequate meaning to the term adaptive management – and if it was, I included the mention in the table. In doing so, I marked which document it was found it, a page number or pinpoint, and a brief excerpt of the mention, highlighting in what context the term was used. In some instances, where the term adaptive management was used multiple times in one table, I would include a number of different excerpts of where it was found in the table, all in the same row, rather than in separate rows – in order to help better pinpoint where these excerpts came from. Finally, as Benga included material from previous documents found in the EIA, if I was able to determine that an entry was a duplicate from a previous document, I would not include those mentions in the table.