Joint Review Panel Request for Additional Information Response Package Addendum 10

Package 2: Vegetation and Reclamation

Benga Mining Limited
Grassy Mountain Coal Project

July 2019

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VEGETATION AND RECLAMATION

2.1 Information Request 2.1

Eighth Addendum to the Environmental Impact Assessment. Part C – A.3 – Conservation and Reclamation. (CEAR #89).

Grassy Mountain Coal Project - Updated Environmental Impact Assessment. Consultant Report #8 – Vegetation. (CEAR #42).

In accordance with Section 137 of the *Environmental Protection and Enhancement Act* (EPEA), an operator is required to conserve, to reclaim, and to obtain a reclamation certificate for specified land. All disturbed land must also be reclaimed to an equivalent land capability as defined in the *Conservation and Reclamation Regulations*. In addition, Benga Mining Limited's (Benga) Environmental Impact Assessment (EIA) terms of reference require a description of the post-development land capability with respect to self-sustaining vegetation communities representative of the surrounding area and capable of ecological succession.

In response to AER-R2-8 (CEAR #89), Benga stated that "The littoral zone of the end pit lake will be seeded to representative shallow open water wetland species that may include, but would not be limited to water sedge (*Carex aquatalis*), awned sedge (*Carex atherodes*), common tall manna grass (*Glyceria grandis*) and slough grass (*Beckmaina syzigachne*)".

In Consultant Report #8, Table 3.9-1 lists noxious weed and invasive species identified in the Local Study Area (LSA). *Glyceria grandis* is listed as an invasive species and assigned the common name "great manna grass". Although Table B-1 in Appendix B identifies *Glyceria grandis* as "common tall manna grass", a species of marsh wetland areas, Table G-1 of Appendix G identifies that the invasive variety of *Glyceria grandis* is found in the LSA. It appears that the variety of *Glyceria grandis* identified in the LSA is invasive and would not be considered representative of the area for reclamation purposes.

a) Verify what variety of *Glyceria grandis* was identified in the LSA.

Response:

Common tall manna grass (*Glyceria grandis*) is a native species in Alberta. The inclusion of this species (as common name great manna grass) as a non-native species in Table 3.9-1 and Table G-1 (Appendix G), in CEAR documents #42, as well as in CEAR 89 is an erratum.

To clarify, common tall manna grass (*Glyceria grandis*) was identified on Grassy Mountain, and it is a native species in Alberta.

b) Provide a rationale for including common tall manna grass (*Glyceria grandis*) as potential species for revegetating the littoral zone of the end pit lake.

Response:

Common tall manna grass is an early seral native species found in hygric-subhygric areas in the subalpine subregion of the Rocky Mountain Natural region (Sinton Gerling *et al.*, 1996) and in marshes (Government of Alberta 2015). It is categorized as an Obligate wetland plant, a species that occurs almost entirely in wetlands (US Army Corp of Engineers National Wetland Plant List 2016).

This vegetation species provides good forage value for wildlife and livestock and are often consumed more readily in late summer and fall if upland grasses become dry (Tannas 2001). It is a rhizomatous species which has shown potential for use in stabilizing wetlands provided they are not saline or alkaline (Tannas 2001).

c) Identify what native plant species could be planted as an alternative to common tall manna grass, and explain the benefits and disadvantages associated with using common tall manna grass vs these native species.

Response:

As indicated in the response to JRP IR-2.1(a) common tall manna grass was included in erratum in the tables and is a native species in Alberta. The rationale for including it in the species for revegetating of the proposed end pit lake littoral zone is provided in the response to information request JRP IR-2.1(b).

2.2 Information Request 2.2

Grassy Mountain Coal Project - Updated Environmental Impact Assessment. Section F – Closure and Reclamation. (CEAR #42).

In accordance with requirements of the *Environmental Protection and Enhancement Act* (EPEA), a company can apply for a reclamation certificate when it can demonstrate that all reclamation requirements from Section 12 of the *Conservation and Reclamation Regulations* have been met. This may include the assurance that the site is functioning similarly to how it did before it was disturbed, and no longer needs intervention.

In Section F.4 of the Conservation and Reclamation Plan (CEAR #42), Benga states, "Through a progressive reclamation program, Benga will have reclaimed almost two-thirds of the mine footprint by the end of the mine life (Year 24). The remainder of the area will be reclaimed within three years of completion of mining (Year 27) with only the infrastructure required for the selenium management program remaining to be reclaimed at a later date (after monitoring)."

The above statement implies that selenium management areas will continue to be operational past Year 27, after mining activities have ceased and reclamation of the rest of the Project area has occurred.

In Figure F.3.6-8 of the Conservation and Reclamation Plan (CEAR #42), water management and selenium management areas are shown as treed wetlands with no closure date specified.

a) Provide timelines for closure and certification of the selenium management areas following the monitoring and management phase.

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 management. Monitoring (assessing success of reclamation) and applying adaptive management 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).

At full closure the water management surge ponds (to manage selenium) will be decommissioned and removed from the plan, when the selenium levels in these ponds are below the release criteria. As stated in the Hydrogeology Consultant Report #3 (EIS 2016, CEAR # 42), selenium was sampled in springs at the toe of legacy mine spoils (waste rock) on Grassy Mountain that have been exposed for approximately 50 years as they were not reclaimed post mining activities of the late 1960's. Concentrations of selenium at these locations were generally below Freshwater Aquatic Life (FWAL) guidelines, which may be interpreted as indicative of no notable residual effect related to historical mining activities.

The hydrogeology assessment also states that groundwater residence time (travel time to the creeks) from the Long Term Closure (LTC) scenario is predicted to be mostly greater than 10 years, except below sedimentation ponds and close to creeks and tributaries. Within the proposed ex-pit and in-pit rock fill footprint, groundwater residence time is predicted by the model to be approximately 20 years. The groundwater modelled with longest residence time (greater than 50 years) is close to the topographic highs and the shortest (around 20 years) are close to the topographic lows. Therefore, most basal leakage from the waste rock dumps would reside in the groundwater system for a duration that substantially exceeds the critical residence time to attenuate any selenium. Areas with short residence time (*i.e.*, less than 10 years) are of limited extent (*i.e.*, less than 5%) in comparison to areas with long residence time; therefore, substantial mixing will occur with groundwater where selenium has attenuated or remains at baseline levels.

Based on the available site-specific data from the exposed waste rock spoil piles and the project assessment, as the Project transitions from EOM to reclamation, ongoing monitoring of the selenium management features is anticipated to be required for 20 to 50 years.

b) Describe what indicators will be monitored to determine when the reclaimed treed wetlands are fully functional and ready for certification.

Response:

Annual monitoring will be conducted post final reclamation activities to monitor progress and to determine when the reclaimed tree wetlands are fully functional. Vegetation communities comprised mostly of species with wetland affinities (*i.e.*, hydrophytes as opposed to non-hydrophytes species), coupled with the complete absence of upland species can be classified as wetlands. The proportion, percent cover, and health of wetland species present is used to determine wetland functionality.

The following indicators will be used to define the ecological function of the reclaimed area and to inform the closure plan for certification:

- community indices: species richness, abundance, community composition, wetland indicator status;
- vegetation health parameters: presence or absence of bare ground cover, litter production, and absence/presence of noxious weeds or invasive species;
- vegetation vigour indices, following the Ecological Land Survey Site Description Manual (Alberta Environment and Parks (AEP), 1994);
- representative vegetation species, including their wetland indicator status according to the USDA National Plant Database (United States Department of Agriculture 2014) and National Wetland Plant List (US Army 2016), the abundance of the species that are presence, and the presence/absence of noxious or invasive species; and
- any other indices that are developed prior to reclamation of the treed wetlands to measure reclamation success.

2.3 Information Request 2.3

Grassy Mountain Coal Project - Updated Environmental Impact Assessment. Section E – Environmental Impact Assessment Summary. (CEAR #42).

Grassy Mountain Coal Project - Updated Environmental Impact Assessment. Section F – Closure and Reclamation. (CEAR #42).

Eighth Addendum to the Environmental Impact Assessment. Part C – A.3 – Conservation and Reclamation. (CEAR #89).

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).

In response to AER-R2-9 (CEAR #89), Benga noted that planting pine trees on reclaimed mountain mines is routine and many examples of successful reforestation exist, with relevant data and best management practices being available from British Columbia.

Benga did not provide the specific examples it referred to, in support of the proposed mitigation measures. It is also unclear what types of measures Benga would consider taking as a result of engaging with recovery planning groups.

a) Provide evidence that there are examples of successful revegetation for large areal extents of whitebark pine and/or limber pine on reclaimed mountain mines in Canada.

Response:

Several projects provide evidence for successful whitebark pine revegetation on large areal extents or on reclaimed mountain mines in Canada or the U.S. including:

- Helena-Lewis and Clark National Forest Reforestation (Montana, USA);
- Blackwater Mine Reclamation (British Columbia, Canada);
- St’at’imc Traditional Territory Whitebark Pine Restoration (British Columbia, Canada);
- Wetzin'Kwa Community Forest Whitebark Pine Restoration (British Columbia, Canada);
- Teck Coal Reclamation Trials (British Columbia, Canada); and
- Shell Canada Waterton Lumber Pine Trial.

Helena-Lewis and Clark National Forest Reforestation

Successful reforestation of Whitebark Pine (WBP) on large areal extents is ongoing at the Helena-Lewis and Clark National Forest in Montana (pers. com. Matthew Voight). WBP plantings have been implemented by the forest service in this area, including the planting of 24,460 whitebark pine seedlings across 56 hectares in the fall of 2016 and spring of 2017 at the Lost Fork Ridge of the Lewis and Clark National Forest. At three other locations near Granite Butte, a total of 14,300 seedlings have been planted. Survival has been over 90% at some of these planting units.

Blackwater Mine Reclamation

A large mining project in the mountains of British Columbia, the New Gold Blackwater Mine, prepared mitigation and reclamation plans that were approved by the provincial government. The project is now in operation and initial trials to propagate and plant WPB has begun.

St'at'imc Traditional Territory Whitebark Pine Restoration

Several sites in the St'at'imc Traditional Territory were selected for whitebark pine planting. Plantings have been conducted since 2013 (Moody 2019). Survival rates ranged from 55 to 74% for seedlings planted in 2016 and 2017. In 2018 3,248 seedlings that had been screened for blister rust were planted on 6.67 ha.

Wetzin'Kwa Community Forest Whitebark Pine Restoration

Bulkley Valley Research Centre began working with the Wetzin'Kwa Community Forest Corporation in 2012 (Haeussler 2014). The first project was to establish an assisted migration planting trial at low (1100 m), medium (1300 m) and high (1600 m) elevations using 373 seedlings grown at UNBC Prince George from seeds collected in central and southern BC, Alberta and Washington. Seedling survival was monitored annually and in 2014 was estimated to be 96% over the three trial areas.

Teck Coal Reclamation Trials

Teck Coal is conducting reclamation trials at their Line Creek Mine and is also selecting for rust resistant plants. Teck is in the process of developing a Species Management Plan for whitebark pine, but that document is not yet publically available (pers com. Chris Stroich). Teck has also been in contact with Parks Canada to use GIS-based methods to map critical habitat for WBP.

Shell Canada Waterton Limber Pine Trial

Shell has been working on reclaiming limber pine in the Waterton, AB area. The program includes harvesting cones from mature trees, growing seedlings and out planting seedlings to test

sites. Initial learnings are that trees need to be protected from trampling in areas with grazing or high wildlife use, that seedlings should be at least two years old before out planting, planting during the wet season is ideal, and that microsites protected from wind and fire should be targeting for planting. The survival rate for seedlings planted to date is 56%.

b) Compare the Project site to the sites used in the examples, and provide a justification for why the experience from the example sites provides confidence that successful revegetation will occur at the Project site.

Response:

The large planting project at the Helena-Lewis and Clark National Forest was conducted following wildfires that resulted in patches of mineral soil and reduced vegetative cover. These conditions are similar to the mineral soil and sparsely vegetated conditions expected following site preparation for reclamation at the Grassy Mountain Coal Project. Similar to practices on the National Forest, management necessary to control any competing tree species and increase WBP survival will be a key element of reclamation efforts at the Grassy Mountain Coal Project.

The Teck Coal project is a comparable mining project, in a mountainous region of Canada that faces similar opportunities and challenges for WBP reclamation. Teck have initiated outplantings and any findings from Teck Coals reclamation efforts will be built into approaches for the Grassy Mountain Coal Project.

The environmental setting for the Grassy Mountain Coal Project and Blackwater Mine sites are similar in many ways. Both sites occur in high elevation regions. The WBP populations at Grassy Mountain were mapped at approximately 1,900 to 2080 metres and those at the Blackwater mine located from 1,200 to 1,900 metres, with WBP tending to occur at the higher elevations. Similarly, WBP is found in association with lodgepole pine, Engelmann spruce, and subalpine fir at both sites (in the “Subalpine Natural Subregion” in Alberta, “Engelmann Spruce-Subalpine Fir” ecosystem in British Columbia). Soils are in the Brunisolic and Luvisolic soil orders, and litter layers tend to be thin and acidic as a result of high moisture regimes and coniferous forest cover.

The approaches to mitigate mine related impacts to WBP for the Grassy Mountain Coal Project are consistent with those for the Blackwater Mine and with recommended methods provided in key guidance documents (Keane *et al*. 2012, Alberta Whitebark and Limber Pine Recovery Team 2014, Moody and Keefer 2018) (Table 2.3-1). The results and subsequent adaptations to methods from reclamation trials conducted by the Blackwater Mine will be drawn upon to inform whitebark pine reclamation methods for the Grassy Mountain Coal Project.

Table 2.3-1 Comparison of Mitigation Measures for Whitebark Pine Approved for Blackwater Mine and Proposed for the Grassy Mountain Coal Project.		
Mitigation Activity	**Grassy Mountain Coal**	**Blackwater Mine**
Reduce direct mortality of WBP – identify all whitebark pine in advance of tree clearing in the footprint	✓	✓
Develop white pine/whitebark pine blister rust resistance – mark disease free trees and collect cones before clearing starts, select disease free trees for planting, monitor survival	✓	✓
Conserve genetic diversity – collect cones/weeds prior to clearing that appear to be disease free. Seeds will be extracted and stored until needed for reclamation.	✓	✓
Manage habitat and regeneration – begin planting trials as soon as feasible, protect existing habitat areas with recommended management methods.	✓	✓

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.

c) For the example-reclaimed sites revegetated to whitebark pine, provide the age and stand densities of the pine species on the reclaimed sites.

Response:

Age

Most of the plantings at the example sites are only a few years old; however, given that the highest percent mortality typically in the first few years after planting, this is useful information to estimate expected mortality rates. Table 2.3-2 shows tree age at the time of monitoring or age predicted at the time of closure.

Table 2.3-2 Whitebark Pine Stand Density and Age						
Projects/Publications	**# Trees Planted**	**Area (ha)**	**# Trees/ha**	**% Survival**	**Final result Trees/ha (actual/est.)**	**Tree Age (years)**
Grassy Mountain Coal Mine	63,000	310	203	50-90[1]	101 – 183 ave. 28-321 range	11 to 18[2]
Blackwater Mine - Reclamation Trial	3,190	2.5	1,273	na	na	

Table 2.3-2 Whitebark Pine Stand Density and Age

Projects/Publications	# Trees Planted	Area (ha)	# Trees/ha	% Survival	Final result Trees/ha (actual/est.)	Tree Age (years)
Helena-Lewis and Clark NF (2016, 2017)	24,460	57	432	na	na	1 to 2
Helena-Lewis and Clark NF (2012 – 2016)	14,300	34	421	90%	379	4 to 6
St'at'imc Traditional Territory	na	na	405	55%	225	1 to 2
St'at'imc Traditional Territory	na	na	300	74%	221	1 to 2
Shell Waterton Limber Pine Trial	na	na	na	56%	na	na
McCaughey *et al.* 2009 - literature review	na	na	479	50%	240	na

[1]50-90% survival assumed for Grassy Mountain Coal Mine

[2]Tree age for Grassy Mountain Coal Mine at Closure

[3]Tree age since planting not since planting seeds and nursery propagation which will likely be 1-3 additional years.

na – Information not available

For the Grassy Mountain Coal Project WBP, planting trials will begin as soon as suitable reclaimed habitat is available. In the Conservation and Reclamation Plan, it states that WBP planting will start years 2-4 after resloping/reclamation material placement and other site preparation. Reclamation certification is planned for year 15-20, if this occurs as expected, WBP would be between 11 and 18 years old at that time (Updated Conservation and Reclamation Plan, 2019, please see response to JRP IR-2.6).

Stand Density

Available information on stand density for planted WBP is primarily expressed in trees per hectare (or trees per acre) (Table 2.3-2). At the Helena-Lewis and Clark National Forest, the goal is to have at least 10 to 25 mature cone bearing trees per acre (pers com. Matthew Voigt).

Planting densities for trees from reforestation and trials ranged from 300 to 1,273 trees/ha (Table 2.3-2). The average per hectare planting density identified based literature review data was 479 trees/ha (McCaughey 2009). The Helena-Lewis and Clark National Forest reforestation effort planted 421 to 432 trees/ha and in some cases had 90% survival. The lowest survival rates observed were 50-60% when seedlings were planted during a dry year (pers. com. Matthew Voigt).

For the projects examined, the resulting tree densities were measured or predicted to be between 221 and 379 trees/ha. The estimated density of WBP at the Grassy Mountain Coal Project pre-disturbance was estimated to range between 28 trees/ha for sparsely distributed WBP and 321 trees/ha for denser patches. Based on survival estimates of between 50 and 90% it is expected that an average of 101 to 183 trees/ha will be present on the reclaimed landscape. The actual density will range from 28 to 321 trees/ha to mimic pre-disturbance WBP distribution patterns. By using rust resistant trees and building on information gained from the successes of other similar projects, it is expected that a higher rate of survival can be achieved.

d) Outline the types of measures that Benga will commit to taking in engaging with whitebark pine recovery planning groups and Indigenous groups.

Response:

Since 2016, Benga has regularly attended the annual Crown Managers Partnership forum. The Crown Managers Partnership originated in 2001, with several federal, aboriginal, provincial and state agencies from British Columbia, Alberta, and Montana. The meetings discuss topics such as native salmonid recovery, terrestrial invasive species, improving drought resilience, and five needle pine conservation.

In 2016, Benga also started attending the Crown of the Continent Ecosystem High Five Working Group meetings. The group includes representatives from industry, non-profit, private, and the agencies mentioned above. Within this working group, there is collaboration of sharing knowledge of the whitebark and limber pine ecosystem, including the restoration project updates, results, and best management practices.

Benga commits to continued participation in the CCE High Five Working Group. Benga has committed to consulting and involving nearby First Nations in development of final C&R plans as the project moves into design and construction. Benga has also committed to an indigenous monitoring program with nearby First Nations which will include monitoring of C&R results and adaptation of plans as required to improve performance.

e) 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.

Response:

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.

PERSONAL COMMUNICATIONS (Redacted)

Matthew Voigt, Culturist
U.S Forest Service, Helena – Lewis and Clark National Forest

Ryan Todd, Director of the Blackwater Project
New Gold – Blackwater Mine, B.C.

Randy Moody
Whitebark Pine Ecosystem Foundation of Canada

Alana Clausen, Post-doctoral Research Associate
Bulkley Valley Research Centre

Chris Stroich, Superintendent Environment Elkview Operations
Teck Coal Limited

Kali Larson, Waterton Community Liaison
Shell Canada

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https://www.crownmanagers.org/history

https://www.crownmanagers.org/2016-forum

2.4 Information Request 2.4

Grassy Mountain Coal Project - Updated Environmental Impact Assessment. Appendix 11 - Public Lands Application. (CEAR #42).

Third Addendum to the Environmental Impact Assessment – Public Lands Application – Revision 2. (CEAR #54).

Grassy Mountain Coal Project - Updated Environmental Impact Assessment. Section F – Closure and Reclamation. (CEAR #42).

According to the Public Lands Application, areas of the Project fall within Protective Notations (PNT) 090084 and 090087 (CEAR #54). Protective notation areas are sites that have been assigned a restricted access or protective status to be used for annual data collection to establish reference plant communities used in the Reclamation Certificate criteria for well sites and in establishing equivalent land capability. The areas of the Project within PNT 090084 and PNT 090087 may contain Foothills Fescue Grassland, which, according to the Mineral Surface Lease Application in appendix to the Public Lands Application (CEAR #89), is "A very valuable native grassland type that is limited in remaining areas. Rough fescue grasslands are very sensitive to surface disturbance and difficult and costly to reclaim."

In the Conservation and Reclamation Plan, under Section F.3.2.4 (CEAR #42), Benga indicated foothills rough fescue dominates approximately 3.4 ha of the Project footprint, with 18.2 ha sub- dominant and as a component in 36.3 ha. The extent of known foothills rough fescue grasslands is provided on Figure F.3.2-2 for whitebark pine and grasslands distribution in the footprint (CEAR #42).

In Figure 3-2 of Addendum 3 (CEAR #54), Benga included a map of potential fescue grasslands within designated protective notation areas. The protective notation areas include future locations of Benga's proposed rock disposal areas as shown in Figures F.3.2-1 and F.3.2-2 of the Conservation and Reclamation Plan (CEAR #42).

Under Section F.3.2.4 of the Conservation and Reclamation Plan (CEAR #42), Benga acknowledges the restoration of foothills rough fescue is relatively unproven. Benga confirmed they will identify areas for direct placement of reclamation material for the foothill rough fescue areas. Where direct placement is not possible, the reclamation material will be salvaged and placed in stockpiles. Benga has identified only one stockpile location at the mine site.

a) Provide an updated map showing the Project footprint, including the proposed ultimate pit extent and ultimate rock disposal areas overlaid on to the map of the

Crown reservations Protective Notations boundaries for potential fescue grassland communities shown in Figure 3-2 of Addendum 3.

Response:

Figure 2.4-1 illustrates the Project footprint, overlaid on to the map of the Crown reservations Protective Notations boundaries for potential fescue grassland communities shown in Figure 3-2 of Addendum 3 (CEAR #54). The updated map includes the proposed ultimate pit extent and ultimate rock disposal areas. The Alberta Government Protective Notations associated with the Project include PNT 090084 and PNT 090087.

b) Provide a copy of any correspondence with Alberta Environment and Parks regarding the referral and clearance / consent / conditions for PNT 090084 and PNT 090087.

Response:

Please see response to JRP IR-3.4.

c) Describe how Benga will mitigate for loss of fescue grassland communities in planned rock disposal areas.

Response:

Benga summarized the mitigation strategies to foothills rough fescue communities in August 2016 in Volume 1 Section E Environmental Impact Assessment, Page E 164-165, which stated the preferred primary mitigation strategy for native rough fescue grasslands is avoidance. Where direct disturbance is unavoidable, the following mitigation strategies will be implemented to preserve the resource:

- construct, or undertake assessments and surveys, during the dormant period for rough fescue (August to March); and
- avoid soil disturbance (Desserud 2006) by:
  - minimizing topsoil stripping and grading;
  - utilizing existing trails; and
  - using geotextiles to minimize the amount of topsoil stripping during construction where grading is required.

Mitigation strategies will also include direct placement of reclamation material (including potential transplantation of rare plants or of foothills rough fescue sod), collection of native seed from areas with foothills rough fescue and rare plants that will be disturbed, seeding of wild harvest seed, as part of a certified, weed-free native seed mixes in revegetation plan, and the potential seeding and growing of plugs grown in a greenhouse to be transplanted onto the site.

Benga will mitigate for the loss of fescue grassland communities in planned rock disposal areas and other affected areas through the implementation of the Foothills Rough Fescue Mitigation

Plan outlined in Section F.3.2.4 Foothills Rough Fescue Mitigation Plan of the updated Conservation and Reclamation (C&R) Plan (Appendix 2.6-1 in response to JRP IR-2.6). Mitigation strategies have also been discussed in Section 4.3.4.1 Mitigation of CR#8 – Vegetation and Wetlands (EIA, CEAR #42).

The preferred primary mitigation strategy for native foothills rough fescue communities is avoidance (Graminae 2009) by siting developments adjacent to existing transportation corridors, trails, cultivated lands or improved pastures (Desserud 2006, AESRD 2010b). However, avoidance is not feasible for all areas of native foothills rough fescue grasslands located in the Project footprint, since they are within the proposed open pit and rock disposal extents.

In addition to avoidance, where possible, the following mitigation strategies will be implemented during Project activities:

- Minimize overall project disturbance.
- Native seeds will be collected to be used for future phased reclamation if the opportunity arises for their use in areas that are representative of pre-disturbance habitats.
- Identify potential areas on hill crests and southern aspects where native seed collected could be planted to establish native fescue grasslands.

Restoration of foothills rough fescue inhabited lands is relatively unproven but will rely on industry best practices and will utilize key findings from successful efforts made on other industrial disturbances in similar fescue grassland areas. A search of available literature, such as Lancaster *et al.* (2016), demonstrates several successes on similar landscapes, which will be incorporated into the reclamation plan. Mitigation measures may include the following:

- direct reclamation material placement from grassland areas, when opportunities exist;
- collection of native foothills rough fescue seed from across the site;
- seeding of wild harvested certified weed-free native seed as a monoculture and as part of a certified, weed-free native seed mix;
- seeding and growing of foothills rough fescue plugs in a greenhouse for transplanting onto reclaimed areas of the site;
- occurrences of natural regeneration of native fescue; and
- promote the seeding of foothills rough fescue on the rough areas of the golf course to increase overall distribution of fescue grasslands.

The application of each of these methods is dependent on:

- the timing of the disturbance *versus* the availability of land ready to be reclaimed;
- availability and viability of certified weed-free seed sources; and
- accessibility of ranges across the mine.

Direct placement of salvaged reclamation material will be prioritized, when opportunities exist, to promote foothills rough fescue and native grassland establishment. Specific opportunities to align the disturbance of the foothills rough fescue dominated communities with the availability of areas scheduled to be reclaimed will be pursued and considered before all other mitigation. Areas where direct placement is targeted will be further supported by other seeding and maintenance techniques to ensure soil stability and vegetation establishment of the desired communities is achieved.

Since the growth of native foothills rough fescue grasslands may require a long period of time, most of the early stage reclamation will use a certified, weed-free native seed mix that is representative of the range type communities for the reclamation of natural upland herbaceous grasslands. Specifically, the *C5 Forest Management Plan 2006-2026* (Government of Alberta 2010b) recommends that reclamation work to adhere to the *Native Plant Revegetation Guidelines for Alberta – February 2001* (Native Plant Working Group 2000). These guidelines state that seed mixes, and the accompanying seed certificates of analysis, be submitted to appropriate Alberta Environment and Parks staff for approval prior seed application.

Seeding of wild harvest collected native fescue seed is the preferred method for all reclaimed grassland ecological units. If the availability and collection of native fescue seed becomes limiting to re-vegetative efforts, seed sources will be supported with locally certified, weed-free native seed mixes.

A portion of wild harvest collected fescue seed will be utilized to grow fescue plugs in local greenhouses. Tannas (2011) has documented that developing seedlings in an environmentally protected location, such as a greenhouse and transplanting to site, protects the seedlings from competition and environmental effects during their most vulnerable growth periods. Transplanting of plugs will target seeded areas of the reclaimed landscape where foothills rough fescue establishment has been limited, and these efforts will be coordinated with local recovery strategies. They are expected to be limited by the availability of local seed and local plugs but may be utilized throughout the life of the mine to ensure fescue communities establish and are maintained. Approximately 276.7 ha of the Project footprint will be reclaimed to Grassland Open Forest, representing 18.2% of the footprint.

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.

Reclaimed areas are also expected to benefit from a certain amount of natural regeneration of foothills rough fescue. These areas will be identified as part of the ongoing monitoring program for the mine. Areas where natural regeneration is identified will provide study opportunities to better understand the success parameters that can then feed into future efforts across the mine, elsewhere throughout the province, and throughout industry. Areas identified during monitoring where foothills rough fescue establishment is limited will be supplemented with a combination of overseeding, amending with hay cuttings/mulch harvested from the foothills rough fescue being collected, and transplanting of plugs as required.

Well-designed monitoring programs are very important during the first five years following construction and reclamation, and long-term monitoring programs are recommended for disturbance and reclamation of rough fescue grasslands (AESRD 2011). In addition to monitoring of the establishment in the first few years of reclamation, range health assessment of natural upland herbaceous grasslands would be conducted at Year 5 and Year 10 once each reclamation phase has been completed. Additional annual range health assessments would be conducted after Year 10 should the results of the range health assessments indicate that the range health functions of the community are not being restored.

d) Discuss the complications and constraints associated with reclaiming foothills rough fescue dominated communities and Benga's confidence about re-establishment of foothills rough fescue dominated communities.

Response:

Complications and constraints of reclaiming foothills rough fescue communities were previously discussed in Section 4.3.3 of CR #8 Vegetation and Wetlands (EIA, CEAR #42). In the discussion Benga stated that long-term restoration success of native rough fescue communities has yet to be demonstrated and documented on industrial sites subjected to a full range of production and operational disturbance related activities (Government of Alberta 2010a). Fescue plant communities have failed to be restored through natural recovery as they cannot compete with invasive non-native plants. Additionally, the seeding of disturbed sites with native plant cultivars has resulted in limited success in reducing nonnative species invasion (Government of Alberta 2010a).

It was reported in a study of reclaimed pipeline right-of-ways (ROWs) in the Foothills Fescue, Foothills Parkland, and Montane Natural Subregions that reclamation at 80% of the sites was unlikely to result in rough fescue restoration, thereby affecting the health and function of these areas (Desserud 2006). At approximately 20% of the sites, elements of reclamation success were present, based on vegetation cover, but the sites had less topsoil, higher clay content, more bare soil, less plant litter, and reduced range health scores when compared to adjacent undisturbed controls (Desserud 2006). The factors attributed to the lack of success were construction outside of the dormant period for rough fescue of August 1 to March 31 and full ROW stripping

techniques. Areas where reclamation success was achieved were on hillcrests and south facing slopes, where aridity was considered to be a contributing factor to the success (Desserud 2006).

Native plant communities in the open grassy areas have already been modified by grazing. Overgrazed areas in the Montane ecoregion may not be expected to recover back to natural communities as continued grazing pressure on a native plant community results in a decline in all native species, allowing invasive species such as Kentucky bluegrass and timothy to establish (Willoughby *et al*. 2005). Many native plant communities, once modified, are not likely to change back to a native plant community regardless of management changes (Adams *et al*. 2009).

Benga further re-iterated the complications associated with reclaiming foothills rough fescue dominated communities in Section F.3.2.4 Foothills Rough Fescue Mitigation Plan of Conservation and Reclamation (C&R) Plan (Appendix 2.6-1 in response to JRP IR-2.6), where it states:

> *Benga acknowledges that restoration of foothills rough fescue inhabited lands is relatively unproven but will rely on industry best practices and will utilize key findings from successful efforts made on other industrial disturbances in similar fescue grassland areas. A search of available literature, such as Lancaster et al. (2016), demonstrates several successes on similar landscapes, which will be incorporated into the reclamation plan as further defined below*.

Benga also identifies three factors that reclamation methods are dependent upon:

- the timing of the disturbance *versus* the availability of land ready to be reclaimed;
- availability and viability of certified weed free seed sources; and
- accessibility of ranges across the mine.

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2.5 Information Request 2.5

Ninth Addendum to the Environmental Impact Assessment. (CEAR #185).

In Addendum 9 (CEAR #185), Benga has made a commitment to turn over privately owned lands to the Káínai Nation or the Blackfoot Confederacy upon final mine closure and reclamation.

The Closure and Reclamation Plan does not provide details on the location and extent of those lands, nor does it specifies what measures and plans are applicable to those lands to mitigate potential effects on the Káínai Nation or the Blackfoot Confederacy.

a) Provide a map and the details of the location and extent of lands that Benga proposes to turn over to the Káínai Nation or the Blackfoot Confederacy.

Response:

Benga has not made a commitment to turn over privately owned lands to the Kainai Nation. Addendum 9 correctly indicates that Kainai Nation has made such a request but Benga's response to the request has been to schedule a meeting with Kainai Nation to discuss the request.

b) Provide a reclamation plan and targeted end land use for lands that are committed to be given to the Káínai Nation or the Blackfoot Confederacy upon final mine closure and reclamation.

Response:

Please see response to JRP IR-2.5(a).

c) Discuss Benga's plans to target vegetation species that are suitable for traditional ecological use by potentially affected Indigenous communities in the area, including the proposed seed mixes for the lands that will be given to the Káínai Nation or the Blackfoot Confederacy.

Response:

Please see response to JRP IR-2.5(a).

d) Discuss the conditions under which the proposed transfer of lands to the Káínai Nation or the Blackfoot Confederacy would occur. Address the potential timing of the transfer (before or after reclamation certification), responsibility for ongoing management and monitoring of the site and responsibility for any future liabilities.

Response:

Please see response to JRP IR-2.5(a).

2.6 Information Request 2.6

Grassy Mountain Coal Project - Updated Environmental Impact Assessment. Section F – Closure and Reclamation. (CEAR #42).

Fourth Addendum to the Environmental Impact Assessment. (CEAR #55).

Fifth Addendum to the Environmental Impact Assessment. (CEAR #69).

Ninth Addendum to the Environmental Impact Assessment. (CEAR #185).

From the Ktunaxa Nation Council to the Joint Review Panel re: Comments on the Grassy Coal Mountain Project Environmental Impact Assessment and Addenda. (CEAR #178).

Benga provided a conceptual Closure and Reclamation Plan on August 12, 2016 in Section F of the EIA. The Closure and Reclamation Plan provided, primarily in qualitative terms, the principles, objectives, and assumptions used by Benga in its assessment of effects on valued components. Since the submission of the Closure and Reclamation Plan on August 12, 2016, Benga has also provided additional information pertaining to closure and reclamation in the Ninth Addendum to the EIA.

For example, the Ktunaxa Nation Council noted that assumptions of reclamation success depend on how climate change is taken into account (CEAR #178). Benga discussed climate change in Addendum 4, Attachment 2, Response to AIR#25, and in Addendum 5, Response to SIR#113.

Although Benga indicated that no additional mitigation measures were required as a result of climate change predictions, Benga did not discuss the influence of climate change on reclamation success, and how it would affect the confidence in its assessment of significance for each valued component.

Additionally, the Closure and Reclamation Plan mentions Benga will develop in further detail several management plans and mitigation plans, and use adaptive management.

An updated Closure and Reclamation Plan is required in order for the Panel to evaluate the adequacy of the effects assessment and the effectiveness of mitigation measures for each valued component.

The Panel requests an updated Closure and Reclamation Plan which:

a) Provides additional details on how reclamation success will be monitored and how adaptive management will be used to address reclamation outcomes that do not meet expectations.

Response:

At the request of the JRP, Benga has provided an Updated C&R Plan (Appendix 2.6-1) to 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 management will be used to address reclamation outcomes that do not meet expectations (Section F.3.10).

b) 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.

Response:

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 management of reclamation plans are some of the key measures that will be used on the Project to mitigate potential adverse effects.

c) Clarifies how uncertainty related to reclamation effectiveness was taken into account in the effects assessment, such as uncertainty from effects of climate change on the reclaimed landscape.

Response:

The conceptual Conservation and Reclamation (C&R) Plan was updated to incorporate the consideration of uncertainty related to reclamation effectiveness, which also includes a discussion of the effects of climate change in the Plan (specifically Section F.5).

FIGURE

R4 W5M

R3 W5M

T9

T8

T7

PNT090087

PNT090087

PNT090087

PNT090087

PNT090084

PNT090084

PNT090084

PNT090084

Daisy Creek

Caudron Creek

Morin Creek

Green Creek

Pelletier Creek

Nez Percé Creek

McGillivray Creek

Crowsnest River

York Creek

York Creek

Lyons Creek

North York Creek

LEGEND

- Primary Highway
- Secondary Highway
- Existing Access Road
- Existing Powerline
- Proposed Water Pipeline/ Service Road
- Proposed Helipad Access
- Access Road
- Railway Loop
- Rail Loadout
- Proposed Haul Road
- Surface Water Drainage
- Blairmore Creek; Gold Creek
- Surface Water Body
- Proposed Mine Permit Boundary
- Ultimate Pit Extent
- Ultimate Rock Disposal Extent
- Reclamation Material Storage
- Construction Camp
- Ponds and Ditches
- Coal Handling Processing Plant and Infrastructure
- Covered Conveyor, Access Road and Powerline ROW
- Railway Loop
- Stormwater Run-off Pond
- Proposed Golf CourseDevelopment
- Undisturbed Area
- Regional Study Area

Potential Fescue Grassland

- PNT 090084
- PNT 090087

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

POTENTIAL FESCUE GRASSLANDS

MILLENNIUM EMS Solutions Ltd.

AltaLIS, 2019; MEMS, 2019; Riversdale, 2016

Coordinate System: NAD 1983 UTM Zone 11N

0 1 2

Kilometres

PROJECT: 14-00201

DRAWN BY: JLAMBERTS

CHECKED BY: MB

DATE: JUNE 3, 2019

FIGURE

2.4-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\Veg\Resubmission\Fescue Grasslands\Fig X Potential Fescue Grasslands 14-00201.mxd

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APPENDIX 2.6-1: GRASSY MOUNTAIN COAL PROJECT CONSERVATION AND RECLAMATION PLAN



Grassy Mountain Coal Project
Conservation and Reclamation Plan

Version 2, Updated July 2019
(presented in Addendum 10, JRP IR-2.6, Appendix 2.6-1)

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F.1 INTRODUCTION

The following document presents the objectives and methods that will be used to develop and reclaim the lands disturbed by Benga Mining Limited's (Benga) Grassy Mountain Coal Project (the Project). This conceptual Conservation and Reclamation (C&R) Plan for the Project has been prepared to:

- provide information about the planning process for the ongoing reclamation and the ultimate closure of the Project; and
- provide the goals and endpoints for the development and reclamation of the Project.

The closure plan provides an overview of the development and reclamation plan, while the conservation and reclamation plan focuses on the 27-year mining and reclamation plan.

This document forms the basis for the application for approval of the Project under the *Alberta Environmental Protection and Enhancement Act* (EPEA). The Project's C&R Plan was originally submitted as Section F of the EIS Submission in August 2016 (CEAR #42). The following document represents an update to the Project's C&R plan at the request of the Project's Joint Review Panel (JRP) as per the Information Request 2.6 (JRP IR-2.6, CEAR #202). The updated conceptual C&R Plan provides the following:

- a more comprehensive reclamation monitoring section (Section F.3.9.3) to address JRP IR-2.6 a);
- a more detailed discussion of adaptive management (Section F.3.10) to address JRP IR-2.6 a);
- summary of reclamation mitigation measures related to reclamation related VCs (Section F.2.8) to address JRP IR-2.6 part b); and
- clarification of how uncertainty related to reclamation effectiveness and climate change was taken into account in the effects assessment (Section F.5) to address JRP IR-2.6 c).

The Project's C&R Plan contains the pertinent information required as per Section 3.2.8 of the Terms of Reference (ToR) for the Project issued by the Alberta Energy Regulator (AER), which states:

3.2.8 Conservation and Reclamation

[A] Provide a conceptual conservation and reclamation plan for the Project. Describe and map as applicable:

a) any existing Conservation and Reclamation Plan;

b) current land use and capability and proposed post-development land use and capability;

c) anticipated timeframes for completion of reclamation stages and release of lands back to the Crown including an outline of the key milestone dates for reclamation and how progress to achieve these targets will be measured;

d) constraints to reclamation such as timing of activities, availability of reclamation materials and influence of natural processes and cycles including natural disturbance regimes;

e) post-development land capability with respect to:
- *i. self-sustaining topography, drainage and surface watercourses representative of the surrounding area,*
- *ii. existing traditional use with consideration for traditional vegetation and wildlife species in the reclaimed landscape,*
- *iii. end pit lakes,*
- *iv. wetlands,*
- *v. self-sustaining vegetation communities representative of the surrounding area capable of ecological succession, and*
- *vi. reforestation and forest productivity;*

f) a revegetation plan for the disturbed terrestrial, riparian and wetland areas;

g) water supply capability of post-mine landscape;

h) reclamation material salvage, storage areas and handling procedures;

i) reclamation material replacement indicating depth, volume and type;

j) existing and final reclaimed site drainage plans;

k) integrating surface and near-surface drainage within the Project Area; and

l) promotion of biodiversity.

[B] Provide a map of the predicted Ecological Land Classification for the post reclamation landscape considering potential land uses, including traditional uses and how the landscape and soils have been designed to accommodate future land use.

[C] Provide a conceptual plan to monitor reclamation performance and success (including soils, vegetation, wildlife and aquatic resources).

[D] Describe how the use of progressive reclamation was considered in the project design and reclamation planning.

[E] Discuss uncertainties related to the conceptual reclamation plan.

Additional legislation and direction regarding the reclamation of coal mines includes:

- *C&R Regulations of EPEA* (Province of Alberta, amended to 2014);
- *C&R Guidelines for Alberta* (Alberta Environmental Protection [AEP], 1997);
- "*A Guide to the Preparation of Applications and Reports for Coal and Oil Sands Operations*" (Land Conservation and Reclamation Center [LCRC], 1991); and
- *Guide to Content for Industrial Approval Applications: New, Renewal and Amendment*, April 2012 Draft.

The updated C&R Plan also contains pertinent information from previous IRs and comments:

- Fourth Addendum to the Environmental Impact Assessment, IR #25 (Att 2, CEAR #55);
- Fifth Addendum to the Environmental Impact Assessment, IR #113 (CEAR #69); and
- From the Ktunaxa Nation Council to the Joint Review Panel re: Comments on the Grassy Coal Mountain Project Environmental Impact Assessment and Addenda (CEAR #178).

F.1.1 Report Limitations

This document is an evergreen plan and it is anticipated it will be periodically updated and reviewed as per expected EPEA approval conditions. As many places in the EIA and other documents reference this plan as Section F, the organization for this update will continue to use this labelling convention.

The future versions of the C&R plan will rely on information that is not currently available: the JRP Report, the Decision Statement, future stages of Project planning and further feedback from Indigenous communities and stakeholders. Benga expects the path forward to finalize this plan would involve the steps listed below, which are not necessarily sequential, and which may result in changes to the structure of this document.

- Receive the JRP Report and Minister's Decision Statement following the JRP Hearing;
- Receive the Alberta *EPEA* approval with conditions;
- Understand the current state of relevant provincial and federal regulations and relevant guidelines to be addressed in the plan;
- Continue engaging with regulators, Indigenous communities and stakeholders to develop more clarity around the indicators, metrics and thresholds or objectives to be used to evaluate mitigation effectiveness;
- Finalize details of this plan considering future stages of project planning and engineering, including technical, environmental and commercial details; and
- Review final plan with regulators, Indigenous communities and stakeholders prior to finalization and submission to appropriate regulators on a continued 3-5 year timeframe, as an anticipated condition of an *EPEA* approval.

F.1.2 The Company and Project Components

Benga Mining Limited (Benga), a wholly owned subsidiary of Riversdale Resources Limited (Riversdale), acquired the Grassy Mountain property from Devon Canada and CONSOL of Canada (50/50 Joint Venture) in 2013. Development efforts on this property to date have included the pre-feasibility study work, a re-evaluation of the historical coal quality data, and the development of a detailed engineering feasibility study.

Benga has the opportunity to develop a world class metallurgical coal mine supplying global seaborne markets and further enhance Canada's reputation as a supplier of high quality metallurgical coal to the world's largest steel makers who continue to be key players in global growth and industrialization. The Project components are shown on Figure F.1.2-1. Table F.1.2-1 provides the estimated areas of disturbance associated with the Project components for the Project.

Table F.1.2-1 Summary of Spatial Extent of the Primary Project Components

Project Component	Component Area (ha)	Percentage of Development (%)
Coal Handling Processing Plant and Infrastructure	94.1	6.2
Coal Load-Out and Railway Loop	33.1	2.2
Construction Camp	1.9	0.1
Haul Road	0.3	<0.1
Powerline, Access and Conveyor RoW	15.2	1.0
Reclamation Material Storage	37.9	2.5
Surface Water Management Ponds and Ditches	74.6	4.9
Ultimate Rock Disposal Extent	589.9	38.8
Ultimate Pit Extent	632.4	41.6
Proposed Water Pipeline/Service Road Right of Way	1.5	0.1
Proposed Golf Course Development [1]	38.1	2.5
Proposed Helipad Access [1]	1.6	0.1
Total Mining Activities Reclamation Area	**1,481.0**	**97.4**
Total Non-Mining (Incidental) Area [1]	**39.7**	**2.6**
TOTALS[2]	**1,520.7**	**100**

[1] Benga Reclamation Responsibility include "incidental physical activities" identified by CEAA

[2] Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

The development and reclamation of the mine project will be phased over time and will allow for implementation of a progressive reclamation program. Figures of the annual mining and reclamation progressions are shown in Figures F.3.6-1 to F.3.6-6.

F.1.3 Project Location

The Project is located in southwest Alberta near the Crowsnest Pass, approximately 7 km north of the community of Blairmore (Figure F.1.2-1). The Project involves a surface metallurgical (steel making)

coal mine, a coal handling and preparation plant (CHPP), and associated infrastructure including a coal conveyor system, a rail load-out facility, an access corridor, maintenance shops, and other pertinent facilities. The rail load out facility will displace a portion of the Crowsnest Pass Golf and Country Clubs golf course (Figure F.1.3-1). The proposed golf course development is included to ensure potential impacts are considered and mitigated.

The Project is located within the Rocky Mountain Natural Region, which is comprised of mountains, high foothills, and deep glacial valleys. Within the Rocky Mountain Natural Region, the majority of the Project is located within the Subalpine Natural Subregion with the remaining portion being located within the Montane Natural Subregion (Natural Regions Committee [NRC] 2006).

Soils in the Subalpine Natural Subregion develop on unstable parent materials over steeply sloping bedrock and contribute to the development of Brunisols (Eutric and Dystric) as well as Regosols and non-soils (*i.e.,* colluvium, exposed bedrock) (NRC, 2006). In areas of less pronounced terrain and finer textured soils, Orthic and Brunisolic Gray Luvisols have developed (NRC, 2006). Wetland soils are usually Gleysols but Organic soils also do occur (NRC, 2006). In the Subalpine Natural Subregion, a broad range of vegetation species are characteristic of mesic sites due to significant variations in elevation. Vegetation communities at lower elevations are characterized by closed canopy forests of lodgepole pine, Engelmann spruce, and subalpine fir. Whitebark pine is found at higher elevations where the forest canopy is generally more open (Archibald *et al.* 1996).

The soils found within the Montane Natural Subregion consist of Chernozems, Brunisols, Regosols, Luvisols, Gleysols, and Organics (NRC, 2006). Orthic Black Chernozems are typical under grasslands and Orthic Dark Gray Chernozems are dominant in wooded areas (NRC, 2006). In the valleys, Eutric Brunisols are dominant on fluvial and glaciofluvial deposits. Regosols are typical of both fluvial terraces adjacent to rivers and side slopes where there have been recent occurrences of erosion or slope movement (NRC, 2006). On valley side-slopes that are stable enough for soil development, Luvisols and Dystric Brunisols can occur (NRC, 2006). Gleysols and Organic soils are typically associated with fens (NRC, 2006). Vegetation in the Montane Natural Subregion is characterized by a pattern of open forests and grasslands, with modal sites having forested stands of Douglas fir, lodgepole pine, white spruce, aspen or mixtures of all. The subregion occurs at lower elevations than the Subalpine Natural Subregion and has warmer climatic conditions as a result. Limber pine may be present, but is commonly restricted to dry, exposed ridge tops. Abrupt changes in vegetation can occur over very short distances due to high variability in microclimates from differing aspects, slope positions and wind exposure (NRC, 2006).

The southern portion of the Project is located within a Mountain Goat and Bighorn Sheep Range and the northern portion within a Grizzly Bear Zone. A small portion on the southwest edge of the proposed Mine Permit Boundary is located within a Key Wildlife and Biodiversity Zone.

The Project area currently has a number of land uses including historic mining, oil and gas, recreation, grazing, timber harvesting, trapping and traditional uses located on both crown and freehold land. The majority of the freehold land is owned by Benga, with access to other freehold land under discussion with the associated landowners.

The proposed golf course development area has been identified by the Canadian Environmental Assessment Agency (CEAA) as "incidental physical activities" associated with the development of the mine. These areas are included as part of the Project assessment. The Crowsnest Pass Golf and Country Club will develop the replacement facilities, will own them and be responsible for the construction, operation and closure of them (Figure F.1.3-1). The golf course development will be zoned recreational and developed accordingly. The Department of Agriculture and Forestry is responsible for the helipad access that will be used as a Forestry resource. As shown in Table F.1.3-1, most of these lands are privately owned (34.7 ha), with a minor component (4.8 ha) being crown lands with 0.5 ha existing roadway. Final reclamation and closure of these areas are not included in this assessment as the useful life of each component is intended to extend beyond the operational and closure plan life of the Project's mining activities.

Table F.1.3-1 Summary of Spatial Extent by Ownership of the Incidental Physical Activities

Incidental Physical Activity	Freehold		Crown	Other	Total [1]
	Benga	Other			
Proposed Golf Course Development - East Area	8.2	0.1	-	-	**8.3**
Proposed Golf Course Development - West Area	25.7	-	4.1	-	**29.8**
Proposed Helipad Access	1.0	0.1	0.2	0.4	**1.6**
Totals [1]	**34.8**	**0.2**	**4.3**	**0.4**	**39.7**
	35.0				

[1] Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

F.1.4 Land Capability

Land capability is defined as:

> *"the ability of the land to support a given land use, based on an evaluation of the physical, chemical and biological characteristics of the land, including topography, drainage, hydrology, soils and vegetation". For the purposes of the definitions of land*

> *capability and equivalent land capability, land is defined as "terrestrial, semi-aquatic, and aquatic landscapes"* (Province of Alberta 2016).

The goal of reclamation in Alberta is to achieve a land capability that is equivalent to what existed prior to disturbance. Specific reclamation targets are determined by regulatory requirements to return lands to an equivalent land capability that will support stated end land use objectives. However, the return of equivalent land capability does not mean that the reclaimed landscape will be identical to pre-disturbance conditions; rather, it will provide flexibility to potential equivalent land uses. For example, land capability may be improved following reclamation. Typically, vegetation and soils are used to evaluate biophysical site factors that will return biologically achievable end land uses.

F.1.5 Reclamation Goals and Principles

The reclaimed lands will feature regionally compatible landforms and vegetation patterns that are ecologically functional and successional. The goal of the reclamation plan is to develop lands that are maintenance-free and self-sustaining. The landscape will evolve through seral states of initial revegetation to self-sustaining ecosystems, consisting of mature vegetation communities typical of the Subalpine or Montane Sub Regions of the Rocky Mountain Natural Region (Natural Regions Committee 2006).

The following goals and principles have been incorporated in the C&R and Closure Plans:

- progressive reclamation will be undertaken within the requirements of the mine plan;
- topsoil/reclamation material will be salvaged during site construction and preserved for reclamation activities;
- where possible, Project construction and operations will minimize impact to established communities;
- direct placement of reclamation material will be undertaken, whenever practical, to maximize the potential viability of native seed banks and propagules;
- landforms will be geo-technically stable and will be integrated into the surrounding natural landforms;
- a variety of landforms (slopes and aspects) will be in the reclamation landscape;
- surface water drainage systems will be designed to minimize erosion rates and sediment loading;
- reclaimed areas will be developed into self-sustaining ecosystems with an acceptable degree of biodiversity (relative number of native species and structural layers as early stage target community);

- forest capability, including commercial forestry potential, will be equivalent to pre-development conditions;
- natural encroachment of native vegetation will be encouraged in ecologically receptive areas;
- local native seed sources will be used wherever practical to maintain genetic integrity of re-established plant communities;
- creation of habitat features that will benefit or help re-establish wildlife species known or reported to occur in the area;
- creation of features to help support SARA listed species (both vegetation and wildlife) known or reported to occur in the area;
- creation of features to promote Traditional Use or promote the establishment of valued components for Traditional Use;
- continued consultation with nearby Indigenous communities will be done to facilitate incorporation of vegetation important to them for its Traditional Use value;
- avoid disturbance to HRIA sites DjPo – 98 and DjPo – 130, which Benga has committed to preserve due to their importance to Indigenous groups and to reclaim the adjacent areas to create an area rich in Traditional Ceremonial value;
- on-site public health and safety will be protected;
- the end pit lake will be ecologically sustainable; and
- reclamation certification will be achieved to allow transfer of the lands back to landowners and to the Crown.

During the on-going reclamation and closure process Benga will ensure that:

- end land use objectives are developed in consultation with Indigenous groups, the public, and regulatory stakeholders, building on the existing consultation process;
- an Indigenous monitoring plan is developed in coordination with nearby Indigenous groups and provides important feedback to guide decisions and adaptive management;
- site wide environmental monitoring will be conducted throughout the life of the Project and throughout reclamation to ensure landforms, soil conditions and vegetative communities maintain the appropriate trajectory towards the desired end land uses; and
- 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.

Land capability objectives, reclamation goals and principles, pre-disturbance vegetation inventories and post-mining monitoring programs, will be used to evaluate reclamation success and identify areas for improvement. Benga has also developed the C&R and Closure Plan in consideration of the environmental impact assessment as well as input from extensive public and Indigenous engagement.

F.1.6 End Land Use

The end land use goals for the Project include:

- reclamation of the landscape to an equivalent land capability, optimizing the value of watershed, timber, grazing, wildlife habitat, fish habitat, recreation or other resources, taking into account threatened species, public input, and Indigenous group VCs;
- return of forest productivity to equivalent pre-development levels;
- return of aesthetic qualities of the landscape;
- provision for traditional land use (*e.g.*, gathering, hunting and trapping) as identified through consultation with Indigenous groups; and
- maintain equivalent recreational land use specific to the proposed golf course development.

Reclamation will be conducted to construct landscape patterns, provide mine soil substrates, establish surface hydrology, and establish plants to initiate development of a functioning ecosystem. End land use will vary spatially and temporally across the reclaimed Project area and will be focused on forestry, grazing, watershed protection, riparian, wetland and wildlife objectives.

The following assumptions were made for end land uses and final certification:

- the target ecosystems and vegetation communities identified in the C&R and Closure Plans will allow multiple uses. For example, areas reclaimed to commercial forest use will also provide for wildlife, recreation and traditional land uses;
- end land use options available will be constrained by the type of landforms to be constructed; and
- final end land use decisions will, in part, depend on government, local stakeholder, and Indigenous group input.

Regional land use was considered in the determination of end land uses. End land use objectives of the Project's reclamation program include watershed protection, ecological values, forestry, fisheries, wildlife habitat, traditional use and recreational use.

F.1.6.1 Integrated Resource Planning

The local study area (LSA) and regional study area (RSA) fall under two Integrated Resource Plans (IRPs) prepared by the Government of Alberta; the Livingstone-Porcupine Hills Sub Regional IRP and the Crowsnest Corridor Local Sub Regional IRP (Alberta Forestry, Lands & Wildlife [AFLW], 1990). Each IRP is put in place to assist proponents in land use planning and assessment. The applicability of each plan to the Project are summarized below:

Livingstone-Porcupine Hills Sub Regional IRP

The primary intent of the Livingstone-Porcupine Hills Sub Regional IRP is:

> *"To achieve social and economic benefits by providing for the optimal use of all available resources, while maintaining the overall integrity of the natural environment for which the area is known (pp. 9)"* IRP (AFLW 1987).

Within the Livingstone-Porcupine Hills Sub Regional IRP, the seven land use zones identified in the Eastern Slopes Policy (Energy and Natural Resources 1984) were refined based on more specific objectives. Of these seven zones, two are located within the LSA and RSA including:

- Special Use Zone where coal development is allowed but may require special conditions and controls; and
- Multiple Use Zone where coal development is considered compatible under normal guidelines and compatible land use regulations.

Within the IRP, the Project area is also distinguished by seven Resource Management Areas (RMAs). The Project area is located within the West Livingstone and Crowsnest Watershed RMAs. As stated in the IRP, the primary intent of the West Livingstone RMA is to *provide a full range of multiple use activities managed to prevent adverse environmental impacts on watershed, fisheries, wildlife and recreation values in the area* (AFLW, 1987, pp. 37) and the intent of the Crowsnest Watershed RMA is *to provide a full range of multiple use activities managed to maintain high watershed quality, and to recognize the social and economic needs of Crowsnest Pass* (AFLW, 1987).

Crowsnest Corridor Local Sub Regional IRP

The primary intent of the Crowsnest Corridor Local Sub Regional IRP is:

> *"To identify a comprehensive, coordinated approach to the management of public land and public resources that optimizes resource decisions in the public interest and provides social and economic benefits to Albertans, especially residents of the Municipality of Crowsnest Pass, while at the same time protecting the natural environment"* (AFLW, 1991).

Within the IRP, the land use zones identified in the Eastern Slopes Policy (Energy and Natural Resources 1984) were modified. Four land use zones are located within the LSA and RSA including:

- Prime Protection Zone where coal development and exploration is not permitted;

- Critical Wildlife Zone where coal development is allowed but may require special conditions and controls;
- Multiple Use Zone where coal development is considered compatible under normal guidelines and compatible land use regulations; and
- Facility Zone where coal development and exploration is not permitted.

Benga recognizes the values contained within these documents and has incorporated them into conservation and reclamation planning. Based on specific IRP objectives for the Livingstone and Crowsnest Watershed RMAs, nine resource uses have been identified for the reclaimed Project landscapes. These uses are ecologically and economically sustainable, socially acceptable and are compatible with government planning objectives and regulatory requirements. One or more of these resource uses will be designated on the unit's reclaimed landscape, depending on site characteristics.

Table F.1.6-1 outlines the nine resource objectives from the West Livingstone and Crowsnest Watershed RMAs that pertain to the development and reclamation of the Project:

Table F.1.6-1 Project Resource Objectives (from AFLW, 1990)

Resource	Objectives Associated with Project Area
Recreation and Tourism	Objectives: (Livingstone p. 57, Crowsnest p. 131) 1. To maintain and upgrade existing recreation facilities as required. (Livingstone) 2. To provide opportunities for dispersed recreational activities with provision for motorized recreation where this use is compatible with other land uses and environmental constraints. (Livingstone, Crowsnest) 3. To manage 19 White Area quarter sections of public lands for extensive recreation values. (Crowsnest) 4. To recognize the Forestry Trunk Road as an important auto touring route. (Livingstone, Crowsnest) 5. To recognize the focus of the area as extensive recreation and its potential for development of recreational staging areas. (Livingstone) 6. To provide opportunities for the private sector to meet the needs of the area's recreational users where appropriate, while recognizing that the Municipality of Crowsnest Pass contains tourism services and facilities. (Crowsnest)

Table F.1.6-1 Project Resource Objectives (from AFLW, 1990)

Resource	Objectives Associated with Project Area
Wildlife	Objectives: (Livingstone p. 62, Crowsnest p. 128) 1. To increase the number and distribution of elk, sheep, moose and goats using the resource management area on a year round basis. (Livingstone, Crowsnest) 2. To promote elk and sheep winter use of former underutilized or current underutilized wintering areas. (Livingstone, Crowsnest) 3. To encourage the increase or re-establishment of goat populations on vacant or underutilized ranges. (Livingstone, Crowsnest) 4. To promote forest management practices to enhance moose habitat. (Livingstone, Crowsnest) 5. To maintain recreational hunting and commercial trapping opportunity and non-consumptive uses of wildlife. (Livingstone, Crowsnest) 6. To develop a land management strategy for parts of the RMA to promote wildland qualities for recreational hunting. (Livingstone) 7. To minimize wildlife depredation on private lands adjacent to the RMA in the Municipality of Crowsnest. (Crowsnest) 8. To reduce the negative impacts of landuse activities on wildlife and wildlife habitat. (Livingstone, Crowsnest) 9. To maintain current levels of abundance and distribution of other wildlife species by maintaining diverse habitat types. (Livingstone, Crowsnest) 10. To maintain a forage base capable of sustaining the following wildlife populations: 15/30 sheep (winter/summer); 35 goats; 100/265 elk (winter/summer); 50/450 mule deer (winter/summer); 100 white-tailed deer, and 75 moose. (Livingstone) 11. To maintain a forage base capable of sustaining the following wildlife populations: 80/65 sheep (winter/summer); 25 goats; 100/200 elk (winter/summer); 100/400 mule deer (winter/summer); 100 white-tailed deer, and 50 moose. (Crowsnest)
Fisheries	Objectives: (Livingstone p. 64, Crowsnest p. 129) 1. To maintain a high quality water supply of sufficient quantity for sport fish production. (Livingstone, Crowsnest) 2. To protect the integrity of aquatic and riparian habitats critical for continued sport fish production, primarily spawning, rearing and overwintering areas on the Oldman River, Dutch Creek, Racehorse Creek and its tributaries. (Livingstone) 3. To protect the integrity of aquatic and riparian habitats critical for continued sport fish production, primarily spawning, rearing and overwintering areas on tributaries to the Crowsnest River. (Crowsnest) 4. To maintain current population levels and high productivity in sport fishing populations. (Livingstone, Crowsnest) 5. To maintain current angler days of recreational fishing. To increase, where possible, recreational fishing opportunities. (Livingstone, Crowsnest)

Table F.1.6-1 Project Resource Objectives (from AFLW, 1990)

Resource	Objectives Associated with Project Area
	6. To recognize and protect the provincial Class 1 stream status of the Oldman River. (Livingstone) 7. To recognize and protect the integrity of the Allison Creek drainage and Chinook Lake drainage for trout blood rearing purposes. (Crowsnest)
Historic	Objectives: (Livingstone p. 67, Crowsnest p. 134)) 1. The broad resource management objective applies within the RMA. (Livingstone) 2. To protect historical resources from potential or actual impact related to future resource development; and to conserve these resources for future generations. (Crowsnest) 3. To protect the Lille Townsite area from physical or visual impact and to preserve this resource for future generations. (Crowsnest)
Timber	Objectives: (Livingstone p. 68, Crowsnest p. 136) 1. To maintain a sustained yield land base capable of satisfying commercial demands for forest products. (Livingstone, Crowsnest) 2. To manage the 19 White Area quarter sections of public land that are contiguous with the Rocky Mountain Forest Reserve and have value for timber production, as part of the sustained yield land base. (Crowsnest)
Range	Objectives: (Livingstone p. 68, Crowsnest p. 137) 1. To provide a forage base capable of supporting 2 184 animal unit months (AUMs). (Livingstone) 2. To provide a forage base capable of supporting 1 039 AUMs in the Rocky mountain Forest Reserve portion of the RMA. (Crowsnest) 3. To maintain current levels of AUMs of domestic grazing on existing grazing dispositions in the White Area north of the Municipality of Crowsnest Pass. (Crowsnest)
Minerals	**Objective**: (p. 69) 1. To provide opportunities for renewed exploration and development of coal reserves particularly where major deposits have been identified. (Livingstone, Crowsnest) 2. To provide opportunities for industry to define the limits of and recover the reserves within the productive geologic structures of the Coleman gas field particularly since there is an existing commitment to its development under A Policy for Resource Management of the Eastern Slopes, Revised 1984. (Livingstone, Crowsnest) 3. To provide opportunities for the orderly exploration and development of hydrocarbons. (Livingstone, Crowsnest) 4. To maintain opportunities for the recovery of limestone in order to support the continued operation of the lime plant in the Crowsnest Pass. (Crowsnest) 5. To provide opportunities for the private sector to explore and develop quarriable and metallic mineral resources. (Livingstone)

Table F.1.6-1 Project Resource Objectives (from AFLW, 1990)	
Resource	**Objectives Associated with Project Area**
Access	Objectives: (Livingstone p. 70, Crowsnest p. 140) 1. The broad access management objectives apply. (Livingstone, Crowsnest)
Ecological	Objectives : (Crowsnest p. 133) 1. To protect the natural values of the Ptolemy Valley and the Ptolemy Caves. (Crowsnest)

F.1.6.2 South Saskatchewan Regional Plan

The Project falls within the southwest limits of the South Saskatchewan Regional Plan (SSRP) (Government of Alberta 2014). The SSRP was established in accordance with Alberta's Land Use Framework (LUF) and came into effect on September 1, 2014. The SSRP identifies strategic directions for the region over the next 10 years and sets the stage for robust growth, vibrant communities and a healthy environment within the region for the next 50 years (Government of Alberta 2014). The previously developed IRPs remain in effect and will continue to provide operational guidance until they are reviewed and incorporated into the SSRP implementation strategy.

Based on the regional vision for the South Saskatchewan region the following regional outcomes have been established as part of the SSRP and are relevant to C&R and Closure planning:

- biodiversity and ecosystem function are sustained through shared stewardship;
- watersheds are managed to support healthy ecosystems and human needs through shared stewardship;
- land is used efficiently to reduce the amount of area that is taken up by permanent or long-term developments associated with the built environment; and
- Indigenous peoples are included in land-use planning.

F.1.6.3 Livingstone-Porcupine Hills Land Footprint Management Plan

To help guide human development on public lands through footprint management under the SSRP, the Livingstone-Porcupine Hills Land Footprint Management Plan was developed (May 2018). The Livingstone-Porcupine Hills LFMP outlines a system to minimize the extent, duration, and rate of cumulative footprint to achieve landscapes with healthy, functioning ecosystems that provide a range of benefits to communities and all Albertans. The purpose of the LFMP is accomplished by addressing two core components of the land footprint:

- motorized access; and,
- spatial human footprint.

There are two management outcomes listed in the plan that relate to this Project:

- Outcome 1: Human footprint and disturbance are effectively minimized so as to sustain biodiversity and watershed values and provide a range of benefits to communities and all Albertans; and
- Outcome 2: Operational planning and management are aligned so as to minimize the extent, duration and rate of footprint development.

The Project is aligned with the objectives of the LFMP in the following manner:

- the Project provides a range of socio-economic benefits to communities and Albertans;
- the Project will undertake progressive reclamation overall Project disturbed areas, to minimize the extent and duration of the footprint;
- the Project has a robust Conservation & Reclamation plan that incorporates monitoring and adaptive management strategies, on topics including biodiversity and watersheds;
- there will be no new permanent motorized access created because of the Project;
- only a portion of the Project Mine Pit Boundary (MPB) is within the Livingstone Public Land Use Zone (2038 ha or 55% of the total MPB area). Of that, only 634 ha of land will be disturbed within this Public Land Use Zone (approximately 43% of the total disturbed Project area); and
- 185 ha of legacy mine footprint will be reclaimed, 62 ha of which is located on Crown Land within the Livingstone Public Land Use Zone.

F.1.7 Gold Creek Stewardship Program

Considerable degradation has occurred within and along Gold Creek because of legacy mining activities and other historical land uses that include ATV and four-wheel drive use in the creek and along the riparian areas. In the absence of any substantive long-term remediation plan to address historical mining activities, which largely terminated in the early 1960s, Benga plans to establish and be a catalyst for a Gold Creek Stewardship Program. The program will address some of the current issues that relate to the water quality and fisheries in Gold Creek. While the aquatic environment is the first priority of this program, the terrestrial and social components may also be captured. Benga will spearhead this program and foresees involvement from a wide range of stakeholders, environmental groups, Indigenous communities, academia, researchers and regulators. A function of the program would be active engagement in local research and monitoring that would tie directly in to the westslope cutthroat trout Recovery Plan.

F.1.8 Public Engagement and Indigenous Group Values and Issues Related to Closure, Conservation and Reclamation Planning

Benga received considerable input on existing land values and expectations for reclaimed lands through extensive past and ongoing public engagement and Indigenous consultation. Information gained during the environmental assessment process, subsequent consultations, and TEK reports has been used to identify issues relating to development and reclamation of the Project. Through the examination of the existing mining operations in the SSRP (Government of Alberta, 2014), input from public engagement and Indigenous consultation and consideration of the Terms of Reference (AER, 2015), an issue screening process has been completed. Examples of identified issues include:

- native plant species are important;
- commercial forest productivity needs to be re-established;
- forest communities need to be established such that all of their functions are returned;
- water quality and quantity is very important;
- fisheries habitat is important to protect and to re-establish;
- landform types and integration with adjacent undeveloped areas;
- reclamation performance in terms of ecological development and sustainability;
- end land uses – balancing the wants and needs of the various stakeholders (*e.g.*, golf course);
- wildlife habitat, health and population levels need to be protected and re-established;
- consideration should be given to creation of habitat suitable for bison to support the possible future installation of a bison population in the area; and
- wildlife density on reclaimed lands needs to be planned and managed so as not to become higher than the natural carrying capacity.

Consultation commenced early in the regulatory process and has continued as the process advances. The results are continuously included in the planning process. Consultation with Indigenous groups on the C&R Plan will be ongoing throughout the environmental assessment process, construction, operations, and reclamation.

F.1.9 Traditional Ecological Knowledge and Land Use

Traditional Ecological Knowledge (TEK) and Traditional Land Use reports were completed as part of the Project by Indigenous groups identified as potentially affected by the Project and are provided in Appendix 4.1-1: Updated Assessment on the Potential Effects of the Grassy Mountain Project on Indigenous Peoples (JRP IR-4.1).

Elders and technicians provided input on the key issues, themes, observations, wisdom, insights, traditional knowledge and land use through a series of site visits, workshops, meetings, and other

communication events. Some of the recommendations and ideas expressed to date by Indigenous groups that are relevant to conservation and reclamation planning include:

- protect and harvest lodgepole pines and other plants of interest on a regular and ongoing basis;
- make efforts to relocate trees from areas of development for use on the reserves;
- protect and monitor water;
- impose no-go buffers around sacred sites of 100 m;
- maintain habitat for wildlife, including eagles' nests;
- ensure that effective reclamation involves reforestation of evergreen species to outcompete weeds;
- ensure efforts for research focus specifically in areas that have not been disturbed;
- provide adequate funding for ongoing project involvement and costs associated with Indigenous traditional environmental monitoring and harvesting vegetation throughout the Project;
- annual project review with Benga for the life of the Project;
- have an emergency preparedness plan in the event of leaks, spills or other disasters to address concerns regarding water quality and species dependent on clean water resources;
- consider including habitat suitable for the possible reintegration of bison into the area in the future;
- ensure new areas of development encompass previously disturbed areas; and
- consider socio-economic effects of the proposed Project.

Various traditional land uses objectives were also identified in the reports. Some of the TEK principles that Benga will incorporate into the C&R and Closure Plans include:

- where possible, impact to significant vegetative communities will be managed or mitigated;
- on Benga private land lodgepole pine and other significant plants will be made available to Indigenous groups for harvesting prior to clearing activities;
- wildlife habitat for traditionally important wildlife species will be re-established in areas of disturbance;
- reclamation, revegetation and reforestation efforts will be implemented to ensure weed species are outcompeted;
- water management plans will be implemented to manage surface and groundwater across the Project so that potential impacts to downstream users is mitigated;

- weed control efforts will be implemented throughout the life of the mine and during reclamation;
- where feasible, encourage biodiversity in the reclaimed landscape and re-establishment of native vegetation through direct placement of salvaged soil;
- local seed sources will be utilized for reforestation of native species and for the reestablishment of traditionally important plant species;
- wetlands, water bodies and grassy areas around waterbodies will be established; and
- previous disturbances across the Project area will be incorporated into the C&R plan for the mine resulting in improved biodiversity.

Benga is respectful of the spiritual aspects of TEK. Local stakeholders have identified the importance of harvesting lodgepole pine as well as other significant plants. Benga will engage with Indigenous groups prior to and during mine construction to offer opportunities for these species to be harvested, re-located or otherwise utilized.

Vegetation species identified during the Indigenous Consultation process including TEK species (vascular and non-vascular) observed in the vegetation LSA during vegetation field surveys are provided in Table F.1.9-1. Additional species identified by Indigenous groups outside of the systematic vegetation field surveys, are also provided in the table. The TEK reports provided additional details on traditionally important plants. The types of vegetation identified as VC's for TEK and the vegetation assessment were also focused on during the C&R Planning to ensure the reclamation program establishes suitable habitat for various wildlife species. Input from the Indigenous consultation has been considered for species selection for revegetation plans and for terrain and vegetation planning to support vegetation and wildlife of importance to Indigenous groups. Consultation is on-going, which will occur through the life of the mine, and should additional species be identified they would be added to the list.

Table F.1.9-1 Traditional Ecological Knowledge Vegetation Valued Component Species Identified in the Local Study Area

Life Form	Name			Number of occurrences in LSA[1]	First Nations Identified VCs				
	Provided TEK	Scientific	Common		Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN
Tree	Sweet pine	*Abies lasiocarpa*	Subalpine fir	44	x	x		x	x
Tree	Lodgepole pine	*Pinus contorta*	Lodgepole pine	93	x	x		x	x
Tree	Poplar	*Populus balsamifera*	Balsam poplar	12	x			x	
Tree	Cottonwood or poplar	*Populus tremuloides*	Aspen	28	x	x			
Shrub	Saskatoon berry	*Amelanchier alnifolia*	Saskatoon	34	x	x		x	
Shrub	Bearberry	*Arctostaphylos uva-ursi*	Common bearberry	30	x	x		x	
Shrub	Mountain sage	*Artemisia* sp.	Sage	2	x			x	x
Shrub	Dogberry	*Cornus stolonifera*	Red-osier dogwood	4		x		x	
Shrub	Juniper	*Juniperus communis*	Ground juniper	59	x	x		x	
Shrub	Juniper	*Juniperus scopulorum*	Rocky mountain juniper	1	x	x		x	
Shrub	Rose hip	*Rosa acicularis*	Prickly rose	41		x			
Shrub	Rose hip	*Rosa woodsii*	Common wild rose	10		x			
Shrub	Raspberry	*Rubus idaeus*	Wild red raspberry	8		x		x	

Table F.1.9-1 Traditional Ecological Knowledge Vegetation Valued Component Species Identified in the Local Study Area

Life Form	Name			Number of occurrences in LSA[1]	First Nations Identified VCs				
	Provided TEK	Scientific	Common		Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN
Shrub	Thimbleberry	*Rubus parviflorus*	Thimbleberry	19		x		x	
Shrub	Willow	*Salix bebbiana*	Beaked willow	4	x	x		x	
Shrub	Willow	*Salix scouleriana*	Scouler's willow	11	x	x		x	
Shrub	Black elderberry	*Sambucus racemosa*	Red elderberry	1				x	
Shrub	Low-bush cranberry	*Viburnum edule*	Low-bush cranberry	2				x	
Forb	Prince's pine	*Chimaphila umbellata*	Prince's-pine	25				x	
Forb	Ferns	*Cystopteris fragilis*	Fragile bladder fern	2					x
Forb	Fireweed	*Epilobium angustifolium*	Common fireweed	54				x	
Forb	Horsetail	*Equisetum arvense*	Common horsetail	10		x		x	
Forb	Horsetail	*Equisetum fluviatile*	Swamp horsetail	1		x		x	
Forb	Scouring-rush	*Equisetum scirpoides*	Dwarf scouring-rush	7		x		x	
Forb	Strawberry	*Fragaria virginiana*	Wild strawberry	56					x
Forb	Three-flowered avens	*Geum triflorum*	Three-flowered avens	7					x

Table F.1.9-1 Traditional Ecological Knowledge Vegetation Valued Component Species Identified in the Local Study Area

Life Form	Name			Number of occurrences in LSA[1]	First Nations Identified VCs				
	Provided TEK	Scientific	Common		Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN
Forb	Cream-coloured vetchling	*Lathyrus ochroleucus*	Cream-coloured vetchling	31					x
Forb	Lupine	*Lupinus arbustus*	Longspur lupine	2					x
Forb	Lupine	*Lupinus arcticus*	Arctic lupine	8					x
Forb	Lupine	*Lupinus argenteus*	Silvery perennial lupine	12					x
Forb	Lupine	*Lupinus sericeus*	Silky perennial lupine	21					x
Forb	Lupine	*Lupinus sulphureus*	Sulphur lupine	8					x
Forb		*Phacelia hastata*	Silver-leaved scorpionweed	4					x
Forb	Silky scorpionweed	*Phacelia sericea*	Silky scorpionweed	3					x
Forb	Lance-leaved stonecrop	*Sedum lanceolatum*	Lance-leaved stonecrop	22					x
Forb	Clasping-leaved twisted-stalk	*Streptopus amplexifolius*	Clasping-leaved twisted-stalk	3				x	
Herb	Yarrow	*Achillea millefolium*	Common yarrow	35	x	x			x
Herb	Tall everlasting	*Antennaria anaphaloides*	Tall everlasting	4					x

Table F.1.9-1 Traditional Ecological Knowledge Vegetation Valued Component Species Identified in the Local Study Area

Life Form	Name			Number of occurrences in LSA[1]	First Nations Identified VCs				
	Provided TEK	Scientific	Common		Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN
Herb	Heart-leaved arnica	*Arnica cordifolia*	Heart-leaved arnica	42					x
Herb	Balsamroot	*Balsamorhiza sagittata*	Balsamroot	4					x
Herb	Thistle	*Cirsium edule*	Edible thistle	1				x	
Herb	Bear root or Indian potato	*Heracleum lanatum*	Cow parsnip	18		x		x	
Herb	Dandelion	*Taraxacum officinale*	Common dandelion	14		x			x
Grass	Common sweetgrass	*Hierochloe hirta*	Sweet grass	6				x	
Lichen - ground	Buffalo horn lichen	*Cladonia* spp. (n=20 species)	Cladonia	156				x	
Lichen	Tree lichen	*Letharia vulpina*	Wolf lichen	47	x	x		x	
Lichen - epiphyte	Tree lichen	*Usnea* and *Bryoria* spp. (n=8 species)	Old man's beard	55	x	x		x	
Shrub	Buffalo berries	*Shepherdia canadensis*	Canada buffaloberry	X[2]		x			
Forb	Prairie crocus	*Anemone patens*	Prairie crocus	X[2]		x			
Forb	Paintbrush plants	*Castilleja miniata*	Common red paintbrush	X[2]		x			

Table F.1.9-1 Traditional Ecological Knowledge Vegetation Valued Component Species Identified in the Local Study Area

Life Form	Name			Number of occurrences in LSA[1]	First Nations Identified VCs				
	Provided TEK	Scientific	Common		Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN
Additional Species Noted in First Nation TEK Reports									
Tree	Birch	*Betula* sp.	Birch	-	x	x			
Tree	Choke cherry	*Prunus virginiana*	Choke cherry	-		x			
Shrub	Poison ivy	*Rhus radicans*	Poison ivy	-		x			
Shrub	Lingonberry	*Vaccinium vitis-idaea*	Lingonberry, northern mountain cranberry	-				x	
Shrub	Muskeg tea	*Ledum groenlandicum*	Labrador tea	-		x		x	
Forb	Alpine fern	*Woodsia alpina*	Alpine fern	-	x				
Forb	Wild licorice	*Glycyrrhiza lepidota*	Wild licorice	-		x			
Forb	Mountain holly fern	Note: this common name is not known to occur in Alberta, identification not confirmed			x				
Bryophyte	Moss			-	x			x	
Bryophyte	Dry tree moss			-		x			
Bryophyte	Moist ground moss			-		x			
Fungus	Mushrooms			-		x			
Fungus	Tree fungus			-				x	
Tree	Tamarack	*Larix laricana*	Tamarack, larch	-		x			

Table F.1.9-1 Traditional Ecological Knowledge Vegetation Valued Component Species Identified in the Local Study Area

Life Form	Name			Number of occurrences in LSA[1]	First Nations Identified VCs				
	Provided TEK	Scientific	Common		Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN
	Lay-down root			-		x			
Forb	Wild onion	*Allium textile*	Prairie onion	-		x			
Shrub	Goose berries	*Ribes spp.*	Gooseberry	-		x			
Shrub	wolfwillow	*Elaeagnus commutata*	Wolf willow, silver-berry	-		x			

[1] Number of observations during the vegetation surveys of the LSA.

[2] Vegetation Species Identified in the LSA

Source: Updated Assessment on the Potential Effects of the Grassy Mountain Project on Indigenous Peoples, Appendix 4.1-1 (JRP IR-4.1)

F.2 CONSERVATION & RECLAMATION PLANNING

F.2.1 Environmental Assessment

Throughout the proposed Mine Permit and the surrounding region, there is evidence of disturbance from historical underground and surface mining activities. These legacy mine disturbances shown in Figure F.2.1-1 and Figure F.2.1-2 were created in the early 1900's to the mid-1960's, and little to no environmental mitigations or reclamation measures were implemented. The potential impacts from these legacy activities have been substantial in the form of erosion and sedimentation and continue to this day. Recent short-term mitigation measures have been implemented by Benga that include surface water management and erosion and sediment control mitigations. Based on this historical disturbance, it is Benga's intention during mining operations and at closure, to include all the legacy Grassy Mountain mining areas in the mitigation measures planned for the entire Project. This will result in an overall net positive improvement in the current conditions on Grassy Mountain and its associated watersheds.

To support the development of the C&R Plan, a baseline assessment was conducted for the Project and an inventory of baseline conditions was prepared. In addition to the baseline conditions, anticipated Project related impacts were assessed and mitigation proposed. Supporting information

for this C&R Plan was sourced from the consultant reports (CR) and any relevant Addendums to the Project submission on the following topics:

- Hydrogeology;
- Hydrology;
- Surface Water Quality;
- Fisheries;
- Terrain and Soils;
- Vegetation and Wetlands;
- Wildlife;
- Land and Resource Use; and
- TEK and Land Use.

F.2.1.1 Hydrogeology

The baseline study was completed based on a literature review and field investigations. A field program was completed with the installation of 19 monitoring wells at five locations (which have been sampled monthly for water chemistry and depths), and installation of nested vibrating wire piezometers on seven geotechnical boreholes, testing of artesian wells, sampling of springs and groundwater discharge points, completion of a water well survey and supplemental sampling of surface waterbodies.

Benga has a geological database that contains over 450 drill holes that were used to develop a groundwater model for the Project. This information has provided a valuable understanding of the groundwater resource and contributions to the local watershed.

F.2.1.2 Hydrology

The Project is located within the Blairmore Creek and Gold Creek watersheds, east of the Rocky mountain range. Blairmore Creek and Gold Creek collect runoff from an upstream area of 50 km² and 60 km² respectively and both discharge into Crowsnest River. The Crowsnest River connects to the Oldman River watershed, which flows into the Saskatchewan River, and ultimately discharges into Lake Winnipeg.

Six hydrometric stations were established in the Blairmore Creek drainage, three stations were established in the Gold Creek drainage and another was set up on the Crowsnest River. These were established to measure the local flows for the Project. In addition to the local hydrometric stations being established, 18 regional meteorological stations and 8 regional hydrological stations were used to refine site specific hydrology parameters for the Project.

The legacy mining activities that are present in the Project area currently have a negative impact on the local hydrology and receiving waters during spring freshet and during intense rainfall events. Incorporation of these into the proposed development will improve current conditions by capturing and managing this previously uncontrolled runoff.

All surface water that enters the active mining area and all groundwater that reports to the pit will be captured, collected and managed. It will be removed from the active mining areas using a series of drainage ditches, sumps and pumps to transport it to one of the five sediment ponds for treatment and release to the environment. Water will be collected, treated, tested and, if suitable, discharged throughout the year which will provide flow to the main stems of Blairmore and Gold Creeks.

F.2.1.3 Surface Water Quality

With the Project being located within three important local drainages (Gold Creek, Blairmore Creek, Crowsnest River), particular attention was given to developing a robust surface water management program. Baseline surface water sampling was completed in each of these three drainage basins with some additional sampling completed in their tributaries.

The legacy mining activities currently have a negative impact on the local water quality during spring freshet and during intense rainfall events. Incorporation of these into the proposed development will improve current conditions by capturing and managing this previously uncontrolled runoff which has not been monitored or measured since the closure of mining activities in the early 1960's.

Surface runoff and rainfall that percolates into the external rock disposal areas are expected to contain selenium concentrations that will require further management prior to release to the environment. Water from these areas will be collected in surge ponds that will not be released immediately to the environment. A selenium management plan has been developed to address this potential water quality/aquatic issue.

F.2.1.4 Fisheries

Considerable effort in the design of the Project was completed to ensure the pit, external rock disposal areas and infrastructure did not directly impact Blairmore Creek, Gold Creek, or the Crowsnest River. No direct disturbance or impact will occur to any of these watercourses, which are all fish bearing. Benga has completed and continues to collect fisheries (fish and fish habitat) data on Blairmore Creek and Gold Creek, which includes, but is not limited to detailed habitat mapping, benthic invertebrate sampling, sediment quality analysis, and a comprehensive fish population assessment. Both Blairmore Creek and Gold Creek are fish bearing and contain populations of brook trout, cutthroat trout, and westslope cutthroat trout, which is a *Species at Risk Act* (*SARA*) (Government of Canada 2015) Schedule 1 listed fish species.

There have been observations indicating that the legacy mining activities continue to provide a source of coal fines (from historical coal slack piles) into Gold Creek (and potentially Blairmore Creek) during times of intense rainfall (*i.e.,* during spring freshet and/or during intense rainfall events). These historical coal slack piles occur at high elevations on Grassy Mountain's east facing slopes, and in some areas along the Gold Creek streambank (*e.g.,* one such pile exists near the historic town of Lille). For the areas of potential deposition into Gold Creek at higher elevations, Benga has implemented sediment and erosion control measures to prevent further deposition. To mitigate this potential coal fine source, reclamation of the legacy mining activities has been incorporated into this C&R Plan. In addition to this C&R Plan, Benga are committed to help initiate and fund a collaborative grassroots stewardship program for the Gold Creek watershed aimed at improving critical habitat for westslope cutthroat trout from present state to help support species recovery.

F.2.1.5 Terrain and Soils

The Project is located primarily within Soil Correlation Area (SCA) 16. Mineral landscapes are largely comprised of till and colluvium, often occurring over shallow bedrock (Pedocan, 1993). Surficial deposits within the soil LSA and RSA are composed mainly of colluvial or leached Cordilleran till and alluvial deposits. Landform type and spatial distribution are closely linked to the physiography of the region.

Upland areas are dominated by Brunisols and Regosols with Luvisols in lower elevations; sporadic occurrence of Chernozems, and Organics are common in poorly drained areas. A soil survey covering the entire Project has been completed based on soil and terrain information obtained during the 2014 field season. A considerable area (185.2 ha) within the proposed pit development was previously mined or disturbed by legacy mining activities as shown in Figure F.2.1-1. There are no soil resources present within these previously mined areas.

All soils present with the Project area have been mapped for soil location, type, thickness and quality. Soil suitability for reclamation was rated as part of the assessment. The following summary is provided:

- A horizons ranged from fair (F) to unsuitable (U) as reclamation growth media;
- B horizons ranged from good (G) to unsuitable (U) as reclamation media; and
- BC and C horizons ranged from good (G) to unsuitable (U) as reclamation media.

All soil will be salvaged as reclamation material (Figure F.2.1-3), as per the Terms of Reference (ToR) and stored for reclamation purposes.

Upland surface soil is a stratum salvaged from an upland soil that includes the forest floor A horizon and in some cases part or all of the B horizon (AEW, 2012), and is referred to as reclamation material

in the ToR (Section 3.2.8[A]h). Salvage of upland surface soil is not constrained by soil chemistry, however handling concerns (*e.g.,* extremely steep slopes) do exist. The salvaged reclamation material will be replaced across the final reclaimed Project landscape.

A majority of landscapes within the Project footprint are colluvium/bedrock controlled. Soils developed in this environment are usually juvenile with little or no profile development. The upland areas have thin leaf litter and A horizons. Salvage of part or all B horizon is recommended to meet the reclamation materials balance requirements. The risk of degrading the quality of the reclamation material by salvaging the deeper substrates is minimal, largely due to it being of very similar quality.

The soil material has been rated for its reclamation suitability as shown in Figure F.2.1-4. Assumptions were used to estimate the post disturbance soil physical and chemical regimes which include:

- Salvaged soil will consist of a mixture of mineral A and B horizons and overlying litter material, referred to as "upland surface soil".
- Chemical and physical characteristics of the mineral A and B horizons were blended in interpretative calculations to simulate reclamation material salvage and placement activities during construction.

Table F.2.1-1 shows reclamation suitability of A and B horizons separately as well as blended together.

Table F.2.1-1 Reclamation Suitability Ratings for Soil Models for A Horizons, B Horizons and blended A and B Horizons (possible reclaimed soils)

Soil Model (SM)	Reclamation Suitability Ratings		
	A horizon	B Horizon	A+B Horizons (blended)
CON5	P	P	P
DNL1	-	-	-
FVCP16	P	G-F	G-P
FVCP4	P	G-F	G-P
FVHE4	P	F	F-P
FVNK16	P	F	P
FVRD5	P	F	P
FVX4	P	F	P
FVXfi11	P	F	P

Table F.2.1-1 Reclamation Suitability Ratings for Soil Models for A Horizons, B Horizons and blended A and B Horizons (possible reclaimed soils)

Soil Model (SM)	Reclamation Suitability Ratings		
	A horizon	B Horizon	A+B Horizons (blended)
HDFR18	-	U	U
HDTB18	U	-	U
MTF20	-	-	-
NKRD1	P	-	P
NS	-	-	-
SPgrWL1	F	G-P	F
SPLT4	G-F	F	G-F
SPR1	F	F	F
SPRgr1	F	P	F
TUCD1	G-U	G	G-P
ZDL	-	-	-
ZWA	-	-	-

All soils have similar reclamation suitability ratings for A horizons and blended A and B horizons.

Approximately 3.3 million m^3 of reclamation material is available to be salvaged which will facilitate an average reclamation material replacement depth of 20 cm on reclaimed lands. All legacy mining disturbance located within the project development will be reclaimed, will have reclamation material replaced and will be revegetated. Reclaiming the legacy mining disturbances will result in an improvement over pre-disturbance conditions.

Land capability for the disturbance area has been catalogued by rating the Soil Map Units (SMUs) according to *Forest Land Capability Classification for the East Slopes Area, Alberta* (Duffy and Nemeth, 1969). This classification system was used to evaluate the soils based on soil and landscape features such as climate, relief, soil conditions and erosion. Rating is adjusted by "limiting factors" as determined in the classification system. Applicable limiting factors include restriction of rooting zone by bedrock, exposure, excess soil moisture, stoniness and elevation. The capability classes are based on mean annual increment and range from Class 3 (the best conditions possible) to Class 7 (marginal for forest production).

Baseline land capability classification has been provided in Figure F.2.1-5 and reclaimed ratings are presented in Figure F.2.1-6. Comparison of the baseline and reclaimed land capability ratings for the

Project footprint are provided in Table F.2.1-2. Post reclamation land capability will be similar or better than ratings determined for the pre-disturbance soil map units.

Table F.2.1-2 Comparison of the Pre-Disturbance and Reclaimed Land Capability Ratings for the Project Footprint

Capability Class	Pre-disturbance Capabilities		Reclaimed Capabilities		Difference (%)
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)	
4	33.6	2.3	57.3	3.9	1.6
4-5	123.2	8.3	426.6	28.8	20.5
4-6	27.1	1.8	877.4	59.2	57.4
5	1.7	0.1	1.7	0.1	0.0
5-6	325.0	21.9	63.8	4.3	-17.6
5-7	679.5	45.9	-	-	-45.9
6	3.5	0.2	-	-	-0.2
7	287.5	19.4	35.8	2.4	-17.0
NA[1]	0.1	<0.1	18.4	1.2	1.2
TOTAL[2,3]	**1,481.0**	**100**	**1,481.0**	**100**	**-**

Dash (-) there are no occurrences of a particular land capability class

[1] Open Water, Post-closure lake

[2] Due to rounding, total values may not equal the sum of the individual values

[3] Area of Proposed Golf Course Development and Helipad Access Areas totalling 39.7 ha is not included

F.2.1.6 Vegetation and Wetlands

A detailed vegetation and wetlands assessment was completed on the project disturbance area in 2014 which was supplemented in the spring of 2016 to provide more information on the abundance and distribution of foothills rough fescue, whitebark pine and limber pine within the Project Footprint. The assessments included:

- vegetation communities;
- rare plants and rare plant communities;
- rangeland resources;
- forest resources;
- old growth forests;

- TEK vegetation resources;
- wetlands;
- biodiversity and fragmentation;
- noxious and invasive species; and
- potential acid input and nitrogen deposition.

The Montane and the Subalpine Natural Subregions occupy 518.8 ha and 523.9 ha of the Project Footprint, respectively. The proposed golf course development and helipad access areas are considered "*incidental physical activities*" (CEAA 2016) and will be owned and operated by the Crowsnest Pass Golf and Country Club and the Department of Agriculture and Forestry, respectively, who will have the construction and reclamation responsibility for these lands. These lands make up 39.7 ha of the Project Footprint, of which 35.0 ha is private land, exclusively within the Montane Natural Subregion.

Within the Project Footprint, 16 ecosite phases were mapped in the Montane and 8 in the Subalpine. The dominant ecosite phases mapped in the Montane Subregion are d2 – creeping mahonia-white meadowsweet Pl (187.7 ha, 12.3% of Project Footprint), e1 – thimbleberry/pine grass Pl (160.6 ha, 7.0%), and c4 – Canada buffaloberry/hairy wild rye Aw-Sw-Pl-Fd (55.0 ha, 3.6%). In the Subalpine Subregion, the dominant ecosite phases are e1 – false azalea-grouseberry Pl (353.4 ha, 23.2%), f1 – thimbleberry Pl (32.0 ha, 2.1%), and B1 – bearberry/hairy wild rye Pl (48.1 ha, 3.2%).

The Project footprint occupies 1,520.7 ha, which removes 1,039.5 ha of upland ecosite phases, 3.2 ha of lowland ecosite phases, 163.2 ha of grassland open forest area, less than 1 ha of open water, 28.0 ha of barren land, and 274.2 ha of anthropogenic disturbance which includes 185.2 ha of legacy mining disturbance. The legacy mining is currently largely disturbed without vegetation.

Whitebark pine (*Pinus albicaulis*) has been identified within the Project Footprint and is designated as an endangered species in the *Alberta Wild Species General Status Listing - 2010* (AESRD 2010a) and is a *SARA* listed Schedule 1 species in the provinces of Alberta and British Columbia. The objectives and strategies of the Alberta whitebark pine recovery plan (WBP Recovery Plan), established by the Alberta Whitebark and Limber Pine Recovery Team (2014a), will be implemented as further detailed in subsequent sections of this report.

Foothills rough fescue (*Festuca campestris*) has also been identified within rangelands located within the Project Footprint and is protected under a provincial Protective Notation due to its known sensitivities to disturbance (Desserud 2006). A mitigation plan that outlines revegetation strategies designed to promote the re-establishment of foothills rough fescue is provided in Section F.3.2-1.

Project development will remove approximately 1,042.8 ha (28.5% decrease from baseline) of ecosite phases that support TEK vegetation potential. Traditional use plants have a high potential to occur within Montane c1, c4, g1, and Subalpine d1 ecosite phases. These include approximately 102.4 ha (27% decrease from baseline) of high TEK potential in the Montane Natural Subregion and 0.8 ha (100% decrease from baseline) of land with very high TEK potential in the Subalpine Natural Subregion. Species with very high or high TEK potential that will be impacted include lodgepole pine, prickly rose, ground juniper, willow, aspen, balsam poplar, Saskatoon, thimbleberry, bearberry and dwarf birch. These species are incorporated into the revegetation planning for the Project.

Timber productivity rating and timber volumes for the Project footprint were provided as part of the vegetation assessment in the EIS and are discussed in Section F.3.3 in the Timber Management Plan. The estimated merchantable timber volume to be removed during Project development includes 122,463 m^3 coniferous timber and 10,692 m^3 deciduous timber volume for a total of 133,155 m^3. The project will result in a 72,153 m^3 drain against the timber dispositions held on public lands which is approximately 34% of the AAC for the C5 forest management unit. There is an additional 60,741 m^3 on private lands. The majority of timber volume within the Project footprint is lodgepole pine. All whitebark pine will be salvaged as well and are part of the total volume. Mitigation for potential Project impacts on forest resources are the salvage of merchantable timber where practicable and implementation of recommended best practice methods described for soil handling and placement, tree species selection, tree planting and periodic monitoring.

Wetlands were found on 16.9 ha of the vegetation LSA. Shrubby open fens (FONS) (11.2 ha) were the most dominant wetland type, followed by treed swamps (STNN) (4.8 ha), open water less than 2 m deep (0.5 ha), and open graminoid marshes (MONG) (0.4 ha). Project development will result in the removal of 9.7 ha of wetlands including 9.6 ha of FONS, and less than 0.1 ha each of MONG and WONN. None of these wetland types will be completely removed from the LSA.

Potential effects to vegetation and wetlands as a result of the Project will be mitigated through revegetation activities, including all the previously disturbed legacy mining areas. Wetlands will be targeted in the remnants of the sediment and surge ponds. The revegetation activities will be aimed at the long term establishment of vegetation communities and wetland types characteristic to the Montane and Subalpine Natural Subregions.

F.2.1.7 Wildlife

One of the goals of the land reclamation program is the return of wildlife habitat and maintaining or increasing wildlife populations, with emphasis on providing suitable habitat for wildlife considered to be valued components to the public and Indigenous groups. Wildlife surveys for the Project were completed to determine the status of the wildlife assemblages present in the area and to inventory the

types and extent of wildlife habitat. The legacy mining disturbances were included in the baseline assessment and contributed little to the effective habitat.

The impact assessment completed as part of the wildlife assessments provided recommendations for mitigation for Project impacts to the wildlife assemblages and wildlife habitats in the Project development area. This included reclamation of the legacy mining disturbance, which results in an improvement of habitat conditions.

Potential Project effects to wildlife and wildlife habitat will be mitigated by the establishment of suitable wildlife habitats in the reclaimed landscape. Refer to Section F.2.5 for a summary of wildlife and wildlife habitat mitigations that have been included in the reclamation planning.

F.2.1.8 Land and Resource Use

The land and resource uses that occur in the proposed development area were assessed to identify how development of the proposed mine may impact those uses and to recommend mitigation measures to reduce impacts to either existing or potential land and resource uses.

In order to minimize the potential direct impacts of the proposed Project development on other land and resource users in the area, Benga will undertake the following:

- progressive reclamation, and reclaim the area to a landscape that includes provisions for a variety of land uses, including forestry, wildlife habitat, grazing, recreational use, *etc.*; and
- monitor changes in land use policies and initiatives and, through adaptive management, incorporate new requirements into the ongoing reclamation plans.

F.2.1.9 Traditional Ecological Knowledge and Land Use

Consultation and discussions with Indigenous groups resulted in a number of recommendations for the Project. Key recommendations include:

- allow annual access to the site and surrounding lands for traditional harvesters;
- provide access to harvest lodgepole pine and other vegetation ahead of mine development;
- provide one-year notice when pine stands may be cleared and where possible lodgepole pine should be harvested in the spring when they have more sap and are easier to peel;
- restore habitat so that moose, elk, deer, and other wildlife may return to the land, without grass there is nothing for moose and elk to eat;
- monitor to see what wildlife is present and use that to assess the health of the land;
- consider creating habitat suitable for bison should they be re-established in the area in the future;

- remediate the damage done by previous mine owners;
- protect the streams and water during development;
- harvest and greenhouse important plants to return them to the land with reclamation;
- protect HRIA sites DjPo-98 and DjPo-130 and reintegrate them into the final landscape as valued cultural sites; and
- include the local communities in developing the final reclamation plans.

F.2.2 Reclamation Schedule

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.

Reclamation will be undertaken in sequential steps as mining operations are completed. These steps and general timing are illustrated in Table F.2.2-1.

Table F.2.2-1 Reclamation Schedule Upon Completion of Mining Activities

Reclamation Activity	Timing
Terrestrial Reclamation:	
Resloping/ Reclamation material placement	Year 0
Initial revegetation	Year 1
Fertilizing	Years 1 – 3
Woody species planting	Years 2 – 4
Biophysical monitoring	Years 1 – 12
Reclamation certification	Year 15 – 20
Release back to Crown	Site-dependent
Lake Reclamation:	
Resloping & channel construction	Year 0
Final water line reached	Site-dependent
Revegetation:	Year 1 – 4

The final reclaimed landscape will consist of 1,462.6 ha of reclaimed lands (Table F.2.2-2); 18.4 ha will remain as the end pit lake (as discussed in Section F.3.6.4), and 39.7 ha will convert to recreational land use. The land use change is due to the proposed golf course development area and alternate helipad access road being identified as *"incidental physical activities"* associated with the development

of the Project. It is assumed that the Crowsnest Pass Golf and Country Club will be responsible for construction, operation and reclamation of these components. They will follow industry best practices for preservation of reclamation materials and will target an equivalent land capability which will be a conversion of end land use to recreational land use.

The detailed site development, disturbed areas and reclamation areas are shown yearly on the annual mine status maps and are summarized in Table F.2.2-2. The maximum Project spatial disturbance will occur in Year 14 with no additional spatial disturbance to follow, and the reclamation closure scenario where the majority of the reclamation is completed will occur in Year 27. At full closure the water management surge ponds (to manage selenium) will be decommissioned and removed from the plan. This will occur when the selenium levels in these ponds are below the release criteria.

Upon completion of mining and backfilling, reclamation activities can commence. This process begins with resloping/recontouring slopes (to a maximum slope angle of 23°), replacement of reclamation material, revegetation and finally reforestation. Reclamation material will be replaced through direct placement techniques when available or will be hauled from reclamation material stockpile areas. Areas will be revegetated depending on the slope class of the reclaimed area and the desired ecological unit (Section F.3.6).

The 2.1 ha Construction Camp will be reclaimed by Year 1 and the first mine area that will be ready to reclaim is in Year 2, located within the South Rock Disposal Area (SRDA) (Figure F.3.6-1). This area will be eligible to have reclamation material directly placed from the active mining area on the north edge of the mine and will be revegetated. Additional areas of the SRDA will be reclaimed on an annual basis until final reclamation of this area is complete in Year 13.

In Year 5, reclamation will commence on the Central Rock Disposal Area (CRDA) and in an area immediately north of the processing plant as shown on Figure F.3.6-1. These areas contribute to the 64.2 ha of land reclaimed by the end of Year 5. These reclamation areas progress towards each other before resulting in a total reclamation area of 155.2 ha in Year 7 (Figure F.3.6-2) that encompasses the southernmost tip of the pit and portions of the CRDA and SRDA adjacent to the powerline right of way and along the east Project Footprint boundary.

Reclamation commences along the northwest edge of the North Rock Disposal Area (NRDA) in Year 11 (Figure F.3.6-3) and contributes to the 292.0 ha of reclaimed land across the mine within the rock disposal areas and the southern portion of the pit by Year 11 (Figure F.3.6-3). The total reclaimed area of the mine progresses annually from each of these reclaimed areas with the reclamation of the CRDA being completed in Year 20, the NRDA in Year 22, and the remaining pit area the year following mine closure in Year 24 (Figures F.3.6-5 and F.3.6-6).

The available mine area to be reclaimed will increase annually through mine closure to Year 24 (Figure F.3.6-6) at which point 1,090.4 ha of Benga's 1,462.6 ha reclamation responsibility will be reclaimed. In Year 25, 206.8 ha of reclamation will be conducted in the areas of the end pit lake and the processing plant. Reclamation will continue beyond mine closure to Year 27 at which point all but 32.2 ha associated with the Selenium Management System will have been reclaimed. The remaining areas will have final surface reclamation completed once the surge ponds have measured selenium levels that are within allowable discharge limits and can be released to the environment without further treatment. Once no longer needed, the surge ponds will be removed and reclaimed. At final closure (end of reclamation), all 1,462.6 ha of Benga's reclamation responsibility will be reclaimed, 18.4 ha will remain as end pit lake, 38.1 ha will remain as the proposed golf course development and 1.6 ha will remain as the proposed helipad access.

The reclamation program will result in the formation of a mosaic of reclaimed areas with multiple end land uses across the mine site. This process allows for the earliest reclamation possible, thereby reducing erosion and increasing the opportunities for direct placement of reclamation material and storing less in stockpiles.

Reclamation certification will be requested when a block of land has achieved the required vegetation cover, landform stability and overall performance criteria. There will be several years between the time that initial reclamation work is completed and the time that tree survival and growth have met the standards set in the evaluation criteria. All reclaimed lands will achieve equivalent capability and lands owned by the crown will be returned to the crown once they have been certified and are no longer required for the Project. Additional details of the mining, reclamation schedule and reclamation material handling are shown in Table F.2.2-2 and provided in Sections F.3 and F.4.

Table F.2.2-2 Annual Reclamation Material Balance of Mining Areas

Mine Year	Disturbance Area[1] (ha)	Cumulative Disturbance Area (ha)	Soil Stripping Area (ha)	Salvaged Deep Organics Volume (m^3)	Salvaged Upland Surface Soil Volume (m^3)	Total Salvaged Reclamation Material (m^3)	Reclamation Area[1,2] (ha)	Cumulative Reclamation Area (ha)	Reclamation Material Replacement Volume[3] (m^3)
Y00	625.1	625.1	537.2	155,088	1,458,562	1,613,649	0	0	0
Y01	93.0	718.2	74.1	-	238,528	238,528	1.9	1.9	3,846
Y02	101.2	819.4	81.1	10,822	189,173	199,995	17.4	19.4	34,890
Y03	124.6	944.0	83.2	164,138	208,596	372,734	19.6	39.0	39,197
Y04	62.0	1,006.0	21.6	-	75,560	75,560	10.0	49.0	20,006
Y05	223.9	1,229.8	156.5	-	440,697	440,697	15.3	64.2	30,550
Y06	61.6	1,291.5	32.0	-	97,599	97,599	19.2	83.4	38,349
Y07	56.6	1,348.1	32.8	-	67,678	67,678	71.8	155.2	143,515
Y08	51.6	1,399.7	26.2	-	78,419	78,419	61.4	216.6	122,804
Y09	0	1,399.7	0	-	-	-	21.1	237.7	42,148
Y10	0	1,399.7	0.0	-	-	-	24.1	261.7	48,124
Y11	25.6	1,425.3	19.2	-	64,916	64,916	30.3	292.0	60,574
Y12	0	1,425.3	0	-	-	-	35.7	327.7	71,436
Y13	0	1,425.3	0	-	-	-	112.3	440.0	224,653
Y14	55.8	1,481.0	38.2	-	99,933	99,933	23.4	463.4	46,731
Y15	0	1,481.0	0	-	-	-	27.2	490.7	54,499
Y17	0	1,481.0	0	-	-	-	13.2	503.9	26,492

Table F.2.2-2 Annual Reclamation Material Balance of Mining Areas

Mine Year	Disturbance Area[1] (ha)	Cumulative Disturbance Area (ha)	Soil Stripping Area (ha)	Salvaged Deep Organics Volume (m^3)	Salvaged Upland Surface Soil Volume (m^3)	Total Salvaged Reclamation Material (m^3)	Reclamation Area[1,2] (ha)	Cumulative Reclamation Area (ha)	Reclamation Material Replacement Volume[3] (m^3)
Y18	0	1,481.0	0	-	-	-	11.5	515.4	23,035
Y19	0	1,481.0	0	-	-	-	111.2	626.7	222,499
Y20	0	1,481.0	0	-	-	-	104.3	730.9	208,512
Y21	0	1,481.0	0	-	-	-	140.7	871.6	281,403
Y22	0	1,481.0	0	-	-	-	40.9	912.5	81,716
Y23	0	1,481.0	0	-	-	-	17.6	930.1	35,204
Y24	0	1,481.0	0	-	-	-	160.3	1,090.4	320,580
Y25	0	1,481.0	0	-	-	-	206.8	1,297.1	413,516
Y26	0	1,481.0	0	-	-	-	0	1,297.1	0
Y27	0	1,481.0	0	-	-	-	133.3	1,430.5	266,654
EOR	0	1,481.0	0	-	-	-	32.2	1,462.6	64,324
Grand Total		**1,481.0**	**1,102.0[4]**	**330,047**	**3,019,660**	**3,349,707**	**1,462.6**	**1,462.6**	**2,925,256**

[1] –Area of Proposed Golf Course Development and Helipad Access areas totalling of 39.7 ha is not included in material balance calculation

[2] – Proposed area of post-closure lake totaling approximately 18.4 ha is not included into reclamation area

[3] – Reclamation Material replacement depth of 20 cm used for all areas. Surplus material will be used to enhance reclamation of the land disturbed for the Project.

[4] – Soil stripping area differs from cumulative disturbance area due to previous disturbances, open water, and steep slopes.

F.2.3 Conservation and Reclamation (C&R) Assumptions

The C&R Plan was developed using several key assumptions regarding closure planning, detailed reclamation planning, end land uses and final certification and release of certain lands back to the Crown, including the following:

- changes to the mine plan will require modification of the reclamation and closure plans;
- the probability of design changes to the mine and closure plans increases over time and changes are therefore expected;
- the design of the closure landscape will be integrated with the surrounding undisturbed terrain;
- the design of the closure landscape will be stable with self-sustainable drainage patterns;
- uncertainties in the closure planning process include the long-term performance of vegetation communities and capability to return landscape biodiversity;
- 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;
- the C&R Plan provided is conceptual in nature due to the evolutionary nature of mine technology development, mine planning and reclamation planning;
- reclamation practices used by other regional coal mine operators and information gained from the EIA are used as the foundation of the Project's reclamation planning;
- current soil handling practices provide the basis for soil reconstruction and revegetation practices;
- reconstructed soil performance will mimic natural soils over time;
- the revegetation program will be guided by information gained by the EIA, and by input from public engagement and Indigenous consultation; and
- target vegetation communities identified in the C&R Plan are conceptual in nature and it is recognized that it is not currently possible to accurately predict ecosystem succession over time.

F.2.4 Reclamation Planning for Biodiversity

The construction and operation stages of the Project will result in the removal of vegetation, and a temporary reduction of native species diversity in the Project Footprint. The ecosite phases impacted by Project development have mostly moderate to high biodiversity potential. After mine closure and reclamation, native species richness is expected to be lower than the intact naturally developed vegetation, with the exception of the 185.2 ha of previously disturbed land on the Project Footprint,

which will result in an improvement over pre-development conditions. Over time, species and community diversity will improve across the reclaimed Project Footprint and landscape.

The re-establishment of species and landscape level biodiversity on reclaimed areas will depend on several factors such as terrain design, soil handling procedures, revegetation plans and the establishment of the drainage system. The reclaimed landscape will increasingly resemble pre-development conditions as the landscape matures and evolves.

The reclamation program designed by Benga will focus on the re-establishment of key species and communities that will promote additional species diversity, community structure, and ecological function in the reclaimed areas of the Project. These communities will emulate the landscape diversity of natural analogues in the area.

There are numerous mechanisms that can be used to enhance the biodiversity of the reclaimed landscape. These include:

- direct placement of salvaged soil (with propagules) from new mining areas as much as is practicable;
- establishing self-sustaining drainage patterns;
- re-establishing native species by planting native trees (including whitebark and limber pine), native shrub species, and native graminoids to provide structural diversity, wildlife habitat and wildlife browse;
- 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;
- creating a micro-hummocky surface that enhances moisture by using rough soil replacement techniques to unevenly spread soil on the recontoured surfaces; and
- managing for introduced or invasive species.

Monitoring for biodiversity will be conducted as part of the vegetation monitoring to identify species, overall health, and to measure progress towards reclamation targets.

A detailed management system for monitoring biodiversity will be developed and implemented, the timing of which is likely to be prescribed in the anticipated EPEA approval conditions. It is anticipated this plan will be appropriately developed upon receipt of an EPEA approval. Input from regional management plans will be incorporated.

F.2.5 Reclamation Planning for Wildlife

As stated in Section F.2.1.7, one of the primary goals for the reclamation program is the return of wildlife habitat. The mitigations proposed in the impact assessment completed for the wildlife assessment were considered in the reclamation planning for the Project.

Reclamation ecological communities established to provide habitat for TLU wildlife species utilization are presented in Table F.2.5-1.

Table F.2.5-1 Wildlife Identified by Indigenous Groups

Wildlife Species	Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN	Reclaimed Ecological Unit	Samson Cree Nation	Metis Nation of Alberta	Metis Nation of BC
Birds									
Owl	x	---	---	---	---	Closed Conifer Forest, Mixed Forest	---	---	---
Woodpecker	---	x	---	-	---	Closed Conifer Forest, Mixed Forest	---	---	---
Wild turkey	---	x	---	---	---	Grassland Open Forest	---	x	---
Crow	---	x	---	---	---	Grassland Open Forest, Mixed Forest, Closed Conifer Forest	---	---	---
Golden eagle	x	x	x	x	---	Barren land, open water	---	---	---
Sprague's pipit (out of range)	---	---	---	---	---	n/a	x	---	---
Prairie chicken (out of range, extirpated)	---	---	---	---	---	n/a	---	---	---
Marten	---	---	---	---	x	Closed Conifer Forest	---	---	---
Grouse	x					Mixed Forest	x	x	x
Furbearers									
Bear	x	x	---	---	x	Closed Conifer Forest, Grassland	x	x	x

Table F.2.5-1 Wildlife Identified by Indigenous Groups

Wildlife Species	Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN	Reclaimed Ecological Unit	Samson Cree Nation	Metis Nation of Alberta	Metis Nation of BC
						Open Forest, Mixed Forest			
Cougar	---	x	---	---	---	Grassland Open Forest	x	---	---
Lynx	---	---	---	---	x	Closed Conifer Forest, Mixed Forest	x	---	---
Wolf	x	x	---	---	---	Closed Conifer Forest, Mixed Forest	x	---	---
Wolverine	---	---	---	---	---	Closed Conifer Forest, Mixed Forest, Barren Land	x	---	---
Coyote	---	---	---	---	x	Closed Conifer Forest, Grassland Open Forest, Mixed Forest, Barren Land	---	---	---
Porcupine	x	---	---	---	---	Closed Conifer Forest, Mixed Forest	---	---	---
Beaver	x	---	x	---	x	Open Water, Mixed Forest	---	---	---
Otter (extirpated)	x	---	---	---	---	n/a	---	---	---
Gopher	x	---	---	---	---	Grassland Open Forest	---	---	---

Table F.2.5-1 Wildlife Identified by Indigenous Groups

Wildlife Species	Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN	Reclaimed Ecological Unit	Samson Cree Nation	Metis Nation of Alberta	Metis Nation of BC
Badger	x	---	---	---	---	Grassland Open Forest	---	---	---
Mink	---	---	---	---	x	Treed Wetland, Open Water	---	---	---
Rabbit	x	x	x	-	---	Closed Conifer Forest, Mixed Forest	---	---	x
Squirrel	x	x	---	---	x	Closed Conifer Forest, Mixed Forest	---	---	---
Skunk	---	---	---	---	---	Closed Conifer Forest, Mixed Forest, Grassland Open Forest	x	---	---
Mice/Small rodents	---	---	x	---	x	Closed Conifer Forest, Mixed Forest, Grassland Open Forest, Treed Wetland, Anthropogenic	---	---	---
Ungulates									
Buffalo (extirpated)	x	x	x	x	---		---	---	---
Moose	x	x	x	x	x	Closed Conifer Forest, Mixed Forest, Open Water, Treed Wetland	x	---	x

Table F.2.5-1 Wildlife Identified by Indigenous Groups

Wildlife Species	Piikani Nation	Kainai Nation	Siksika Nation	Tsuut'ina Nation	Stoney Nakoda FN	Reclaimed Ecological Unit	Samson Cree Nation	Metis Nation of Alberta	Metis Nation of BC
Bighorn sheep	x	x	x	x	---	Grassland Open Forest, Barren Land	x	---	---
Mountain goat	x	---	---	---	---	Barren Land	---	---	---
Deer	x	x	x	x	x	Mixed Forest, Closed Conifer Forest, Grassland Open Forest	x	x	x
Elk	x	x	x	x	x	Grassland Open Forest, Mixed Forest	x	x	x

[1] Source: Consultation information and Updated Assessment on the Potential Effects of the Grassy Mountain Project on Indigenous Peoples (Appendix 4.1-1, JRP IR-4.1)

F.2.5.1 Ungulates

Ungulates are often used as umbrella species for reclamation to wildlife habitat because they have large home ranges, require a variety of landform features and vegetation types to fulfill their annual life requirements, and are important prey for carnivores. The provision of the habitat requirements for ungulates fulfills the habitat requirements for an assemblage of other wildlife species.

Elk and moose were identified as VCs for the Project. Both species are secure provincially, not at risk federally, known common residents of the study area, important harvest and recreation hunting species, culturally important to Indigenous groups, and prey base for large predators. Elk are known to colonize reclaimed coalmines and are indicators of grassland habitat. Moose are indicators of riparian zones, shrubland and moist forests.

Incorporating diverse wildlife habitat components is a key wildlife mitigation measure associated with the Project. The mitigation recommendations for wildlife and wildlife habitat reclamation include:

- minimize the overall disturbance footprint through the mine planning process;
- establish a variety of vegetation communities consisting of upland grasslands, shrublands, wetlands, mixed wood forest and coniferous forest;
- encourage understory complexity in the reclaimed forests by planting native shrubs such as alder and willow;
- establish a variety of vegetation communities suitable for moose, consisting of mixed wood forest and wetlands and to encourage structural complexity to the forest;
- establish willow species as they are of particular importance to moose;
- ensure that core security areas are provided for wildlife;
- maximize the direct placement of salvaged soil to enhance native plant development;
- retain slash and large woody debris in the salvaged soil to provide microsites for native plant and hide cover for wildlife;
- preserve remnant forest patches within the development areas where feasible to provide habitat, habitat connectivity and hide cover for wildlife species; and
- limit sight lines by maintaining mature forest stands as buffers between roads and reclamation areas.

Where feasible these mitigations have been incorporated in the conceptual reclamation planning for the Project.

F.2.5.2 Carnivores

Carnivores are very important indicators of the status of ecosystem development. The following carnivore VCs were identified for the Project:

- grizzly bear;
- American marten; and
- Canada lynx.

Grizzly bear, lynx, and marten, all known residents of the area, are culturally important to Indigenous groups and are affected by anthropogenic disturbances. Grizzly bears are at risk both provincially and federally and are rated as "Special Concern" by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) but are not on *Species at Risk Act* (SARA) Schedule at this time. Populations in the Castle-Livingstone region are potentially declining. Lynx are listed as "sensitive" in Alberta, are economically important for fur harvest and are an indicator of early successional forest and mine reclamation. Marten are important for fur harvest and are indicators of late successional conifer forests.

Project specific mitigations provided by the impact assessments have been incorporated into the reclamation planning. Carnivore-targeted mitigations will include:

- minimize the overall disturbance footprint through the mine planning process;
- retain slash and large woody debris in the replaced soil landscape;
- establish mixed wood forest stands;
- establish high density coniferous tree stands;
- provide understory complexity in the reclaimed forests by planting native shrubs such as alder and willow to provide security cover for the carnivores and their prey;
- plant native shrubs early in the reclamation process to initiate hiding cover;
- preserve remnant forest patches in the development areas to provide habitat, habitat connectivity and hide cover for wildlife species;
- maximize the amount of ungulate habitat;
- prior to final reclamation, disrupt linear disturbances and sight lines by mounding surface soils, piling brush; and
- limit sight lines by maintaining mature forest stands or by planting high density coniferous stands to act as buffers between roads, project disturbance boundaries and the reclaimed mine areas.

Mitigation that is specifically targeted to grizzly bears and grizzly bear habitat but also provides additional support to carnivore habitat include:

- maintaining a 100 m undisturbed forested buffer around Blairmore Creek and other riparian corridors;
- leaving patches of residual forest within and adjacent to the mine footprint; and
- commence reclamation early on in mine operations by seeding reclaimable areas with plant species favourable to grizzly bear forage and plant shrub and tree species that provide suitable cover (*e.g.*, willow, alder, coniferous trees)."

These have been incorporated in the conceptual reclamation planning for the Project.

F.2.5.3 Amphibians

The western toad and Columbian spotted frog were identified as VCs. Both species are known residents of the study area and are listed as "Sensitive" in Alberta and are vulnerable to human disturbance. The western toad is listed as "Special Concern" by COSEWIC[1], and is an indicator of wetland and aquatic habitat. The Columbian spotted frog is an indicator of aquatic/riparian habitat and relies on breeding ponds in the wildlife study area, which are of limited availability and distribution in the pre-disturbance landscape.

Overall mortality risk to amphibians from anthropogenic disturbances is low but the primary anthropogenic cause of mortality is likely to be a direct result of off-road ATV and vehicle traffic.

The mitigation measures relevant to the reclamation planning are:

- conduct monitoring to identify other habitable ponds and identify habitat requirements and constraints;
- construct trial breeding ponds;
- reclaim upland habitat adjacent to reconstructed breeding ponds; and
- avoid habitat destruction and alteration.

Benga intends to maintain sediment ponds through to reclamation before partially dewatering them to become treed wetlands. These waterbodies and wetlands will be evaluated for habitat suitability and may be developed as amphibian habitat.

[1] Western toad was originally listed as Special Concern by COSEWIC in 2002, and then put on SARA's Schedule 1 in 2005. In November 2012, the species was split into two populations, both of which were listed as Special Concern by COSEWIC. Neither population has been reassessed by SARA or placed on a SARA schedule at the time of report submission.

F.2.5.4 Birds

Two bird species were identified as VCs for the Project: olive-sided flycatcher and great grey owl.

Olive-sided flycatcher, a confirmed resident of the study area, is a species at risk both provincially and federally and is a SARA Schedule 1 species for which a federal draft recovery strategy exists. Olive-sided flycatchers are an indicator of mature coniferous and riparian forests, burned woodland, and edge habitat. They and their nest sites are protected under the *Migratory Bird Convention Act*.

Great grey owls are uncommon residents of the study area and the species is listed as sensitive in Alberta. It is an indicator of mature and old growth forests and is vulnerable to habitat loss from forestry practices. Great grey owls and their nests are protected under the *Alberta Wildlife Act*. This species is of significant cultural importance to Indigenous groups.

The mitigation measures for birds relevant to the reclamation planning are:

- where possible, vegetation clearing will be planned to avoid the April 15 to August 31 breeding bird season. If clearing is required during this period, nest surveys will be completed prior to the clearing operations to determine specific requirements to protect the wildlife resource;
- retain slash and large woody debris in the salvaged soil to provide microsites for native plants and hide cover and perches for wildlife; and
- ensure reclaimed areas promote the re-establishment of woody species and are on a trajectory for reforestation.

Disturbed areas of the mine will proceed directly to reclamation upon completion of operations for that specific area. Targeted establishment of tree species *via* tree planting or natural regeneration will promote reforestation of the Project area and the restoration of disturbed bird habitat.

F.2.5.5 Bats

In Alberta, little brown myotis are common and are likely the most abundant bat species. This species was selected as a VC for the Project. They are a known resident of the study area, are endangered federally, and are on SARA's Schedule 1. They are an indicator of mature and old growth forests and have been known to colonize old mines.

The mitigation measures for bats relevant to the reclamation planning are:

- ensure reclaimed areas promote the re-establishment of woody species and wetland vegetation and are on a trajectory for forest and wetland establishment; and
- preserving remnant forest patches within the development areas where feasible to provide habitat, habitat connectivity and roost sites for bat species.

Disturbed areas of the mine will proceed directly to reclamation upon completion of operations for that specific area. Targeted establishment of tree species *via* tree planting or natural regeneration will ensure reforestation of the Project area and the restoration of disturbed bat habitat.

F.2.6 Reclamation Planning for Vegetation

Benga intends to establish self-sustaining plant communities that are equivalent in capability to the native plant communities that occur in the area.

Since soil nutrient, moisture regime, slope, aspect, and slope position of specific points within the mine footprint will not be the same as baseline conditions, nearby natural analogues will be used to guide the establishment of suitable plant communities across the reclaimed areas rather than the restoration of what existed at baseline conditions.

To achieve equivalent land capability Benga will implement:

- a re-vegetation program that aims to establish diverse native vegetation communities (closed conifer forests, moderate mixed forests, natural upland herbaceous grasslands, and treed wetlands) with equivalent pre-disturbance capability;
- a plan that aims to establish communities that are locally and regionally limited in distribution where conditions allow;
- preservation of adjacent vegetation communities by minimizing the area required for construction and operation of the Project;
- provision of appropriate soil substrate where vegetation communities can establish;
- a seed collection program in advance of construction and operations to collect seed from local sources for use in reclamation;
- seeding of stockpiled reclamation material with suitable vegetation species mix to ensure long term stability of the soil piles, which reduces erosion and the potential for weed establishment;
- use of coarse woody debris and direct soil placement techniques to augment mycorrhizal and microbial inoculums;
- use direct placement of soil for provision of propagules to enhance opportunity for re-establishment of native species composition and enhanced species richness; and

- planting of multiple layers of native vegetation (*e.g.*, trees, shrubs and graminoids) to provide initial structure for wildlife habitat and to enhance biodiversity.

Given that various wetland classes are rare in the Project Footprint and in the region, added mitigation measures for wetland impacts should include the following:

- use of best practices to maintain the hydrologic regime of mineral soil wetlands;
- creation of transition areas between re-vegetated communities as outlined in the reclamation plan to the treed swamps, where it is possible and/or appropriate to do so; and
- placement of culverts within wetlands that will be divided by roads to ensure that water flow between wetlands will not be affected.

Vegetation species that have current or historical uses and importance to Indigenous groups are considered TEK resources. Supplementary mitigation measures for TEK vegetation impacts include the following:

- consult with and involve Indigenous groups in designing mitigation measures for sustainable management of TEK vegetation;
- implement a re-vegetation program that aims to re-establish vegetation communities, such as those previously mentioned (closed conifer forests, mature mixed forests, native upland herbaceous grasslands and treed swamps) that are common to the pre-disturbed landscape and that will support TEK vegetation for gathering and hunting purposes; and
- where practicable, utilize locally collected seed to preserve the legacy of species and of place.

Vegetation species to be targeted for establishment *via* planting and natural recovery are presented in Table F.3.6-2 and Table F.3.6-4. TEK vegetation species to be established that correspond with targeted reclamation species include:

Species to be Established - Planting and Natural Recovery:

- Lodgepole pine;
- Prickly Rose;
- Ground Juniper;
- Willow;
- Aspen; and
- Balsam Poplar.

Naturally-occurring plant species to be encouraged:

- Saskatoon;

- Thimbleberry;
- Bearberry; and
- Dwarf Birch.

Native Woody Plant Species for Reclamation (tree plantings from locally collected seed or cuttings):

- Subalpine fir; and
- Dogwood.

The establishment of reclaimed ecological communities will support natural recovery of TEK vegetation species that are not being established through direct planting.

F.2.7 Reclamation Planning for Traditional Land Use

Benga has and will continue to incorporate TEK into C&R planning and implementation. Mitigation for TEK mitigation includes:

- consult with and involve Indigenous groups in designing mitigation measures for sustainable management of TEK vegetation;
- implement a re-vegetation program that aims to re-establish vegetation communities, such as those previously mentioned (closed conifer forests, mature mixed forests, native upland herbaceous grasslands and treed swamps) that are common to the pre-disturbed landscape and that will support TEK vegetation for gathering and hunting purposes; and
- where practicable, utilize locally collected seed to preserve the legacy of species and of place.

Benga has committed to consulting and involving nearby Indigenous groups 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.

F.2.8 Summary of Reclamation Mitigation

Table F.2.8-1 presents a summary of the mitigation for the VCs for which reclamation is an important part of the mitigation plan. Reclamation details (*i.e.,* plans, maps, quantities) have been amalgamated from the EIA (CEAR #42), Appendix A-3 (Addendum 6, CEAR #70), and the details of this report into the table to highlight the detailed mitigation that is planned for each VC.

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
Terrain and Soils		
Soil Quality (Soil profile disturbance)	Increased sedimentation prior to reclamation Poor recovery of salvaged soils	Mitigations to reduce the extent and severity of surface disturbance include: • upland surface soil and sufficient subsoil and suitable overburden materials (coversoil) will be salvaged using best management practices. Supervision of salvage operations, stockpiling, and placement of materials during reclamation (including direct placement) by qualified individuals is recommended • organic soil material will be salvaged for later use in reclamation: Soil Balances and annual salvaged volumes are provided in Table F.2.2.2 • placement of coversoil material will require that it is stored in a manner to minimize material loss or degradation of quality and located in areas that are accessible and retrievable • varying thicknesses of coversoil will be replaced, with a target of 20 cm average thickness, to assist in creating diversity in the reclaimed landscapes • decompaction of the replaced materials will be done; • all reclaimed lands will be initially vegetated using a cover crop upon completion of soil placement to minimize soil loss *via* erosion
Soil Quality (Erosion)	Excessive soil erosion	Mitigations to reduce wind and water erosion potential include: • when stockpiling reclamation material, piles will be placed in strategic locations, to minimize exposure to wind or water • stockpiles will be seeded with a non-invasive and weed free seed mix that establishes quickly • erosion control materials (mats, netting, mulches, straw) will be used to reduce soil surface exposure, as required • reclaimed landscapes will be reseeded with a quick establishing; non-invasive cover crop to minimize the length of time bare soil is exposed to potential wind and water erosion. In addition, reclaimed landscapes that have a moderate to high water erosion risk (*i.e.,* steep side slopes) will have soil stabilizers or other measures implemented (where necessary) to minimize the potential of erosion (*i.e.,* rough mounding, check bales, silt fences, tackifiers, and/or mulch).
Soil biodiversity & ecological integrity	Blending of soils creates homogenous conditions that could reduce overall diversity	Effects will be mitigated by progressive reclamation that includes: • appropriate soil salvage and replacement (see mitigations for soil profile disturbance, above) • site re-contouring (see mitigations for impacts to terrain, below) • revegetation for establishing target end land uses

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
Alteration of terrain	Reduction of overall slopes and organic wetlands	Impacts to terrain will be mitigated through: • appropriate re-contouring of reclaimed landscapes to provide topography and surface forms that provide appropriate surface drainage, blend with the adjacent undisturbed terrain (*i.e.*, drainage, aspect), remain stable, provide suitable habitat for the formation of diverse reclaimed soil and vegetation patterns in the reclaimed landscape, and meet the desired end land use objectives. In instances where the reclaimed landscape is expected to differ from the original terrain type (*i.e.*, end pit lake or wetland), the landscape will be designed to ensure that end land use objectives are met. • a reclamation plan that includes the development of various ecosystem features (wetlands, surface drain ways (swales), and end pit lakes that will function as wetlands) to ensure that a range of diverse terrain and terrain features are created post development. Final re-contouring of depleted mine blocks and appropriate soil replacement will create soil landscape patterns appropriate for the desired end land uses. The landscapes will provide surface water drainage to ensure water movement across disturbed lands, provide surface runoff for constructed wetlands and end pit lakes, as well as establishment of ecosystem patterns appropriate for desired end land uses.
Land Capability Effects (Reclaimed overburden materials)	Unsuitable materials may limit reclamation success	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
Land capability Effects	Unexpected changes to land use patterns	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 management to promote effective reclamation practices

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
Vegetation & Wetlands		
Terrestrial vegetation	Removal of vegetation	Reclamation plans (Table F.4.3.1) in the Project footprint include: • 987.9 ha of closed conifer forest (increase of 7.5%) • 276.7 ha of grassland open forest (increase of 7.7%) • 141.8 ha of mixed forest (increase of 0.1%) • 18.2 ha of treed wetlands (increase of 1.2%) • 18.4 ha of open water (increase of 1.1%) • 38 ha of barren lands/dam (reduction of 17.7%) -Table F.3.6-2 indicates the target plant species that can be used for revegetation of each of the vegetated ecological units. The topography, aspect and ecosite that the reclaimed ecological unit is expected to represent in the medium to long-term is provided. Figure F.3.6-4 depicts the conceptual plan for reclaimed ecological units across the reclaimed mine site at Year 15, and Figure F.3.6-7 illustrates the reclaimed ecological units at Year 27. Vegetation species to be targeted for establishment *via* planting and natural recovery are presented in Table F.3.6-2 and Table F.3.6-4. -Reclamation material placement prescriptions are shown in F.3.6.2 -Revegetation Prescriptions, including seed mix and rates are described in F.3.6.3.3 - Tree and shrub plantings will typically be undertaken two to four years after initial revegetation. By this time, the grass-legume cover has lost its nurse crop species, leaving opportunities for less aggressive plants to establish. A preliminary tree and shrub species selection is provided in Table F.3.6-5. Other terrestrial vegetation mitigation measures will include: • implementation of a re-vegetation program which aims at the establishment of target vegetation with equivalent capability • develop a reclamation plan that includes the establishment of communities that are locally and regionally limited in distribution where conditions allow • preservation of adjacent vegetation communities by limiting disturbance to areas required for development of the Project; • use of an appropriate soil substrate where re-vegetated areas can establish • seed coversoil stockpiles with suitable vegetation species mix to ensure long term stability of the soil piles, which reduces erosion and the potential for weed establishment • the use of coarse woody debris and direct soil placement techniques • the use of direct placement of soil for provision of propagules to enhance opportunity for re- establishment of native species composition and enhanced species richness • implement a weed management and control program • incorporate traditional use plants into the reclamation program

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
		• establish multiple layers of native vegetation (*e.g.*, trees, shrubs and graminoids) to provide initial structure for wildlife habitat and to enhance biodiversity Table F.3.7-1 presents the targets and indicators Benga will use to assess reclamation success
Rare plants	Removal of rare plant potential	Effects on rare plant potential will be mitigated through measures implemented to also mitigate for effects on: • terrestrial vegetation (above) • biodiversity (below) • wetlands (below) • forest resources (below) • rangeland resources (below) • rare plants (below)
	Removal of rare plants	The Fescue Grassland Community Mitigation Plan (CR #8 (EIA) Section 4.3.4.1) includes the following mitigations: • minimize overall project disturbance and avoid fescue where possible • identify potential areas on hill crests and southern aspects suitable for re-establishment of native fescue grasslands • direct reclamation material placement from grassland areas, when opportunities exist • collect native foothills rough fescue seed from across the site • use wild harvested certified weed-free native seed as a monoculture and as part of a certified, weed-free native seed mix; • seed and grow foothills rough fescue plugs in a greenhouse for transplanting onto reclaimed areas of the site; • promote seeding of foothills rough fescue on the rough areas of the golf course to increase overall distribution of fescue grasslands The targeted distribution of reclaimed grassland ecological units is shown in Figures F.3.6-4, F.3.6-7, and F.3.6-8. Table F.3.2-2 demonstrates the distribution of foothills rough fescue dominant grasslands and grasslands with a foothills rough fescue component in the pre-disturbance landscape and the target distribution for the final reclaimed landscape. Foothills rough fescue distribution increases from 57.9 ha pre-disturbance to 280.7 ha in reclamation in the Project footprint. The foothills rough fescue dominant grasslands are expected to be disturbed early in the mine development from Year 1 through to Year 5. Foothills rough fescue seed will be collected prior to disturbance and annually through the five years as further discussed below. Avoidance measures will be exercised annually to allow seed collection from undisturbed portions of the foothills rough fescue dominated lands through to Year 5 when the lands surrounding the fescue-dominated areas are completely disturbed. Rare Plant Propagule or Relocation Mitigation Plan – for the seven perennial vascular plants as identified in Section F.3.2.1: - *Angelica dawsonii , Berberis (Mahonia) repens , Carex petasata, Crepis atribarba, Eucephalus engelmannii, Phacelia hastata,Streptopus roseus*

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
		Rare plant propagule collection (F.3.2.1.1) - The species will be placed (*i.e.,* seeded and transplanted) within one of the four following reclamation ecological units: closed conifer forests, moderate mixed forests, natural upland herbaceous grasslands, and treed wetlands (Figure F.3.6-7 and Figure F.3.6-8). Rare plant relocation (F.3.2.1.2) Rare Plant General Mitigation Plan – for all other rare plant species - a re-vegetation program which aims to establish diverse native vegetation communities (closed conifer forests, moderate mixed forests, natural upland herbaceous grasslands, and treed wetlands) with equivalent pre-disturbance capability; - establishing communities that are locally and regionally limited in distribution where conditions allow; - preservation of adjacent vegetation communities by minimizing the area required for construction and operation of the Project; - provision of appropriate soil substrate where re-vegetated areas can establish; - seeding of stockpiled reclamation material with suitable vegetation species mix to ensure long term stability of the soil piles, which reduces erosion and the potential for weed establishment; - use of coarse woody debris and direct soil placement techniques to augment mycorrhizal and microbial inoculums; - use direct placement of soil for provision of propagules to enhance opportunity for re-establishment of native species composition and enhanced species richness; and - planting of multiple layers of native vegetation (*e.g.,* trees, shrubs and graminoids) to enhance biodiversity and to provide initial structure for wildlife habitat. Revegetation Prescriptions, including seed mix and rates are described in F.3.6.3.3 - Tree and shrub plantings will typically be undertaken two to four years after initial revegetation. By this time, the grass-legume cover has lost its nurse crop species, leaving opportunities for less aggressive plants to establish. A preliminary tree and shrub species selection is provided in Table F.3.6-5. Table F.3.7-1 presents the targets and indicators Benga will use to assess reclamation success.

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation

	Removal of whitebark (and limber pine)	The Whitebark Pine and Limber Pine Mitigation Plans (CR #8 (EIA) Section 4.2.6.3) include the following mitigations:
		• minimizing the Project footprint to avoid populations of whitebark pine where possible
		• adhering to the mitigation approaches outlined in the Alberta Whitebark Pine Recovery Plan
		• introducing white pine blister rust resistant strains during reclamation phases
		• conserving genetic diversity, by collecting cones from whitebark pine trees within the disturbance Footprint that are healthy and free of disease after harvesting is completed. The cones will be provided to a greenhouse and seed will be extracted and stored until needed for the reclamation program
		• planting according to the following strategies:
		  • identification of high light, low competition sites;
		  • planting in pure stands or patches to avoid competition from other trees
		  • avoidance of potential swales and frost pockets
		  • creation of microsites for seedling establishment (rocks, stumps or other coarse woody debris)
		  • use of recommended spacing to avoid interspecies competition
		  •preferentially planting seedlings in the fall to avoid hot dry summer conditions.
		The additional mitigation includes planting primarily in the fall to avoid hot dry summer conditions and strategically placing seedlings to promote seedling growth and establishment within targeted ecological units and landscapes. The number of seedlings that will be planted is 63,000 and is three times the conservative pre-disturbance number to account for planting and natural mortality, reclamation of historical mine areas, and future losses. The areas to be planted will target exposed hilltop areas within developed grasslands, areas with a variable or lack of reclamation material, and other areas where limited competition exists including the benches along the high wall. This will occur over an area of approximately 310 ha in the reclaimed landscape.
		Areas where whitebark and limber pine will be planted are identified in Figures F.3.6-4, F.3.6-7, and F.3.6-8.
		Table F.3.7-1 presents the targets and indicators Benga will use to assess reclamation success.

Rangeland resources	Removal of rangelands	Effects on rangeland resources will be mitigated with the Fescue Grassland Community Mitigation Plan (provided above for rare plant mitigation)

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
Forest Resources	Removals of forests	Mitigation for effects on forest resources includes: • salvaging merchantable timber, both coniferous and deciduous • collecting locally available cones and seed for future reforestation programs • planting seedlings on areas where reclamation and revegetation have been completed. Table F.3.7-1 presents the targets and indicators Benga will use to assess reclamation success.
Old growth forests	Removal of old growth forests	Mitigation for effects on old growth forest will include: • reclamation using tree species capable of achieving of old growth conditions with equivalent capabilities prior to development • preserving adjacent vegetation communities by minimizing the area required for construction and operation of the Project.
Traditionally use plants	Removal of traditionally used plants	Mitigation measures for TEK vegetation will include: • on-going consultation with Indigenous groups for designing mitigation measures for sustainable management of TEK vegetation • implementing a re-vegetation program that will aim at re-establishing vegetation communities that are common to the pre-disturbed landscape and that will support TEK vegetation • implementing a re-vegetation program that includes native vegetation species and does not include agronomic invasive species • providing opportunities to identify and collect suitable lodgepole pine for traditional use ceremonies • re-vegetate with locally collected seed to preserve the legacy of species and of place, where practicable TEK vegetation species to be established that correspond with targeted reclamation species include (Section F.2.7): Species to be Established - Planting and Natural Recovery: - Lodgepole pine; Prickly Rose; Ground Juniper; Willow; Aspen; and Balsam Poplar. Naturally-occurring plant species to be encouraged: - Saskatoon; Thimbleberry; Bearberry; and Dwarf Birch. Native Woody Plant Species for Reclamation (tree plantings from locally collected seed or cuttings): - Subalpine fir; and Dogwood.
Wetlands	Removal of wetlands	Wetland mitigation measures will include: • using wetland construction best practices to maintain the hydrologic regime of mineral soil wetlands • creating transition areas between re-vegetated ecological units to the treed swamps • re-vegetating appropriate depression wetland areas to mineral soil wetlands, where possible • re-vegetating mineral soil wetlands with wetland riparian, emergent, and submergent vegetation species • during construction, salvage and store wetland soil and propagule materials from existing (baseline) wetlands within the Footprint for replacement during wetland reclamation and reconstruction activities

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
		• directly place wetland soil materials (soils and propagules) from adjacent wetlands, to provide a soil substrate with a propagule source for wetlands • placing culverts within wetlands that may be divided by roads, to enable water flow between wetlands, where applicable Reclamation plans include 18.2 ha of treed wetlands of wetlands to be built
Biodiversity	Reduction in biodiversity	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
Noxious vegetation	Increase in weeds	Mitigation measures to prevent/minimize the spread of noxious and invasive species will include: • controlling noxious weed populations identified during baseline field sampling (hand-pulling, cultivation, and/or spot-spraying of herbicide) prior to site disturbance and mine operation • conducting ongoing inspections during each growing season to identify the presence of noxious weeds, throughout the lifetime of the Project • minimizing areas of bare ground during Project construction and operation • promptly reclaiming and re-vegetating bare ground upon completion of mining • using a non-invasive certified seed mix for erosion control, and using approved re-vegetation species that are compatible with the target vegetation communities • implementing a noxious and invasive species control program prior to and during construction and operation of the Project, and during reclamation phases • cleaning equipment arriving from offsite to remove soil and vegetative material before accessing the Project • using recommended re-vegetation techniques and species that will limit the establishment and spread of noxious and invasive species during reclamation

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
Wildlife		
General Mitigation	Reduced habitat availability	Effects on wildlife habitat will mitigated with the following measures: • a C&R Plan that aims to establish suitable wildlife habitat. One of the primary goals for the reclamation program is the return of wildlife habitat. Reclamation ecological communities established to provide habitat for wildlife VCs and other TLU wildlife species presented in Table F.2.5-1. The surface areas locations of these ecological communities planned for reclamation are detailed in Table F.4.3.1 and Figure F.3.6-7. • avoiding habitat destruction and alteration outside of the defined Project footprint to the best extent possible • pre-disturbance surveys will be conducted along the edges of all areas to be cleared during Project development to determine the occurrence of any important wildlife habitat features • in areas of suitable wildlife habitat (on the edge of the Project footprint boundary) appropriate setback distances (or buffer zones) will be considered • clearing and equipment use/storage/cleaning in undisturbed areas within and adjacent to the Project footprint will be avoided • where appropriate, vegetated buffer zones (100 m or minimum of 30 m; pending topography constraints) will be maintained between Project infrastructure and wetlands, creeks, and streams to the best extent possible • retain slash and large woody debris in the salvaged soil to provide microsites for perches for migratory birds • ensuring reclaimed areas promote the re-establishment of woody species and are on a trajectory for reforestation • minimizing loss of mature and old-growth forest habitat and avoid complex, multi-story mixedwood forest where possible

	Reduced movement ability	Measures to mitigate effects on wildlife movement include:
		• a minimum of six wildlife crossings (underpasses and overpasses) will be incorporated into the design of the coal conveyor (the conveyor route is approximately 5.4 km in length);
		• where appropriate, vegetated buffer zones (100 m or minimum of 30 m; pending topography constraints) will be maintained between Project infrastructure and wetlands, creeks, and streams to the best extent possible;
		• a C&R Plan that aims to establish suitable wildlife habitat, including:
		  • minimize the overall disturbance footprint through the mine planning process
		  • preserve remnant forest patches in the development areas to provide essential habitat, habitat connectivity, and hide cover for wildlife species
		  • retain slash and large woody debris in the replaced soil landscape
		  • plant native shrubs early in the reclamation process to initiate hiding cover
		  • establish mixed wood forest stands and high density coniferous tree stands
		  • provide understory complexity in the reclaimed forests by planting native shrubs such as alder and willow to provide security cover for the carnivores and their prey

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
		• maximize the amount of ungulate habitat; • prior to final reclamation, disrupt linear disturbances and sight lines by mounding surface soils, piling brush • limit sight lines by maintaining mature forest stands or by planting high density coniferous stands to act as buffers between roads, project disturbance boundaries and the reclaimed mine areas
	Increased mortality	Mitigations for effects on wildlife mortality risk include: • timing vegetation site clearing activities are to occur outside the April 15 to August 31 period to avoid disrupting nesting migratory and resident songbirds and raptors • in the event that vegetation clearing must occur within the restricted activity period, pre-disturbance nesting surveys will be conducted by experienced avian biologists according to established sensitive species inventory guidelines (Government of Alberta 2013b) • retaining slash and large woody debris in the salvaged soil to provide hide cover • design water management ponds and drainage ditches, and pit lakes to minimize potential entrapment of wildlife.
	Reduced abundance	Effects on wildlife abundance are mitigated through the measures implemented to mitigate habitat loss, movement, and mortality risk (above).
Columbia spotted frog / Western toad	Reduced habitat availability	In addition to mitigations for wildlife in general (above), mitigations for effects on Columbia spotted frog and western toad include: • conducting monitoring to identify other habitable ponds and to identify habitat requirements and constraints • constructing trial breeding ponds • reclaiming upland habitat adjacent to reconstructed breeding ponds.
Olive-sided flycatcher	Reduced habitat availability	Those listed above for wildlife in general, and: • where possible, vegetation clearing will be planned to avoid the April 15 to August 31 breeding bird season. If clearing is required during this period, nest surveys will be completed prior to the clearing operations to determine specific requirements to protect the wildlife resource; • retain slash and large woody debris in the salvaged soil to provide microsites for native plants and hide cover and perches for wildlife; and • ensure reclaimed areas promote the re-establishment of woody species and are on a trajectory for reforestation • Should Environment and Climate Change Canada (ECCC) have other requirements (*e.g.*, beneficial management practices), Benga will work with ECCC to ensure those mitigation measures are also implemented

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
Great gray owl	Reduced habitat availability	For great gray owl and other raptors, additional relevant mitigations include: • retain residual patches of essential habitat and habitat features within and adjacent to the mine footprint (*i.e.*, mature poplar trees, tall conifer trees) to provide perches, nest sites, and hide cover • minimize loss of mature and old-growth forest habitat and avoid complex, multi-story mixedwood forest where possible • maintain a 100 m buffer of undisturbed forest around Blairmore Creek, Gold Creek and other riparian corridors • planning vegetation clearing outside of the great gray owl nesting period (March 1 to April 30) characteristic of the region
Little brown myotis	Reduced habitat availability	Mitigation measures specific to little brown myotis and other bat species include: • avoiding direct and indirect impacts to known, primary maternity roosts should any such roosts be located/identified • consulting with ECCC and AEP should hibernacula, fall swarming sites, or maternity roosts be observed during operations • implementing a reclamation plan to promote the re-establishment of woody species and wetland vegetation • preserving remnant forest patches within the development areas where feasible to provide habitat, habitat connectivity and roost sites for bat species • ensure reclaimed areas promote the re-establishment of woody species and wetland vegetation and are on a trajectory for forest and wetland establishment
	Reduced movement ability	Effects on habitat connectivity and movement will be mitigated by: • implementing a reclamation plan to promote the re-establishment of woody species and wetland vegetation • preserving remnant forest patches within the development areas where feasible to provide habitat connectivity for bat species
	Increased mortality	Effects on mortality will be mitigated by: • timing clearing outside of the summer breeding/rearing window (falls into the breeding bird window) • avoiding direct and indirect impacts to known, primary maternity roosts should any such roosts be located/identified
	Reduced abundance	Effects on abundance will be mitigated by mitigating for effects on habitat loss and mortality, as described above.
Grizzly bear	Reduced habitat availability	• minimize the overall disturbance footprint through the mine planning process; • retain slash and large woody debris in the replaced soil landscape; • establish mixed wood forest stands; • establish high density coniferous tree stands; • provide understory complexity in the reclaimed forests by planting native shrubs such as alder and willow to provide security cover for the carnivores and their prey; • plant native shrubs early in the reclamation process to initiate hiding cover;

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
		• preserve remnant forest patches in the development areas to provide habitat, habitat connectivity and hide cover for wildlife species; • maximize the amount of ungulate habitat; • prior to final reclamation, disrupt linear disturbances and sight lines by mounding surface soils, piling brush; and • limit sight lines by maintaining mature forest stands or by planting high density coniferous stands to act as buffers between roads, project disturbance boundaries and the reclaimed mine areas. Additional mitigations that are specifically targeted to grizzly bears and grizzly bear habitat include: • maintain a 100 m undisturbed forested buffer around Blairmore Creek and other riparian corridors • leave patches of residual forest within and adjacent to the mine footprint • commence reclamation early on in mine operations by seeding reclaimable areas with plant species favourable to grizzly bear forage, and by planting shrub and tree species that provide suitable cover (*e.g.*, willow, alder, coniferous trees).
	Reduced movement ability	Mitigations are the same as for wildlife general mitigation (above)
	Increased mortality	To mitigate effects on grizzly bear mortality (in addition to mitigations for wildlife in general): • Benga commits to supporting active bear management plans associated with the Project. If a site specific plan is required, it will be developed in consultation with AEP personnel as part of the Wildlife Mitigation and Monitoring Plan.
	Reduced abundance	Effects on abundance will be mitigated by mitigating for effects on habitat loss and mortality, as described above.
Moose and Elk	Reduced habitat availability Increased mortality	• minimize the overall disturbance footprint through the mine planning process; • establish a variety of vegetation communities consisting of upland grasslands, shrublands, wetlands, mixed wood forest and coniferous forest; • encourage understory complexity in the reclaimed forests by planting native shrubs such as alder and willow; • establish a variety of vegetation communities suitable for moose, consisting of mixed wood forest and wetlands and to encourage structural complexity to the forest; • establish willow species as they are of particular importance to moose; • ensure that core security areas are provided for wildlife; • maximize the direct placement of salvaged soil to enhance native plant development; • retain slash and large woody debris in the salvaged soil to provide microsites for native plant and hide cover for wildlife; • preserve remnant forest patches within the development areas where feasible to provide habitat, habitat connectivity and hide cover for wildlife species; and

Table F.2.8-1 Mitigation specific to reclamation

Valued Component	Potential Effects	Proposed Mitigation
		• limit sight lines by maintaining mature forest stands as buffers between roads and reclamation areas. And general mitigations listed above for wildlife general mitigation (above)
Migratory Birds	Reduced habitat availability Increased mortality	Key measures include: • planning vegetation clearing outside of the breeding bird period (April 15 to August 31) characteristic of the region, • conducting pre-disturbance nest searches • implementing an effective conservation and reclamation plan that promotes the development of habitats required for migratory birds. • should Environment Canada have other requirements (*e.g.*, in beneficial management practices or species recovery strategies), Benga will work with Environment Canada to ensure those mitigation measures are also implemented Many of the Project effects associated with wildlife habitat loss will be minimized through implementation of the Project's reclamation plan. • maintain a 100 m undisturbed forested buffer around Blairmore Creek and other riparian corridors • leave patches of residual forest within and adjacent to the mine footprint • bird collisions with buildings will be mitigated by placing visual markers on windows, and collisions with the proposed power line will be mitigated by installing large 'floats' or other markers Reclamation plans include increases (relative to baseline) of open water and treed wetlands to encourage waterfowl or shorebirds: • 18.2 ha of treed wetlands (increase of 1.2%) • 18.4 ha of open water (increase of 1.1%) Reclamation plans include (relative to baseline) of grassland to encourage grassland groups of birds. • 276.7 ha of grassland open forest (increase of 7.7%) Reclamation plans include increases (relative to baseline) of mixed forest to encourage coniferous and deciduous dominant forest, and old-growth birds. • 141.8 ha of mixed forest (increase of 0.1%) • 987.9 ha of closed conifer forest (increase of 7.5%)

F.3 CONSERVATION AND RECLAMATION PLAN

The C&R Plan for the Project provides details on the reclamation activities throughout the life of the Project and at mine closure. The C&R Plan provides the specific reclamation procedures that will be employed while the Closure Plan outlines the goals and processes of the reclamation planning.

The mine reclamation plan identifies efforts needed to maintain the development area's biodiversity, to sustain ecological conditions, and to achieve equivalent land capability. Following mine closure, the Project Footprint will maintain comparable distribution of upland forests, grasslands, and wetlands. A slight reduction in overall slope of the site is expected at closure, which will facilitate a rapid revegetation of the Project Footprint. This plan will identify how and when these end points are expected to be achieved.

The reclamation plan was developed for the mine by integrating information assessed in the project EIA, applying standard and innovative reclamation practices and techniques, incorporating and considering TEK, and with consideration to stakeholder preferences.

The documents used in the preparation of this plan are referenced in the applicable sections.

Prior to the commencement of mining operations, the conservation of timber and soil resources will be completed. Prior to soil disturbance, the construction of the surface water management systems will be completed. It is estimated that full development of the Project will disturb 1,520.7 ha. The progression of clearing for the first 15 years of mine development is described in detail in Section F.3.6 (Mine Reclamation) and shown in associated figures, Figure F.3.6-1 (Years 1 to 5), Figure F.3.6-2 (Years 6 to 10) and Figure F.3.6-3 (Years 11 to 15).

F.3.1 Vegetation Clearing

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.

All merchantable timber will be salvaged as per the Timber Salvage Plan discussed in Section F.3.3. The disposition of timber removed from crown land will be made available to the local timber rights holders. The timber from private land will be made available to Indigenous groups, to local timber rights holders, or disposed by some other process.

Non-merchantable timber and slash materials will be disposed of, incorporated with soil, or will be stored for use during reclamation. The placement of coarse woody debris on reclaimed landscapes

will provide value for the establishment of native plant species as well as providing wildlife habitat values such as perching and hiding cover.

In areas where there will be minimal soil disturbance, such as powerline rights of way, the remaining vegetation may be mulched after the merchantable timber has been removed. Mulching will be completed to the requirements of ASRD *Directive 2009-1* (as amended) that requires a maximum mulch depth of 5 cm to promote micro topography, moisture storage during dry periods and erosion control. Managing the volumes and depths of mulch as per this directive will ensure volumes do not degrade soil quality or become a pathway for wildfire. Mulching will only be conducted on areas within the project footprint intended for disturbance (Alberta Sustainable Resources and Development [ARSD] 2009).

F.3.2 Rare Plant Mitigation

Rare plant species rankings in Alberta are largely determined by the number of observations of the species that are reported in the province. Based on this system, low profile, difficult to locate, and hard to identify species are more likely to be listed as rare (Alberta Biodiversity Monitoring Institute [ABMI] 2007). It is difficult to determine if some species are rare due to location at the edge of their natural range. Taxonomic uncertainty and misidentification may also result in the rare status of certain species. Avoidance of rare plant species provincially ranked between S1 and S3 is the most preferred mitigation option. Where avoidance is not an option, site-specific and species-specific mitigation planning may be possible. Based on a review of the species descriptions and habitat requirements of the rare plant species located in the Project Footprint, Benga has developed a rare plant species mitigation program.

The Project's rare plant species mitigation program took the following factors into account during the plan's development:

- transplanting rare plants from one location to another is a potential mitigation strategy but is not widely accepted (Canadian Botanical Association 1991, Fahselt 1998). Transplanting has been shown to have a low rate of success for rare vegetation (Allen 1994, Howald 1996);
- collecting seed and propagating it for additional seed, or for propagules for transplantation (*e.g.,* container stock) from rare plant species is more successful than direct transplantation, but can also have a low success rate unless proper planning is involved (Munshower 1994, Sinton Gerling *et al*. 1996);
- locating and identifying rare vascular plant species, especially annual plant species, on a yearly basis is difficult;
- transplanting rare vascular plants to an undisturbed location with equivalent habitat (which is often sensitive in nature) often causes considerable disruption to the undisturbed habitat

(*e.g.*, damage to plants in the undisturbed area, introducing a plant species not indigenous to the undisturbed habitat, opening additional habitat for weed and invasive species) (Canadian Botanical Association 1991, Fahselt 2013); and

- transplanting is even more difficult for non-vascular lichen and bryophyte species, as they often have specific microclimate requirements and/or symbiotic relationships that must remain intact for survival, which makes transplanting an unviable option (Canadian Botanical Association 1991, Allen 1994, Howald 1996).

Based on these factors, the Project's rare plant species mitigation plan was developed to accommodate the following four strategies:

- Rare Plant Propagule or Relocation Mitigation Plan – for perennial vascular plants (with the exception of whitebark pine and foothills rough fescue grasslands [Sections F.3.2.3 and F.3.2.4, respectively]);
- Rare Plant General Mitigation Plan – for all other rare plant species (except whitebark pine and rough fescue grasslands);
- Whitebark Pine and Limber Pine Mitigation Plans; and
- Fescue Grassland Community Mitigation Plan.

The details of each sub-plan are discussed in the following sections.

F.3.2.1 Rare Plant Propagule or Relocation Mitigation Plan

A review of the rare plant species located in the Project Footprint, their specific growth traits and habitat requirements, and the factors outlined above, has identified the following seven vascular plant species as potential candidates for propagule collection and or relocation:

- *Angelica dawsonii* – yellow angelica (observed at three sites in the Subalpine e1 ecosite phase);
- *Berberis (Mahonia) repens* – creeping mahonia (one site in Montane c4);
- *Carex petasata* – pasture sedge (two sites in Subalpine a1, one site along Overland Conveyor in Montane c4);
- *Crepis atribarba* – slender hawk's-beard (observed once in a disturbed site along the Overland Conveyor within the Montane Subregion);
- *Eucephalus engelmannii* – elegant aster (one site in Subalpine e1);
- *Phacelia hastata* – silver-leaved scorpionweed (five sites Subalpine a1, e1, and previously mined area); and
- *Streptopus roseus* – rose mandarin (one site in each of Montane c1 and g2 and Subalpine e1).

Separate mitigation plans are developed for whitebark pine and limber pine, and rough fescue containing grasslands, which are included in Sections F.3.2.3 and F.3.2.4, respectively.

F.3.2.1.1 Rare Plant Propagule Collection

The collection of seed and reseeding rare plant species (including producing additional seeds from the collected seeds), or the potential propagation of individual plants from collected seed for transplantation, into the reclaimed landscape is a more successful revegetation strategy when compared to direct transplantation, but still has limitations (Munshower 1994, Sinton Gerling *et al.* 1996). Prior to any collection, the seven species listed in Section F.3.2.1 will be reviewed by a seed collection and propagation specialist, with experience in seed collection, storage and propagation. The feasibility to collect seeds for any of these seven species, when the seed should be collected, and if the collected seeds should be stored for use in reseeding, propagated for additional seed, or propagated for use in a transplantation propagation will be determined by this expert. This will depend on the inherent characteristics of each species.

Once the species suitable for seed collection have been selected, accessible locations of these plants will be visited (as plotted on Figure F.3.2-1) for approximately the first 22 years after Project operations start (*i.e.,* from start of Project operations to maximum Project disturbance, or when no seed collection areas remain). This will be completed at varying intervals during the summer and fall prior to area disturbance, to determine if seeds are available for collection (*i.e.,* at the time of flowering and before dispersal) as not all species go to seed, or seed at the same time, every year. If disturbance of the rare plant species location will not occur for three to four years in the future (or more), no more than 50% of the seed will be collected at each visit from no more than 10% of the plants, with 2 years between each collection (Alberta Native Plant Council 2007, Native Plant Working Group 2000). If the disturbance is going to occur immediately, 100% of the seeds will be collected. The seeds will be collected, identified, transported, registered, stored, cleaned and tested according to the *Alberta Native Plant Council Plant Collection Guidelines for Horticultural Use of Native Plants* (Alberta Native Plant Council 2007) and *Alberta Native Plants and Seeds: Wild Harvest, Registration and Deployment. A Guide for Technicians and Practitioners* (Smreciu 2011) documents. Given the variable nature of plant species in terms of regeneration, and responses to biotic and abiotic variables, some or all of these rare plant species may not be located or provide enough seed to be used.

Based on the input of the seed collection and propagation specialist, the inherent characteristics of the particular rare plant species, and the volume of the seeds collected, they will remain in storage for future seeding, be propagated for more seeds, or propagated for transplantation in accordance with the Smreciu (2011) document. The type and areas for seeding and transplantation propagation (*e.g.,* bare rootstock, container type, container size, *etc.*) will be determined in consultation with the seed collection and propagation specialist. This work will be coordinated with the reclamation schedule for the Project so that appropriate amount and type of material for revegetation will be

available for placement (*i.e.,* seeding and/or transplantation) into a habitat that correlates as close as possible with the requirements of each particular species. The species will be placed (*i.e.*, seeded and transplanted) within one of the four following reclamation ecological units: closed conifer forests, moderate mixed forests, natural upland herbaceous grasslands, and treed wetlands (Figure F.3.6-7 and Figure F.3.6-8).

F.3.2.1.2 Rare Plant Relocation

If consultation with the seed collection and propagation specialist determines that any of the seven species outlined above are not candidates for seed collection or enough seed cannot be collected, direct transplantation is the only remaining mitigation plan. For direct placement, if any of the species' known locations are included in the upcoming years' Project planned disturbance; these locations would be visited as early as possible in that spring (*i.e.,* so that the species have remained hardened-off) to attempt to transplant the species as soon as possible. Direct transplant of hardened-off, or plants remaining as hardened-off as possible, increases the likelihood of revegetation success (Munshower 1994).

Unlike seed or propagated transplants, direct transplantation candidates, cannot be stored or developed as needed. As a result, rare species that may be disturbed in the first two years of Project operations will not be transplanted. However, as reclaimed areas will be available two years after Project operations start, rare plants in areas to be disturbed after this time will be available for transplantation. This process will be completed each spring until the maximum extent of disturbance is reached and no areas are left for transplantation; approximately 22 years after operations commence.

Given the variable nature of plant species in terms of regeneration, and responses to biotic and abiotic variables, candidate rare plant species may not be located for direct transplantation. If the target rare plant species is located, the plant species population will be noted in terms of area occupied by the population, the patches (if applicable) of the species within the population area, and the number of individuals plants within the various patches and population area. For transplantation, 100% of the located individuals within the population will be moved, if possible, as all of them are slated for disturbance. Guidance on the type of transplantation method most applicable to each species (*e.g.,* cuttings, whole plant transplantation, sod transplantation, *etc.*) will be provided by a qualified specialist and also as found in the *Establishing Native Plant Communities* (Smreciu *et al*. 2003) document.

As noted above, rare plant species will not be directly transplanted into undisturbed areas due to the considerable disruption that would occur to the undisturbed habitat. Suitable relocation sites will be identified within areas of the mine undergoing reclamation or recently reclaimed.

F.3.2.1.3 Rare Plant Monitoring & Management Program

The seeding or transplantation of grown propagules, especially the direct transplantation of rare plant species is often challenging; therefore, comprehensive monitoring and management of areas seeded or transplanted with rare species will be required to ensure it is successful. The following is an outline of the monitoring for the Rare Plant Propagule or Relocation Mitigation Plan:

- annual assessment of seeded areas to determine germination success and survival; and
- annual assessment of propagule transplantation and/or direct transplantation areas to determine transplant survival and health.

The following is the management that may be required to ensure success of the mitigation plan:

- continuous reseeding of areas that may have an initial low germination rate (less than 5-15 plants/m^2) (Alberta Environment 2003);
- additional transplantation (of propagated materials) due to low survival (less than 2 plants/m^2) of initial transplanting activities (Alberta Environment 2003a);
- managing weed and invasive species in seeded areas and transplant areas to limit competition; and
- watering (by Benga Operations and Reclamation staff) of transplanted areas to assist with long-term transplant survival.

The Best management Practices for determining revegetation success, as provided in *Sites Reclaimed Using Natural Recovery Methods Guidance on Site Assessment* (Alberta Environment 2003b) will be adhered to.

F.3.2.2 Rare Plant Species General Mitigation Plan

With the exception of whitebark pine and limber pine, all rare species identified are considered globally secure and do not have provincial or federal recovery plans in place. For the Project whitebark pine and limber pine have species specific recovery plans, and fescue are protected under provincial protective notations, the other 18 rare plant species located in the Project Footprint are globally secure and are not suitable for Rare Plant Propagule collection or Relocation Mitigation Plan for the following reasons:

- they are annual vascular plants and the likelihood of locating them is low;
- they do not produce propagules that can be stored or propagated (*e.g.*, the spores of lichens, mosses and liverworts); or

- they have specific microclimate requirements and/or symbiotic relationships that must remain intact for survival, which makes transplanting an unviable option (*e.g.*, obligate mycorrhizae associated with orchid species).

Based on these factors the following mitigation measures will be implemented for rare plants (with the exception of whitebark pine, limber pine and native fescue grassland):

- a re-vegetation program which aims to establish diverse native vegetation communities (closed conifer forests, grassland open forests, mixed forests, and treed wetlands) with equivalent pre-disturbance capability;
- establishing communities that are locally and regionally limited in distribution where conditions allow;
- preservation of adjacent vegetation communities by minimizing the area required for construction and operation of the Project;
- provision of appropriate soil substrate where re-vegetated areas can establish;
- seeding of stockpiled reclamation material with suitable vegetation species mix to ensure long term stability of the soil piles, which reduces erosion and the potential for weed establishment;
- use of coarse woody debris and direct soil placement techniques to augment mycorrhizal and microbial inoculums;
- use direct placement of soil for provision of propagules to enhance opportunity for re-establishment of native species composition and enhanced species richness; and
- planting of multiple layers of native vegetation (*e.g.*, trees, shrubs and graminoids) to provide initial structure for wildlife habitat and to enhance biodiversity.

Also, the following monitoring measures will be implemented:

- periodic assessment of the composition, structure, ecological succession and biodiversity of reclaimed vegetation; and
- survival, growth and health assessments of re-vegetated areas to monitor the effectiveness of reclamation efforts relative to re-vegetation targets (including noxious and invasive species and effectiveness of control methods).

These mitigative measures are also applicable to the species included in the Rare Plant Propagule or Relocation Mitigation Plan (Sections F.3.2.1) and the Foothills Rough Fescue Mitigation Plan (Section F.3.2.4).

F.3.2.3 Whitebark Pine and Limber Pine Mitigation Plan

Whitebark pine (Pinus albicaulis) is listed as "Endangered" in Alberta and British Columbia under SARA Schedule 1 in 2012 (Government of Canada 2015), and limber pine (Pinus flexilis) was designated as "Endangered" throughout its range in Alberta and British Columbia by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in November 2014. Limber pine is listed as globally secure (G4 or G5) while whitebark pine is not (G3/G4).

The distribution of whitebark pine and limber pine species have been confirmed *via* aerial assessment and plotted on Figure F.3.2-1. Pre-development counts estimated 20,692 whitebark and limber pine with less than 1,000 limber pine stems estimated across the entire Project Footprint. Since limber pine are difficult to distinguish from whitebark pine without cones and before the pollen season, at the time of assessment they were included in the whitebark pine counts. In the Project Footprint, whitebark pine individuals, sparse clusters, and mixed species stands were found on both east and west aspects along crest and upper slope positions (Figure F.3.2-1).

The reclamation plan will follow guidance provided in the Alberta Whitebark Pine Recovery Plan and Limber Pine Recovery Plan, established by the Alberta Whitebark and Limber Pine Recovery Team (2014a, and as updated). In addition to recommending a reduction of direct mortality of the species, which has been considered throughout the development of the Project Footprint, Benga will develop and introduce white pine blister rust-resistant strains; conserve genetic diversity; and manage habitat and natural regeneration.

The criteria identified in the provincial recovery plan will be followed to identify disease resistant trees. To preserve genetic diversity, clusters of whitebark pine will be investigated for suitability for cone/seed collection prior to disturbance, and seed collection would include selection of trees showing evidence of white pine blister rust resistance. Seeds will be provided to greenhouses for seed extraction and storage until needed for reclamation and or to support provincial recovery plans.

Whitebark pine, due to its greater vulnerability and more limited range, will be preferred over limber pine for reclamation. No specific recommendations for planting of limber pine are available at this time; trials are underway. Recommendations specific to planting of whitebark pine will be used when planting limber pine until specific guidance is available.

Whitebark Pine will be planted in pure stands or patches in areas with high light and low competition. Microsites will be established from rocks, stumps, or coarse woody debris and will avoid swales or frost pockets. Spacing recommendations identified in the Recovery Plan will be followed to avoid interspecies competition. Combined, the number of seedlings planted will be three times the pre-disturbance number (Table F.3.2-1), to account for planting and natural mortality, reclamation of historical mine areas, and future losses. Planting will occur primarily in the fall to

avoid hot dry summer conditions and seedlings will be strategically placed to promote seedling growth and establishment within targeted ecological units and landscapes. Planting locations will target exposed hilltop areas within developed grasslands, areas with a lack of reclamation material, and other areas where limited competition exists including the high wall. Areas where whitebark and limber pine will be planted are identified in Figures F.3.6-4, F.3.6-7, and F.3.6-8.

Table F.3.2-1 Pre-disturbance and Proposed Post Reclamation Distribution of Whitebark Pine

Tree Species	Pre-disturbance landscape			Reclaimed landscape		
	Area (ha)	% Area	Count	Area (ha)	% Area	Count
Whitebark Pine	47.4	3.1	15,203	310	20	63,000
Whitebark Pine (sparse distribution)	197.3	13.0	5,489			
Total Whitebark Pine	**244.7**	**16.1**	**20,692**	**310**	**20**	**63,000**

[1] Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

F.3.2.4 Foothills Rough Fescue Mitigation Plan

The preferred primary mitigation strategy for native foothills rough fescue grasslands is avoidance. Vegetative disturbance within the project footprint is unavoidable, and therefore mitigation strategies will be implemented to improve the likelihood of re-establishing rangeland communities across the project throughout the life of the mine. The targeted distribution of grasslands in the reclaimed landscape is demonstrated in Table F.3.2-2 and is shown in comparison to pre-disturbance landscapes.

Benga acknowledges that restoration of foothills rough fescue inhabited lands is relatively unproven but will rely on industry best practices and will utilize key findings from successful efforts made on other industrial disturbances in similar fescue grassland areas. A search of available literature, such as Lancaster *et al.* (2016), demonstrates several successes on similar landscapes, which will be incorporated into the reclamation plan as further defined below.

Vegetation assessments conducted across the mine have identified multiple fescue community types across the Project footprint. Foothills rough fescue dominant communities occupy 3.4 ha of pre-disturbance landscape, grassland communities where foothills rough fescue is a sub-dominant component occupy approximately 18.2 ha, and open forest grassland ecological units which have foothills rough fescue as a component of the ecological unit contain 36.3 ha, as identified in Table F.3.2-2 and as shown in Figure F.3.2-1. The pre-disturbance foothills rough fescue communities exist in open valley bottoms, on south facing slopes, on ridges, and in patches in the Montane and

Sub-Alpine Natural Subregions. The targeted distribution of reclaimed grassland ecological units is shown in Figures F.3.6-4, F.3.6-7, and F.3.6-8.

Table F.3.2-2 demonstrates the distribution of foothills rough fescue dominant grasslands and grasslands with a foothills rough fescue component in the pre-disturbance landscape and the target distribution for the final reclaimed landscape. The foothills rough fescue dominant grasslands are expected to be disturbed early in the mine development from Year 1 through to Year 5. Foothills rough fescue seed will be collected prior to disturbance and annually through the five years as further discussed below. Avoidance measures will be exercised annually to allow seed collection from undisturbed portions of the foothills rough fescue dominated lands through to Year 5 when the lands surrounding the fescue-dominated areas are completely disturbed.

Table F.3.2-2 Pre-disturbance and Proposed Post Reclamation Distribution of Foothills Rough Fescue

Foothills Rough Fescue Community	Pre-disturbance landscape		Reclaimed landscape	
	Area	% Area	Area	% Area
Foothills rough fescue dominant	3.4	0.2	4.0	0.3
Grasslands	18.2	1.2	276.7	18.2
Open forest grasslands	36.3	2.4		
Total foothills rough fescue distribution	**57.9**	**3.8**	**280.7**	**18.5**

[1] Due to rounding of values, totals may not equal the sum of the individual values presented in the table.

Mitigation specific to the re-establishment of foothills rough fescue will include:

- direct reclamation material placement from grassland areas, when opportunities exist;
- collection of native foothills rough fescue seed from across the site;
- seeding of wild harvested certified weed-free native seed as a monocultures and as part of a certified, weed-free native seed mix;
- seeding and growing of foothills rough fescue plugs in a greenhouse for transplanting onto reclaimed areas of the site;
- occurrences of natural regeneration of native fescue; and
- promote the seeding of foothills rough fescue on the rough areas of the proposed golf course development to increase overall distribution of fescue grasslands.

The application of each of these methods is dependent on:

- the timing of the disturbance *versus* the availability of land ready to be reclaimed;
- availability and viability of certified weed free seed sources; and
- accessibility of ranges across the mine.

Direct placement of salvaged reclamation material will be prioritized, when opportunities exist, to promote foothills rough fescue and native grassland establishment. Specific opportunities to align the disturbance of the foothills rough fescue dominated communities with the availability of areas scheduled to be reclaimed will be pursued and considered before all other mitigation. Areas where direct placement is targeted will be further supported by other seeding and maintenance techniques to ensure soil stability and vegetation establishment of the desired communities is achieved.

As the growth of native foothills rough fescue grasslands may require a long period of time, the majority of early stage reclamation will use a certified, weed-free native seed mix that is representative of appropriate range type communities for the reclamation of natural upland herbaceous grasslands. Specifically, the *C5 Forest Management Plan 2006-2026 (*Government of Alberta 2010b) recommends that for reclamation work to adhere to the *Native Plant Revegetation Guidelines for Alberta – February 2001* (Native Plant Working Group 2000). These guidelines state that seed mixes, and the accompanying seed certificates of analysis, be submitted to appropriate AEP staff for approval prior to seed application. Benga has discussed the conceptual mixes with AEP and has been directed to confirm specific seed mixes prior to seeding.

Seeding of wild harvest collected native fescue seed is the preferred method for all reclaimed grassland ecological units. If the availability and collection of native fescue seed becomes limiting to re-vegetative efforts, seed sources will be supported with locally certified, weed-free native seed mixes.

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.

A portion of wild harvest collected fescue seed will be utilized to grow fescue plugs in local greenhouses. Tannas (2011) has documented that developing seedlings in an environmentally protected location, such as a greenhouse and transplanting to site, protects the seedlings from competition and environmental effects during their most vulnerable growth periods. Transplanting of plugs will target seeded areas of the reclaimed landscape where foothills rough fescue establishment has been limited, and these efforts will be coordinated with local recovery strategies. They are expected to be limited by the availability of local seed and local plugs but will be utilized throughout the life of the mine ensure fescue communities establish and are maintained.

Reclaimed areas are also expected to benefit from a certain amount of natural regeneration of foothills rough fescue. These areas will be identified as part of the ongoing monitoring program for the mine. Areas where natural regeneration is identified will provide study opportunities to better understand the success parameters that can then feed into future efforts across the mine, elsewhere throughout the province, and throughout industry. Areas identified during monitoring where foothills rough fescue establishment is limited will be supplemented with a combination of overseeding, amending with hay cuttings/mulch harvested from the foothills rough fescue being collected, and transplanting of plugs as required.

Well-designed monitoring programs are very important during the first five years following construction and reclamation, and long term monitoring programs are recommended for disturbance and reclamation of rough fescue grasslands (AESRD 2011). In addition to monitoring of the establishment in the first few years of reclamation, range health assessment of natural upland herbaceous grasslands would be conducted at Year 5 and Year 10 once each reclamation phase has been completed. Additional annual range health assessments would be conducted after Year 10 should the results of the range health assessments indicate that the range health functions of the community are not being restored.

F.3.3 Timber Management Plan

The Project Footprint is located on both private and public land and will require timber removal from areas intended to be developed. Figure F.3.3-1 demonstrates the proposed and potential timber harvest areas by owner across the mine. Timber salvage will commence in Year 1 of mine development and will progress annually until full disturbance of the mine area is achieved in Year 14.

On public land, timber rights fall under the C5 Forest Management Unit (FMU). FMU C5 has five quota holders in the project area which will be given first right of refusal for the timber salvage generated by the development of the mine. As per the approval conditions for the FMU, "*Timber salvage produced in the FMU shall be accounted and reported as drain against each timber operator's disposition based on the disposition holders allocated percentage of the AAC*" (Government of Alberta, 2010).

The current approved Coniferous Allocations and Annual Allowable Cut (AAC) (Government of Alberta, 2014) are shown in Table F.3.3-1.

Table F.3.3-1 Approved FMU C5 Annual Allowable Cut (AAC)

Company Name	Disposition Number	C5 FMU	
		Primary Disposition Allocation (%)	Total Approved AAC (m^3)
793128 Alberta Ltd.: Private	CTQC050002	1.65	3,455
770538 Alberta Ltd.: Forest Resource Improvement Association of Alberta	CTQC050005	4.38	9,172
Spray Lakes Sawmills (1980) Ltd.	CTQC050008	29.07	60,877
Crowsnest Forest Products Ltd.	CTQC050009	58.69	122,905
Community Timber Permit Program (CTPP)	CTPP	6.21	13,005
FMU C5 TOTAL		**100.00**	**209,414**

The estimated merchantable timber volumes available for distribution to quota holder (public land) and to be distributed by the titled landowner (private land) are summarized in Table F.3.3-2.

Table F.3.3-2 Estimated Merchantable Timber Volumes

Landowner	Coniferous Timber Volume (m^3)	Deciduous Timber Volume (m^3)	Total Timber Volume (m^3)
Crown	71,480	673	72,153
Freehold Benga (100% ownership)	50,494	10,019	60,513
Freehold Benga (50% ownership)	228	0	228
Freehold – Crowsnest Pass Golf & Country Club	261	0	261
TOTAL	**122,463**	**10,692**	**133,155**

The project will result in a 72,153 m^3 drain against the timber dispositions held on public lands which is approximately 34% of the AAC for the C5 forest management unit. There is an additional 60,513 m^3 on private lands for a total of 133,155 m^3. Coniferous timber volumes consist of approximately 68 to 83% pine, 6 to 12% spruce and 5 to 20% other coniferous species. Deciduous timber volumes consist of 98 to 100% aspen.

As per AEP guidance (Juhlin, 2016 pers. com.), timber volumes from Crown land will be offered to the two main quota holders, Spray Lakes Sawmills (1980) Ltd. and Crowsnest Forest Products. Should these quota holders decline, the volumes will be made available to other interested parties.

Private land within the Project Footprint falls within the CO2 FMU in which generic provincial regulations apply. Each individual landowner is responsible for determining the use of the timber resources. Indigenous groups have expressed interest in small volumes of timber for poles and rails, and Benga will engage interested Indigenous groups in advance of clearing to identify opportunities to provide timber for this purpose. Consultation in advance of clearing will identify potential plants and trees that are of cultural importance to Indigenous groups either for relocating or for salvage and use. Remaining merchantable timber will be offered to quota holders of the adjacent public lands or to other interested parties as per the public lands process.

All cleared timber will be placed in log decks located strategically around the mine and removed by quota holders and/or Indigenous groups. Non-merchantable timber will be salvaged with the reclamation material. If the volumes of non-merchantable timber are excessive and cannot be incorporated into the soil, it will need to be disposed of, most likely by burning. Some of the excess material may be stored as coarse woody debris for select reclamation areas.

F.3.4 Soil Conservation Program

A foundational component of achieving equivalent land capability is ensuring sufficient volume and quality of reclamation material are maintained; and this soil management plan achieves that. The goal of the soil conservation program is to ensure there will be sufficient volumes of suitable reclamation material to support the self-sustaining vegetation communities required to achieve the planned end land uses. These help satisfy the ToR, specifically Section 3.2.8 [A], as provided in Section F.1, which includes: *h) reclamation material salvage, storage areas and handling procedures and i) reclamation material replacement indicating depth, volume and type.*

Soil surveys were conducted in 2014-2015 with soil inspection data obtained at an intensity level as defined in the AER ToRs for the Project. Surface soil characteristics were identified and rated for reclamation suitability as Good, Fair, Poor or Unsuitable.

Reclamation material salvage operations will ensure the salvage of all available upland surface soil. The soil balances and annual volumes are provided in Table F.2.2-2. Terrain features indicate that 1,102 ha of land has salvageable upland surface soil and salvageable organic soil present. Some of the project area has lands without soil material present or the topography is too steep to allow soil to be salvaged safely (Figure F.2.1-2). Soil salvage guidance by experienced professionals and pre-disturbance soil survey information will result in minimal soil losses due to conventional salvage and handling methods and minimize impacts to soil quality.

All available reclamation material will be salvaged to meet the requirements of the reclamation plan with some additional volume for contingency. There are limitations to the volumes of soils that can be salvaged. Salvageability of wet soils and soils located on slopes steeper than 23˚ may be limited due to access and safety restrictions.

The soil salvage practices planned by Benga will provide a suitable quality reclamation material with sufficient volume for the soil replacement requirements of the reclamation plan while providing a suitable seed bed for the revegetation program.

F.3.5 Overburden

The *in situ* overburden has been analyzed for reclamation suitability and most of the samples have been rated as suitable for reclamation. A few samples had high pH or sodium adsorption ratio (SAR) values that exceeded the guidelines, but these occurred in small isolated zones and should not be of concern. All overburden material will be sampled prior to reclamation material placement to determine the suitability of the material and unsuitable material will be covered by at least 1 m of suitable material prior to replacement.

An overburden sampling program will be conducted prior to reclamation material placement to determine the soil replacement requirements at reclamation. An overburden assessment program coupled with proper reclamation material salvage and prescriptive replacement plan will allow for suitable reclaimed soil profiles to be replaced after mining.

F.3.6 Mine Reclamation

Annual progression maps, as prepared and updated as required during mine planning highlight the mining and reclamation progress on an annual basis throughout the life of the mine to reclamation closure. It should be noted that the Grassy Mountain area has had considerable surface and underground mining activities in the past. The legacy operations will mostly be captured by this mine plan and will be disturbed again. It is critical to note that the entire legacy disturbance (185.2 ha) will then be reclaimed to the current standards and that despite no available reclamation material available on this area, the final reclamation of the mine will ensure adequate reclamation material is available to incorporate these areas into the final reclamation plan.

The first reclamation to be completed is planned for Year 2 (Figure F.3.6-1). The planned reclamation for the Project has been shown in five-year intervals on the following figures:

- Years 1 to 5 – Figure F.3.6-1;
- Years 6 to 10 – Figure F.3.6-2;
- Years 11 to 15 – Figure F.3.6-3;
- Years 16 to 20 – Figure F.3.6-5; and
- Years 21 to End of Reclamation (EOR) – Figure F.3.6-6.

At Year 27, all reclamation activities will be completed, with the exception of three surge ponds that will be retained as part of the selenium control and management program. These will be required until the selenium levels in the water are within the allowable release limits to the environment. Once the water is below the release limits, the earthworks will be removed and small wetlands will remain, with all water flowing directly to Blairmore or Gold Creeks.

The mine reclamation program will include the following major activities:

- final grading and recontouring;
- reclamation material replacement;
- revegetation; and
- reforestation.

As mining operations on certain areas of the mine are finalized, the mining areas will be graded and contoured in preparation for reclamation material placement as part of final reclamation. Reclamation material will be sourced from active mining areas if direct placement opportunities exist or will be hauled from stockpile locations on the mine. Replaced reclamation material will be revegetated through a combination of seeding, planting and natural regeneration, depending on the type and extent of the reclamation area, to ensure soils are stabilized and that the species selection promotes the intended final ecological end point.

F.3.6.1 Final Grading and Recontouring

Recontouring operations will be undertaken progressively as each mining phase is completed. Two external rock disposal areas will be created and the majority of the pit will be backfilled with rock as well. As the backfilled areas are completed, they can be leveled off and reclamation can begin. Dozers will be used to recontour all disturbed areas. The dozers push material from the crest to the toe (top to bottom); this process achieves the necessary slope reduction and, at the same time, breaks down the coarse rock overburden into finer material.

All areas will be recontoured to a maximum slope angle of 23˚ (2.5:1) with the exception of the standing highwall located on the north end of the pit.

The final topography will form the final reclamation landforms and will include ridges, benches, valleys, and steep slope inclines that will be integrated with surrounding undisturbed landscape as further discussed in Section F.4.1. The final reclamation landforms will consist of micro and macro scale topographies that will support re-vegetation and provide valuable wildlife habitat components. Activities such as design dumping will be completed on the tops of the reclaim areas to provide an undulating surface. Mineral wetlands will be constructed in depressional areas that are capable of holding water for parts of the year. The sediment ponds will be contoured to develop into small waterbodies and constructed wetlands. Final closure landscapes are further discussed in Section F.4.

F.3.6.2 Reclamation Material Replacement Plan

Upon completion of recontouring and final grading, an assessment of the overburden material will be completed as per Section F.3.5, and previously salvaged and stockpiled reclamation material will be replaced on reclaimed lands. The surge ponds, sediment ponds and the end pit lake that will remain as part of the final reclamation landscape will have mineral soil replaced around the perimeter and across the littoral zones. The surge and sediment ponds will be developed into treed wetlands. Undisturbed areas of the mine site that have the original soil profile intact will not require additional soil placement.

Reclamation material will be replaced over the overburden and will be left in a rough or mounded state. The advantages of a rough soil surface are well documented (Knapik *et al*, 1995) as a rough soil

surface will provide a variety of values for revegetation and wildlife reclamation planning. Benga will replace reclamation material across the Project Footprint at a targeted average depth of 20 cm, over suitable overburden. Reclamation material will be replaced on the reclaimed areas and spread roughly at depths expected to vary between 10 and 30 cm. Areas of the reclaimed mine that have been compacted will be ripped to promote microsites that support tree planting and or natural regeneration.

The following preliminary reclamation material replacement prescriptions are provided for the replacement plan for areas with suitable overburden/subsoil:

- upland soils: 20 cm average replacement depth of reclamation material;
- wetland soils: 20 cm average replacement depth of reclamation material:
  - areas will be reclaimed as wetlands; and
  - lake littoral zones will have mineral soils replaced.
- no soil replacement required:
  - open water sections of surge ponds and sediment ponds;
  - end pit lake;
  - standing highwall area; and
  - areas with no disturbance to the soil profile.

For areas that may have overburden/subsoil that is classed as unsuitable, one metre of suitable material will be placed over the unsuitable material before the reclamation material will be replaced.

As part of the progressive reclamation program, direct placement of salvaged reclamation material will be prioritized for recontoured areas of the completed mining area as they become available for reclamation and as areas of new development have reclamation material salvage operations conducted. The geology of the coal bearing strata and the required mine plan for the development of the Project make the scheduling of direct placement of reclamation material difficult to achieve, however potential for direct placement opportunities are expected to be available during reclamation material salvage of the foothills rough fescue areas scheduled for Year 2. Stockpiled reclamation material will be used to reclaim areas on the majority of the disturbance area.

As areas of the mine are backfilled and recontoured, reclamation material will be directly placed from active areas of the mine or imported from the reclamation material stockpile locations. The reclamation material will be excavated from the source location using an excavator and loaded on trucks for transport to the reclamation areas. Once reclamation material has been replaced at the reclamation areas, dozers will spread the soil at the prescribed depths.

The preferred method of reclamation material placement is to place it with minimal levelling or bulldozing to create a rough soil surface with enhanced micro-relief. To ensure efficient use of the available reclamation material, and to prevent potential shortages, some levelling and spreading will be necessary. The average depth of the replaced reclamation material will be 20 cm but is expected to vary from 10 cm to about 30 cm. Woody slash, stumps, seeds and roots provide significant surface cover, roughness, and source of native plant propagules. Knapik *et al.* (1995) reported that this method has several advantages over conventional "dump & level" methods:

- The soil is not as dense, and so is allowed to settle. This produces a suitable soil bulk density for rooting, with water infiltration and reduced run-off/erosion.
- The varied relief provides more effective shelter from wind, collects and holds snow during chinook wind events, and utilizes more snow melt moisture than levelled soil.
- The slash and debris stay on top to provide cover.
- This technique produces numerous microsites for planting tree seedlings and encourages natural invasion, which produces diversity and opportunity for native species establishment.
- The median thickness provides sufficient water holding capacity on those sites where soil depth may be a limiting factor.
- Surface temperatures are lower on hot summer days due to roughness and debris cover.

This soil spreading practice can be achieved on various surfaces ranging from level to steep areas, or on concave land surfaces.

F.3.6.3 Revegetation Plan

Benga has identified six ecological units occurring over the minesite, based on ecosite phases present in the Montane and Subalpine Natural Subregions (Table F.3.6-1). Many of the ecological units can be further broken down, based primarily on moisture (dry *versus* moist). Archibald's *et al.* (1996) ecosites do not conform exactly to the ecological units, for example, ecosite "c" can be broken into open coniferous, deciduous, and mixedwood ecological units. The ecological units do conform to ecosite phases. Additional ecosite phases for grassland and shrubland have come from Willoughby (2007).

Archibald *et al*. (1996) do not provide ecosite phases for non-vegetated ecological units; the codes provided in Table F.3.6-1 for these ecological units come from the Alberta Vegetation Inventory (AVI) (ASRD 2005). The AVI wetland types have been provided in Table F.3.6-1 for the treed wetland ecological unit.

Table F.3.6-1 Correlation of Pre-Mining Ecosite Phases to Reclaimed Ecological Units	
Pre-Mine Ecosite Phase	**Reclaimed Ecological Unit**
Montane: b1, c1, c2, d2, d3, e1, e3	Closed Conifer Forest
Subalpine: a1, b1, e1, e2, e3, e4, f1, f2, h1	
HG, SO[1], SC[1]	Grassland Open Forest
Montane: a1[1]	
Subalpine: d1	
Montane: b2, b3, c3, c4, d1, e2, f1, g1, g2	Mixed Forest
FONG/MONG[1], FONS[1], FTNN[1] & STNN[1]	Treed Wetland
Subalpine: g1[1], h2[1]	
NWF, NWL, NWR (WONN) [1]	Open Water
NMR	Barren Land
AIH, AII[1], AIM, ASC, CC, CIP, CIW, CL, CO, CP	Anthropogenic

[1] Ecosite Phase or AVI Unit mapped outside of the Project Footprint but within the terrestrial LSA

Table F.3.6-2 indicates the plant species that can be used for revegetation of each of the vegetated ecological units. The topography, aspect and ecosite that the reclaimed ecological unit is expected to represent in the medium to long-term is provided. It is anticipated that the reclamation program will provide the conditions that will guide each reclaimed ecological unit on the desired trajectory.

The reclaimed ecological units that incorporate slope, aspect, and the plants/plant materials should be similar to the ecosites provided in Table F.3.6-2. Figure F.3.6-4 depicts the conceptual plan for reclaimed ecological units across the reclaimed mine site at Year 15, and Figure F.3.6-7 illustrates the reclaimed ecological units at Year 27.

Table F.3.6-2 Target Species of Reclaimed Ecological Communities

Reclaimed Ecological Unit	Climactic Zone		Ecosite Expected (Montane)	Trajectory Setting	
	Topographic Position	Aspect		Naturally Occurring Plant Species to be Encouraged	Species to be Established – planting and natural recovery
CONIFEROUS, CLOSED FOREST					
dry	level, crest, upper to mid-slope	level, north, east, south	d	Shrubs: snowberry, creeping mahonia, white meadowsweet	Trees: lodgepole pine, white spruce Shrubs: green alder, prickly rose Forbs and Grasses: seed mix 1, 2
moist	midslope	all aspects	e	Shrubs: snowberry, Saskatoon, thimbleberry Forbs and Grasses: hairy wild rye, pine grass	Trees: lodgepole pine, white spruce Shrubs: prickly rose Forbs and Grasses: seed mix 3
GRASSLAND, OPEN FOREST					
dry	midslope	level and south	b	Shrubs: Canada buffalo-berry, bearberry Forbs and Grasses: hairy wild rye	Trees: lodgepole pine Shrubs: prickly rose, ground juniper Forbs and Grasses: seed mix 1, 2
moist	midslope	west	c	Shrubs: Canada buffalo-berry Forbs and Grasses: hairy wild rye, rough fescue	Trees: white spruce, lodgepole pine Shrubs: willow, prickly rose Forbs and Grasses: seed mix 3

Table F.3.6-2 Target Species of Reclaimed Ecological Communities

Reclaimed Ecological Unit	Climactic Zone		Ecosite Expected (Montane)	Trajectory Setting	
	Topographic Position	Aspect		Naturally Occurring Plant Species to be Encouraged	Species to be Established – planting and natural recovery
MIXEDWOOD FOREST					
moist	mid- to lower-slope	south, east north	e + c	Shrubs: Canada buffalo berry, snowberry, Saskatoon, thimbleberry Forbs and Grasses: hairy wild rye, pine grass	Trees: aspen, balsam poplar, white spruce, lodgepole pine Shrubs: willow, prickly rose Forbs and Grasses: seed mix 3
TREED WETLAND					
moist	depression to level	level	h (Subalpine)	Trees: Engelmann spruce, dwarf birch	Trees: white spruce Shrubs: prickly rose Forbs and grasses: seed mix 4

F.3.6.3.1 Traditional Use Species

Consultation with Indigenous groups identified a desire to preserve and utilize existing vegetative resources from the mine site. Areas intended for development can benefit Indigenous groups by providing the harvested lodgepole pine and the opportunity to collect and relocate other key species used for medicinal, ceremonial, food, or aesthetic purposes in the Project area.

Project development will remove approximately 1,042.8 ha (or 28.5% of the vegetation LSA at baseline) of ecosite phases that support TEK vegetation potential (Table F.3.6-3). These include 2.4 ha (27.3% decrease from Baseline) of very high or high TEK potential areas in the Montane and 0.8 ha (100%) Subalpine Natural Subregions. This information was presented in the vegetation and wetlands reported (CR #8) of the EIA (2016).

Table F.3.6-3 Effects on TEK Plant Potential in the Local Study Area

TEK Plant Potential	Ecosite Phase / Land Class Description[1]	Area (ha)		Change from Baseline (Without Mitigation)	
		Baseline	Application Case	Area (ha)[2]	Percent Change (%)
Montane					
High	c1, c4, g1	374.3	271.9	-102.4	-27.3
Moderate	b1, b2, b3, c2, c3, d1, d2, d3, e1, e2, e3, f1	1,600.8	1,187.9	-412.9	-25.8
Low	a1, g2	88.0	84.4	-3.6	-4.1
Total Montane	-	**2,063.0**	**1,544.2**	**-518.8**	**-25.1**
Subalpine					
Very high	d1	0.8	0.0	-0.8	-100.0
Moderate	a1, b1, e3, e4, f2, h1	489.7	391.0	-98.7	-20.1
Low / Very low	e1, e2, f1	1,109.1	684.7	-424.5	-38.3
Total Subalpine	-	**1,599.6**	**1,075.7**	**-523.9**	**-32.8**
Total LSA	-	**3,662.7**	**2,619.9**	**-1,042.8**	**28.5**

[1] Ecosite phases are from Archibald *et al.* 1996.

- not applicable.

Note: For individual species or groups of species identified during the consultation process many are common and occur within a range of ecosites. For example, pine, poplar, rose, raspberry, fireweed are common species with wide distributions. Other TEK species or groups of species identified, such as tree lichens and fungus, are common but occur primarily in late succession within mature and old forests. For these species, removal by the project will have an extended effect similar to that described for the assessment of the old growth forest VC.

Ecosite phases with high and moderate TEK plant potential equate to reclamation ecological communities closed coniferous (Montane b1, c1, c2, d2, d3, e3 and subalpine a1, b1, e3, e4, f2), grassland open forest (Subalpine a1, b1), mixed forest (Montane b2,c3, c4, d1, e2, g1) and treed wetland (Subalpine h1).

Indigenous groups have expressed that Benga should take steps to ensure existing resources are salvaged and native plant species are included in reclamation plans.

Benga will undertake further consultation with the Indigenous groups to initiate research and development to determine the potential efficacy of the use of the identified native plant species in the reclamation program. Revegetation targets will aim to include native vegetation species and establish communities that support TEK vegetation.

F.3.6.3.2 Revegetation Techniques

The primary criteria for the selection of revegetation techniques are that they:

- meet reclamation goals;
- are manageable to implement over the spatial scale to which they will be applied;
- meet AER and AEP reclamation standards; and
- have manageable on-going maintenance requirements.

Lands will be progressively reclaimed and adaptive management techniques will be incorporated when selecting the appropriate revegetation techniques.

One of the goals of the revegetation program is to reduce erosion and sedimentation in the watershed. Typically, in moderate to high erosion risk areas, a grass-legume cover is established immediately after soil placement to control erosion. One to four years after the grass-legume mix is seeded, woody species establishment commences with the planting of tree and shrub seedlings. Fertilizer is applied at the time of seeding to increase vegetative growth.

In low erosion risk areas, seed application (grass-legume) will be reduced or eliminated and the planting of shrub and trees and transplantation of plant and plant materials will be done concurrently. Benga will reduce fertilizer application rates and usage.

Revegetation techniques and equipment typically include:

- broadcast seeding and fertilizing using a range of equipment from hand-held seeders to aerial means;
- the direct placement of salvaged reclamation material on recontoured areas, where possible;
- collection of local tree/shrub seed and cuttings;
- contracted greenhouse production of quality tree and shrub seedlings, produced from seed or cuttings which are collected from native (genetically local) plants;
- individual tree and shrub fertilization at the time of planting; and
- rough soil surface and incorporating LFH and woody debris during the final stages of spoil dump construction to create microsites.

The advantages of the direct placement of reclamation material are well documented including utilizing the plant propagules contained in the soil to aid the establishment of native vegetation. To enhance ecosite development, Benga will identify opportunities for direct placement of salvaged reclamation material. The scheduling of direct placement opportunities is limited to having recontoured lands available in proximity to reclamation material salvage areas.

Risks and uncertainties involved with revegetation include:

- availability of native and agronomic seed;
- impact of browsing on newly established deciduous species; and
- extreme weather events.

F.3.6.3.3 Revegetation Prescriptions

Natural Recovery

Natural recovery can be an effective means to encourage presence of native species and improve biodiversity and is most appropriate for revegetation of linear corridors or disturbed lands within approximately 25 m of a desired plant community. If erosion is a concern, erosion control materials (*e.g.,* silt fences) can be placed strategically over bare ground to limit erosion potential. Seeding an annual cover crop, such as annual ryegrass, will also be implemented to control erosion potential on natural recovery sites.

Seeding

Seeding after soil placement is an effective means of increasing vegetated ground cover at a variety of spatial scales, to limit erosion, to control the spread of weed and invasive species, and to allow for the return of ecological structure and function (including succession) over time. The primary method for the application of seed will be aerial broadcasting. This method has been proven the most cost effective delivery system on larger areas of reclaimed land. In small areas, a broadcast seeder, manual or mounted on an ATV, may be used. Species used in seeding and planting are limited by cost, availability, and growth attributes. This technique, along with tree planting, is likely to represent the major revegetation activity by Benga in reclaimed areas.

The conceptual seed mixes have been prepared in line with the Native Plant Revegetation Guidelines for Alberta (Native Plant Working Group, 2000) and included a review of the native plant communities in the pre-disturbance and surrounding landscapes to develop the species composition and distribution required for each ecological reclamation unit. Where necessary, a nurse crop is included to promote establishment of the native species by limiting early successional species (such as tickle grass), to support early establishment and to provide cover for later successional species such as foothills rough fescue and needle grass species.

The seed mixes and specific species proposed for each ecological unit were selected based on:

- availability of high quality seed sources from the local natural region;
- likelihood of successful germination and survival;

- performance and seed purity that is appropriate for the project goals;
- likelihood of achieving reclamation and revegetation objectives; and
- economic viability.

The recommended seeding rates are designed to promote establishment of species for erosion control and soil conservation while allowing natural encroachment of native species. Forested mixes promote vegetative establishment that is not expected to outcompete establishing tree species as the cover crop and early successional species are seeded at a low rate.

Table F.3.6-4 provides the conceptual seed mixes and seeding rates proposed for the Project.

Table F.3.6-4 Seed Mixes

	% by wt
1a. Direct placement monoculture (15-35 kg/ha, no fertilizer)	
Foothills rough fescue	60
Annual ryegrass	40
	100
1b. Direct placement (50 kg/ha, no fertilizer)	
Annual ryegrass	65
Tufted hairgrass	8
Slender wheatgrass	25
Ticklegrass	2
	100
2. Grassland, Open Forest (60-70 kg/ha)	
Foothills rough fescue	15
American vetch	5
Awned slender wheatgrass	10
Annual ryegrass	40
Mountain brome	10
Junegrass	10
Richardson needlegrass	5
Columbia needlegrass	5
	100
3. Closed Conifer Forest (60-70 kg/ha)	
Foothills rough fescue	10
Fringed brome	10
Tufted hairgrass	15

Table F.3.6-4 Seed Mixes	
	% by wt
Awned slender wheatgrass	15
American vetch	5
Annual ryegrass	40
Ticklegrass	5
	100
4. Mixed Forest (60-70 kg/ha)	
Foothills rough fescue	10
Fringed brome	5
Tufted hairgrass	5
Awned slender wheatgrass	10
American sweet vetch	2
American vetch	3
Annual ryegrass	40
Ticklegrass	5
Fowl bluegrass	5
Tufted hairgrass[1]	5
Streambank wheatgrass	10
	100
5. Treed Wetland (60-70 kg/ha)	
Streambank wheatgrass	10
Tufted hairgrass[1]	20
Fowl bluegrass	25[1]
Annual ryegrass	45
	100

[1] Updated as per Addendum 5, IR 117 (CEAA Doc #69)

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.

During the reclamation process, Benga will inspect the lands being reclaimed and evaluate the erosion potential. If the potential for erosion is low, there may be opportunities to limit the seeding

program or the seeding rate. The reduction in seeded species should allow natural succession to aid in the revegetation of the site.

After seeding has been completed and the soils are demonstrated to be stable, tree/shrub planting will be conducted.

Fertilization

Typically, all replaced soils are fertilized during the initial revegetation program. The quick establishment of a vegetative cover is one of the primary tools used at the mine to protect the soils resource from erosion. Fertilization is used to ensure that the initial vegetative cover is established as quickly as possible. Fertilizer will not be used on direct placed soils or organic soils used in wetland reclamation.

The fertilizer commonly used by regional mines is a blend of ammonium phosphate (27-27-0) with an application rate of approximately 180 kg/ha. Benga will use advice from the seed supplier for the type of fertilizer and application rates for the seed mixes being used. The application rate will be based on historical usage at regional coalmines with good results.

It is recognized that the use of fertilizer can slow the ingress of native species by promoting the establishment of the agronomic species in the seed mix. It is anticipated that more emphasis will be put on tailoring the fertilization process to the specific needs of the revegetation program. The slope and aspect of the revegetation areas coupled with an assessment of the erosion potential will be used to assist in the determination of the fertilizer requirements.

Woody Species

Tree and shrub plantings will typically be undertaken two to four years after initial revegetation. By this time, the grass-legume cover has lost its nurse crop species, leaving opportunities for less aggressive plants to establish. A preliminary tree and shrub species selection is provided in Table F.3.6-5.

Table F.3.6-5 Native Woody Plant Species for Reclamation

Coniferous	Deciduous
White spruce (*Picea glauca*)	Trembling aspen (*Populus tremuloides*)
Lodgepole pine (*Pinus contorta*)	Balsam poplar (*Populus balsamifera*)
Whitebark Pine *(Pinus albicaulis)* or limber Pine (*Pinus flexilis*) as available	Dwarf birch (*Betula glandulosa*)

Table F.3.6-5 Native Woody Plant Species for Reclamation	
Coniferous	**Deciduous**
Engelmann spruce (*Picea engelmannii*)	Green alder (*Alnus crispa*)
Douglas fir (*Pseudostuga menziensii*)	Prickly rose (*Rosa acicularis*)
Subalpine fir *(Abies lasiocarpa)*	Willow (*Salix sp.*)
Ground juniper (*Juniperus communis*)	Dogwood (*Cornus stolonifera*)
	Buffalo-berry (*Shepherdia canadensis*)
	Common Bearberry (*Arctostaphylos uva-ursi)*
	Snowberry (*Symphoricarpos sp.)*
	Currant (*Ribes sp.)*

This list includes some, but not all, of those woody species that will regenerate naturally on the Project reclaimed areas, particularly on directly placed soil.

All woody plants used in the program will be grown from locally collected seed or cuttings. Coniferous tree planting densities will be determined by the planned end land use. Shrubs will be interplanted with tree species. Planting will be completed by professional tree planters and will typically occur in the spring to provide a full growing season for the trees to develop a root structure prior to winter.

Plant and Plant Material Transplantation

Transplanting plants and propagules into recently reclaimed areas can assist in increasing the presence of naturally occurring vegetation and/or accelerating a reclaimed area's rate of increasing natural species cover. Examples of transplantation include:

- collection of local tree/shrub seed and cuttings;
- collection of root cuttings;
- LFH plugs from lowland and upland areas to preserve naturally occurring plants and propagules. LFH plugs can be placed in clusters to act as propagule sources to adjacent areas to improve biodiversity; and
- transplanting individuals or small clusters of grass, forb, shrubs, seedlings, and saplings to appropriate reclaimed ecological units. This practice can be categorized as a localized and strategic activity to improve biodiversity, structural diversity, and age distribution.

Rare or culturally valued plants can be transplanted to suitable positions in the reclaimed landscape, if there is a reasonable expectation that relocation will be successful; however, persistence of the species after relocation cannot be ensured.

Cuttings or seed from local sources may also be used to propagate seedlings at a greenhouse or tree nursery for future outplanting. Planting will be completed by professional tree planters and will occur in the spring to provide a full growing season for the trees to develop a root structure.

Weed Control

Weed management is conducted in accordance with the *Weed Control Act*. Benga environmental personnel will be trained in weed identification and will complete visual inspections of reclamation, active mining areas, and legacy mining areas prior to mine development for the occurrence of noxious weeds. All weed occurrences are controlled on an 'as needed' basis. Mechanical treatment and herbicide applications are utilized for control. Control methods will be dependent upon factors such as:

- the type of weed;
- the scale of the weed problem; and
- the location of the weed problem.

Control methods that require the application of a herbicide will be completed by a licensed weed control specialist.

F.3.6.4 Lake Development

Part of the reclamation and closure plan for the Project will include the development of an end pit lake. The lake will have the following general characteristics:

- water level 1,700 m
- perimeter 2,577 m
- littoral area 1.8 ha
- surface area 18.4 ha
- maximum depth 105 m
- average depth 36 m
- volume 6,500,000 m^3
- drainage area 1,032 km^2
- filling time 15.1 yrs

The lake is expected to discharge, east toward Gold Creek. Water in the lake should not contain elevated levels of selenium. Selenium enriched water will be captured and passed through the saturated backfill areas. The saturated backfill areas will remove the selenium from the water and will eventually discharge from the saturated backfill zones into Blairmore Creek.

F.3.7 Targets and Indicators

Table F.3.7-1 presents the targets and indicators Benga will use to assess reclamation success.

Table F.3.7-1 Criteria, Indicators and Targets of Successful Reclamation at Time of Certification

Criteria:	
1. Ecosystem diversity – conserve ecosystem diversity at the landscape level by minimizing disturbance to existing communities and by reclaiming communities that naturally occur in the area.	
2. Species diversity – conserve species diversity at the landscape level, ensuring that functional habitats are re-established in the reclaimed landscapes and that disturbance to existing habitats is minimized.	
3. Genetic diversity – conserve genetic diversity within local populations within the range of natural variability.	
4. Ecosystem resilience and productivity - Conserve ecosystem resilience by minimizing disturbance to communities and by reclaiming communities to equivalent pre-disturbance capability.	
Indicator	**Target**
Species diversity	Increasing trend in number of locally native species
Vertical structure	Trend towards increased vertical structure in all communities except grasslands
Downed woody debris	Clumped and scattered distribution
Native species presence and trends	All woody species are locally native; herbaceous species have trend towards increased native composition
Woody species density and trend in height growth	All woody species are locally native; densities are stable or increasing and increasing trend in height growth at similar level to baseline
Ground cover (erosion control)	No active erosion; ground cover is stable or has increased stability
Vegetation community diversity	Reclaimed habitat types have increasing trend in number of locally native species
Presence of noxious weeds	No prohibited noxious weeds are present

Table F.3.7-1 Criteria, Indicators and Targets of Successful Reclamation at Time of Certification	
Criteria:	
Presence of plant species favoured by targeted wildlife species	Species targeted for introduction as part of the reclamation and revegetation program allow for increased trend in native composition
Habitat availability for targeted species (*e.g.*, grizzly bear, lynx, marten, moose, elk, western toad, Columbian spotted frog, olive-sided flycatcher, great grey owl, and little brown myotis)	Mosaic of reclaimed landforms and target reclamation species trend towards increased native composition
Connectivity between reclaimed communities and adjacent communities	Vegetation communities established on reclaimed lands provide an increasingly effective connection with adjacent communities in terms of safe wildlife movement

F.3.8 Maintenance

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.

F.3.9 Research and Monitoring

Benga will have an extensive monitoring and research program involving a wide range of environmental values including water quality, fisheries, soils, wildlife and revegetation as part of the Project's overall monitoring requirements. The following sections summarize the Project's research and monitoring initiatives as they relate to land reclamation.

F.3.9.1 Reclamation Research and Monitoring Program (RRMP)

Additional research will focus on identifying and resolving issues associated with mine development and reclamation. The research programs will continue to build on the successes made in these areas.

Benga's RRMP will focus on the soils and vegetation resources that are essential to the attainment of the end land use objectives.

Objectives of the RRMP are to:

- assess operational and experimental techniques of soil handling and vegetation establishment against the achievement of stated end land use objectives;

- provide opportunities for comparison with "baseline" or "accepted target" soil and vegetation characteristics in terms of productivity, species composition, capability, and biodiversity;
- identify trends or changes in soil and vegetation characteristics on reclaimed lands over time; and
- assess land capability on reclaimed sites as part of the documentation needed in preparation for reclamation certification.

F.3.9.2 Research Focus

Benga's RRMP will focus on the establishment of plant communities that will have ecological functions similar to those in the surrounding landscape. The main elements of the research component of the program include:

- soil management practices that encourage natural recovery and ecological function;
- the establishment of local native plant species;
- re-establishment of a commercially productive and ecologically appropriate forest cover including whitebark pine and limber pine; and
- achievement of biodiversity objectives to promote biodiversity, such as:
  - landform design including rough soil placement and irregular contour development; and
  - revegetation practices such as natural recovery, nurse crop establishment, direct soil replacement

F.3.9.3 Reclamation Monitoring Program

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 monitoring component of Benga's RRMP involves those aspects that are important in reclamation certification:

- soil replacement characteristics (*e.g.,* depth and quality);
- spoil/regolith characteristics;
- revegetation patterns and performance; and
- wildlife response to reclamation.

Long-term monitoring will be established on undisturbed and reclaimed sites of the Project. 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. Revegetation patterns and characteristics will be assessed using a number of methods, including permanent transects (*e.g.*, modified Whittaker) and temporary plots. Assessment includes vegetation cover, species composition, vegetation competition indices and vegetation/tree changes over time. These plots will also monitor the response of wildlife usage to the newly created habitats, and how they change over time.

Monitoring specific to reforestation will include temporary plots established at the time of planting to measure planting density, planting quality and initial species composition; permanent transects (*e.g.*, modified Whittaker) and forest regeneration surveys (modified Alberta forest regeneration surveys). The forest regeneration surveys will be conducted between years 4 and 8 following planting, and between years 10 and 14, with at least 5 years between each survey. These programs address tree/shrub seedling survival, densities, stocking, productivity and limitations, ground cover composition and change over time, and downed woody debris. Benga will integrate both soils and vegetation monitoring programs where possible to allow analysis and evaluation of reclamation performance.

In addition to the assessment of techniques and the measurement of reclamation outcomes for certification, measurable reclamation criteria must be monitored.

Table F.3.9-1 presents aspects of vegetation and wildlife that will be monitored to determine reclamation success. Monitoring results would be compared to agreed upon EPEA approval conditions.

Table F.3.9-1 Monitoring Plans related to VCs		
VC	**Monitoring plans**	**Indicator, Target**
Soil	• on all reclaimed sites, soil audits will be conducted to confirm that soil placement depth and quality criteria have been met. These audits will be conducted as per provincial guidelines and will be performed within one to two years following soil replacement. direct supervision of salvage and replacement activities by a qualified individual; • erosion of stockpiled or recently replaced soil material as well as effectiveness of erosion control activities; • quality of overburden material through a sampling program in order to determine material replacement requirements; • assessment of vegetation communities to determine if the seral communities established are appropriate for the target local common forest ecosystems and desired end land uses. • monitoring of stockpiled soils and reclaimed areas to ensure erosion is minimized; • develop and implement an erosion control plan as required; • 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; • quality of overburden after mine backfilling and contouring to determine if overburden material located at surface is suitable or unsuitable as root zone medium; • quantity of suitable overburden material placed over unsuitable overburden; and • reclaimed areas for coversoil quality and quantity (depths) and suitability of overburden materials.	• no active erosion • ensure coversoil replacement coverage and depths meet required standards, average of 30 cm depth • no unsuitable overburden at the surface
Terrestrial Vegetation	• Annual assessment of seeded areas to determine germination success and survival. • Annual assessment of propagule transplantation and/or transplantation areas to determine transplant survival and health. • Periodic assessment of the composition, structure, ecological succession and biodiversity of reclaimed vegetation through the establishment of long term monitoring plots. • monitor the survival, growth and health assessments of re-vegetated areas (including noxious and invasive species and effectiveness of control methods). • Routine inspections of reclaim areas to identify erosion problems early so corrective actions can be taken including the establishment of vegetation. • Implement annual weed monitoring.	• effectiveness of reclamation efforts relative to re-vegetation targets • self sustaining vegetative cover • no erosion • vegetation cover, species composition, vegetation competition indices and vegetation/tree changes over time • trend towards increased vertical structure • clumped and scattered distribution of downed woody debris

Table F.3.9-1 Monitoring Plans related to VCs		
VC	**Monitoring plans**	**Indicator, Target**
Rare plants	• Annual assessment of seeded areas to determine germination success and survival • Annual assessment of propagule transplantation and/or transplantation areas to determine transplant survival and health • Periodic assessment of the composition, structure, ecological succession and biodiversity of reclaimed vegetation • Survival, growth and health assessments of re-vegetated areas to monitor the effectiveness of reclamation efforts relative to re-vegetation targets (including noxious and invasive species and effectiveness of control methods)	• Successful germination success and survival • Successful transplant survival and health of propagules • germination rate of reseeded areas 5-15 plants/m^2 • transplantation survival rate 2 plants/m^2
	Rough Fescue: • Range health assessment of natural upland herbaceous grasslands would be conducted at Year 5 and Year 10 once each reclamation phase has been completed. • Additional annual range health assessments would be conducted after Year ten should the results of the range health assessments indicate that the range health functions of the community are not being restored. • Identify areas where natural regeneration of fescue is occurring	• Quantity of successful establishment on reclaimed areas
	White bark and limber pine • identify all limber pine and whitebark pine in advance of tree clearing in the Footprint; • assess which whitebark pine trees are free of disease in the Footprint and mark these individual trees so the cones can be collected before any clearing starts; • careful control of the collected seed and seedling growth when preparing for reclamation; and • monitor the success of all limber and whitebark pine planted seedlings on reclaimed or offset areas.	• Survival rate and Successful establishment on reclaimed areas
Forests/ Old growth forest	• Monitoring specific to reforestation (will be conducted between years 4 and 8 following planting, and between years 10 and 14, with at least 5 years between each survey. • Include temporary plots established at the time of planting to measure planting density, planting quality and initial species composition; permanent transects (e.g., modified Whittaker) and forest regeneration surveys (modified Alberta forest regeneration surveys). • Tree/shrub seedling survival, densities, stocking, productivity and limitations, ground cover composition and change over time, and downed woody debris. • Periodically assess the composition structure ecological succession and biodiversity of reclaimed forested stands • Monitor reforested areas for seedling survival.	• Successful establishment on reclaimed areas • Meet stocking densities for coniferous, deciduous and mixed forests

Table F.3.9-1 Monitoring Plans related to VCs		
VC	**Monitoring plans**	**Indicator, Target**
TEK vegetation	• Periodic assessment of the composition, structure, ecological succession and biodiversity of reclaimed vegetation through the establishment of long term monitoring plots • engage local Indigenous groups to participate in the establishment of TEK vegetation on reclaimed lands and the follow-up monitoring.	• Successful establishment on reclaimed areas • All woody species are locally native; herbaceous species have trend towards increased native composition
Wetlands	• Monitoring and maintenance of drainage control structures should be conducted regularly to ensure water flow and flow patterns are maintained in wetlands adjacent to the Project Footprint • Monitoring road removal at project closure which may have had an effect on adjacent wetlands to ensure restoration of the hydrogeologic regime • Monitoring or reclaimed wetlands should continue for a minimum of ten years to ensure the composition and structure, and key wetland functions are consistent with those in wetlands in the LSA prior to the Project disturbance • Monitoring of reclaimed wetlands should include the use of sub-emergent vegetation species as indicators of wetland health and integrity in the monitoring program.	• Successful establishment on reclaimed areas
Biodiversity	• re-generation survival surveys to monitor for health and survival of planted trees, shrubs and graminoids • 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 re-vegetation • Periodic assessment of the composition, structure, ecological succession and biodiversity of reclaimed vegetation through the establishment of long term monitoring plots.	• Health and survival of planted trees • Composition on monitoring plots • Species diversity: increasing trend in number of locally native species • Community diversity: reclaimed habitat types have increasing trend in number of locally native species
Noxious weeds	• ensure regular annual site inspections during the life of the Project (construction and operation to closure) to identify noxious and prohibitive noxious weeds and invasive species distribution, spread and establishment; • control noxious vegetation species occurrences that are identified during inspections (monitoring); and • assess and report on the success of weed control activities.	• presence of noxious weeds

Table F.3.9-1 Monitoring Plans related to VCs		
VC	**Monitoring plans**	**Indicator, Target**
Wildlife	See Draft Wildlife Mitigation and Monitoring Plan (Appendix 5.39-1) • It is important that monitoring efforts are focused on parameters that are directly related to effects mitigation and that provide opportunities to improve mitigation performance over time. For these reasons, the wildlife monitoring program will initially focus on the following, but will not be limited to: • Continuing with and expanding the use of wildlife camera monitoring as a low-disturbance, passive monitoring approach to quantitatively measure changes in use of preferred habitat types by larger species such as grizzly bear, moose, and elk and elusive species of concern such as marten, lynx, and wolverine in the vicinity of the Project footprint. • Monitoring breeding birds, raptors, waterbirds, bats, and amphibians using sensitive species inventory guidelines (Government of Alberta 2013b) and recommendations from federal recovery strategies (olive-sided flycatcher, common nighthawk, and little brown myotis) as reclamation progresses over the landscape: • Implement a wildlife sighting program for Project personnel and contractors to document wildlife occurrences within the Project footprint during the construction and operations to document wildlife movements. This information can be used for monitoring wildlife use/crossings of access roads to identify major wildlife crossing areas for signage placement, improve employee/contractor wildlife awareness, and assist with monitoring the effectiveness of mitigation measures (*i.e.,* avoiding wildlife-vehicle collisions). • Construction monitoring to ensure timing windows, setbacks, and other mitigation measures are followed. • Monitoring wildlife use of Project-related linear features (*e.g.,* railway loop, transmission line, pipelines, drainage ditches, and ponds) during operation. • Monitoring wildlife crossings to determine the efficiency of the structures at maintaining wildlife movements • Monitoring the effectiveness of any access control measures (*e.g.,* gates) on roads and other linear features. • Monitoring and documenting all human-wildlife interactions that occur within the Project footprint. • Post-closure wildlife monitoring linked with the reclamation monitoring program and any other related environmental monitoring programs, continuing until all permit conditions are satisfied and the AER releases the Project site.	• Monitor and conduct surveys • # animal sightings on wildlife cameras • # of usages of over/underpasses • # of human-wildlife interactions and locations See Draft Wildlife Mitigation and Monitoring Plan (Appendix 5.39-1)

F.3.9.4 Indigenous Engagement in Monitoring

Benga has committed to developing an Indigenous monitoring program in cooperation with nearby Indigenous communities 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.

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.

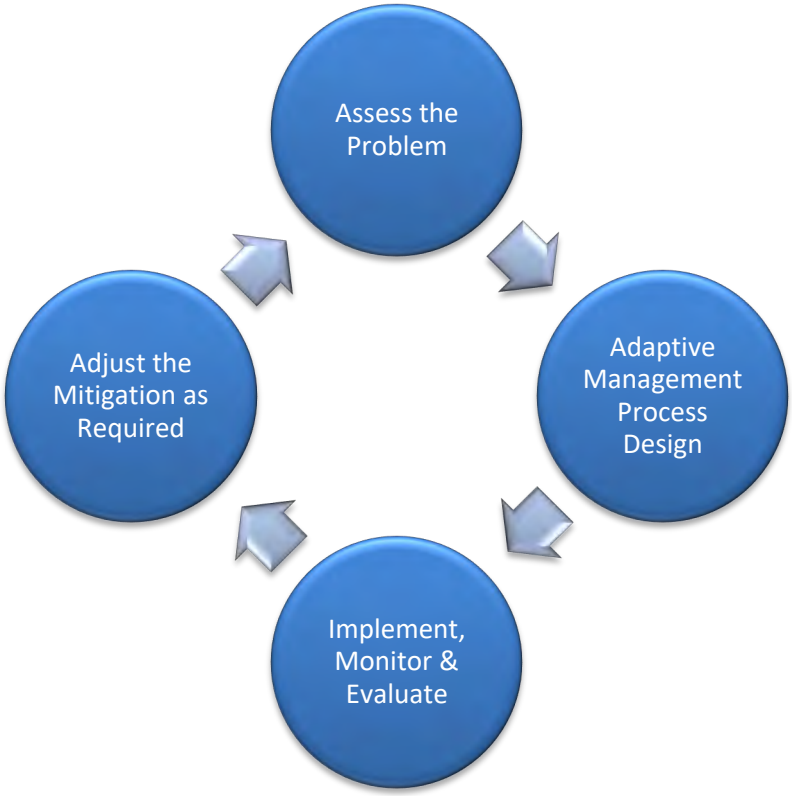


Figure F.3.10 Benga's Adaptive Management Process

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.

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.

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 coal mines, AEP, AER and local stakeholders, to further develop criteria and monitoring programs that clearly demonstrate progress toward reclaiming environmentally sound sustainable ecosystems.

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.

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 the 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.

F.3.10.1 Assess the Problem

Assessing the problem Includes an assessment of the uncertainty associated with the mitigation effectiveness, the likelihood that the uncertainty can by reduced and/or, the opportunities to refine or modify the best practices. To increase the probability of successful reclamation, Benga has monitoring indicators, outlined measurable parameters and targets to achieve reclamation endpoints. Monitoring approaches related to reclamation are generally well understood in the industry and best practices are typically accepted by regulators.

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 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 F.3.10-1.

F.3.10.3 Implement, Monitor and Evaluate

Once Project development begins and the mitigation has been implemented, effectiveness monitoring will commence and observed trends will be compared to predicted trajectories. An evaluation of the monitoring results will determine if adaptations to mitigation need to be implemented. A sequence of actions is triggered if monitoring data indicate that environmental performance does not meet targets.

The mitigation described throughout the EIA (and as updated) will be incorporated into monitoring plans for the Project. Monitoring protocols will be established soon after Project development begins so that trends and progress can be evaluated. Should indicators meet targets or align with desired trends, business will be conducted as usual. 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.
- Adaptations to mitigation will be identified and evaluated based on monitoring results.
- Develop a work plan to adapt mitigation or monitoring, if required.

F.3.10.4 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/ 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. 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.

Table F.3.10-1 Adaptive Management Strategies

Valued Component	Potential Effects	Potential Adaptive Management Strategies
Terrain and Soils		
Soil Quality (Soil profile disturbance before mining)	Increased sedimentation prior to reclamation Poor recovery of salvaged soils	• Add to, or make modifications to, water management system to contain additional sedimentation. • Use different equipment to salvage soils to see if there are improvements to volumes recovered and quality.
Soil Quality (Erosion)	Excessive soil erosion	• Utilize various erosion control techniques like using different geotech materials, add water diversion and energy dissipation structures, modify revegetation techniques and patterns, utilize different equipment, change the recontouring procedures, reduce slopes.
Soil biodiversity & ecological integrity	Blending of soils creates homogenous conditions that could reduce overall diversity	• Try different soil replacement depths and combine different revegetation prescriptions. • Different prescriptions for various slopes, aspect and position on slope. • Modify initial soil salvage techniques.
Alteration of terrain	Reduction of overall slopes and organic wetlands	• Create more micro relief on reclaimed areas. • Modify and improve created wetland features. • Adjust slope angles and slope length. • Modify surface runoff drainage patterns.
Land Capability Effects (Reclaimed overburden materials)	Unsuitable materials may limit reclamation success	• Early identification of problematic materials and develop special handling plans, eliminating the presence from the surface. • Experiment with different additives to modify spoil characteristics to improve quality. • Utilize different revegetation species and techniques to improve overall vegetation success.
Land capability Effects	Unexpected changes to land use patterns	• Incorporating stakeholder driven plans may drive changes. • Identify opportunities to reintroduce human presence onto reclaimed lands.

Table F.3.10-1 Adaptive Management Strategies

Valued Component	Potential Effects	Potential Adaptive Management Strategies
Vegetation & Wetlands		
Terrestrial vegetation	Vegetation removal	• Changes to soil treatments prior to seeding where areas of additional topsoil or de-compaction of subsoils are required to achieve targeted growth. • Modify the site conditions if required to achieve greater germination success and survival by re-creating suitable microtopography conditions for establishment of seeded species. • Adjust planting and transplantation methodologies as required to implement any advances in planting and transplantation methodologies that occur during the life of the operation and reclamation phases that may enhance the establishment of vegetation communities. • Adjust the species composition to be planted if reclamation trends indicate it is required for successful regeneration or if required as a result of future consultation with regulators and stakeholders. • 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.
Rare plants	Removal of rare plants	• Adjust the mitigation strategy of seed and propagule planting to direct transplantation if consultation with the seed collection and propagation specialist determines that any of the seven species (yellow angelica, creeping mahonia, pasture sedge, slender hawk's-beard, elegant aster, silverleaved scorpionweeed, and rose mandarin) are not candidates for seed collection or enough seed cannot be collected. • Reseeding of areas identified by monitoring that may have an initial low germination rate (less than 5-15 plants/m^2) (AENV 2003a). • Implement additional transplantation (of propagated materials) if monitoring indicates low survival (less than 2 plants/m^2) of initial transplanting activities (AENV 2003a). • Manage weed and invasive species in seeded areas and transplant areas to limit competition; and increase weed and invasive control activities in areas where monitoring indicates the occurrence of noxious weeds or invasive species that may affect the successful establishment of seeded and transplanted species. • Watering (by Benga Operations and Reclamation staff) where safe to do so of transplanted areas to assist with long-term transplant survival. • Update mitigation strategies to reflect changes to recommended or required mitigation plans from updated species Recovery Plans (ECCC 2017)

Table F.3.10-1 Adaptive Management Strategies

Valued Component	Potential Effects	Potential Adaptive Management Strategies
	Rough Fescue	• Supplement areas identified during monitoring where foothills rough fescue establishment is limited with a combination of increasing the seeding rate, amending with weed-free rough fescue hay cuttings/mulch harvested from the collection of rough fescue, and transplanting rough fescue plugs as required. • Manage weed and invasive species in seeded areas and transplant areas to limit competition to enhance the establishment of rough fescue. Increase weed and invasive control activities in areas where monitoring indicates the occurrence of noxious weeds or invasive species that may affect the successful establishment of seeded and transplanted rough fescue.
	Removal of whitebark (and limber pine)	• Adjust the locations of whitebark pine plantings if site conditions are not favorable for successful regeneration. • Modify the site conditions to achieve greater germination success and survival such as creating suitable microtopography conditions for seedlings to establish. • Adjust planting and transplantation methodologies as required to implement any advances in planting and transplantation methodologies that may enhance the survival rate of whitebark and limber pine as they arise over the course of the mine reclamation. • Adjust the species composition to be planted if reclamation trends indicate it is required for successful regeneration or if required as a result of future consultation with regulators and stakeholders.
Rangeland resources	Removal of rangeland resources	• See rough fescue
Forest Resources, Old growth forests	Removal of forests	• Adjust seeding and planting rates as well as seed mixes as identified during monitoring activities to ensure appropriate trajectories towards targeted communities determined during finalization of the C&R plan.
Traditionally used plants	Removal of traditionally used plants	• Presence of species as determined during finalization of the C&R plan. • Alter the species composition planted as a result of future consultation.
Wetlands	Removal of wetlands	• Implementation of new wetland establishment techniques developed during the life of the operations and closure of the mine. • Adapting mitigation measures as required such as changes to erosion and sediment control in areas of erosion potential identified during ongoing monitoring, culvert installation and sizing for maintaining drainage patterns, weed control and additional seeding or planting of desirable wetland species.
Biodiversity	Reduction in biodiversity	• Adjustments to monitoring frequency, control of noxious and prohibited noxious weeds and invasive species, and if required additional planting or seeding to maintain trajectory towards biodiversity targets

Table F.3.10-1 Adaptive Management Strategies

Valued Component	Potential Effects	Potential Adaptive Management Strategies
Noxious vegetation	Increase in weeds	• Increase number of site inspections during the course of the year if the density distribution of noxious and prohibitive noxious weeds and invasive species increase or threaten the trajectory of reclaimed vegetation communities and neighboring undisturbed communities • Adjust control measures if they have an undesirable impact on reclaimed vegetation communities and neighboring undisturbed communities. • Utilize any new advances in management and control of noxious and prohibited noxious weeds that are developed during the operation and reclamation life of the mine.
Wildlife		
All VCs Also see the Draft Wildlife Mitigation and Monitoring Plan (Appendix 5.39-1)	Reduced Habitat Availability (direct and indirect loss)	• Development or implement appropriate setback or timing procedures for sensitive wildlife habitat features. • Should Environment and Climate Change Canada (ECCC) have other requirements (*e.g.*, beneficial management practices), Benga will work with ECCC to ensure those mitigation measures are also implemented. • Consulting with ECCC and AEP should hibernacula, fall swarming sites, or maternity roosts be observed during operations. • Lighting: Change the positioning and timing of use of mobile lighting set ups or alter the directional shades (CR#1, EIA, CEAR #42). • Noise: consider replacing noise alarms with lights during night-time activities; use of directional back-up alarms, varying the tones on the back-up alarms (CR#2a, EIA, CEAR #42).
	Reduced movement ability	Crossing modifications: • Evaluate wing fencing at entrances to crossing passages. • Alter walking substrate in underpasses. • Create vegetated buffers adjacent to crossing structures. • Modifications to vegetated buffers (frequency, width, composition).
	Increased mortality	• Establish appropriate buffers around discovered nests. • C&R plan adaptive management. • Modify onsite access and control activities, or employee training around operations practices regarding ATVs or hunting. • Alter speed limits, road signage, or employee training. • Modify waste storage and management (*i.e.* different type of trash containers, or height/type of fencing of waste areas). • Modify spill response or materials storage. • Modify the timing or structure of the procedures to clear areas prior to blasting.

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.

F.4 CLOSURE PLAN

The Closure Plan provides the principles and objectives that will define the reclamation end points needed to achieve equivalent land capability following mine closure. The timing of reclamation efforts throughout the life of the mine is essential to ensure the Project maintains a trajectory towards the desired end land uses and ultimately achieve equivalent land capability. This section describes the C&R and Closure principles that Benga will use for the development of the Project. The implementation of environmental management practices and reclamation efforts designed to achieve these end points are discussed in the following sections.

Through a progressive reclamation program, Benga will have reclaimed almost two-thirds of the mine footprint by the end of the mine life (Year 24). The remainder of the area will be reclaimed within three years of completion of mining (Year 27) with only the infrastructure required for the selenium management program remaining to be reclaimed at a later date (after monitoring).

F.4.1 Reclaimed Landscapes

Although new landscapes will be created during development and reclamation of the Project, they will be stable and able to support a variety of end land uses. The reclaimed landscapes are shown in Figure F.3.6-7. Cross-sections are provided on Figures F.4.1-1, F.4.1-2, F.4.1-3 and F.4.1-4. The new landscapes will be integrated with the surrounding undisturbed lands and will have a diversity of slope classes similar to the pre-disturbance landscapes (Table F.4.1-1). In general, some of the steeper slopes that currently exist will be replaced by shallower slopes that will be purposely leveled to a maximum angle of 23˚ (2.5:1 ratio). There will be some highwall areas on the north side of the pit area left standing (barren land) (Figure F.3.6-7), with slopes of approximately 55˚ to 60˚. A comparison of the pre-mine and post mine topography are shown on Figure F.4.1-6.

A total disturbance of 1,520.7 ha is estimated for the life of the Project. Developments within the minimal disturbance areas will be subject to similar objectives as the minesite, thereby ensuring that these areas are also reclaimed to equivalent capability.

Table F.4.1-1 Comparison of Pre-mining and Reclaimed Terrain at Closure

Slope class	Slope (%)	Approximate Slope (°)	Pre-disturbance (ha)	Pre-disturbance %	Post Reclamation (ha)	Post Reclamation %
1	0-0.5	0	3	0.17	232	15.24
2	>0.5-2	0.3-1.1	13	0.84	104	6.83
3	>2-5	>1.1-3	51	3.35	77	5.04
4	>5-10	>3-5	68	4.45	95	6.24
5	>10-15	>5-8.5	139	9.16	88	5.80
6	>15-30	>8.5-16.5	338	22.21	798	52.50
7	>30-45	>16.5-24	360	23.66	67	4.38
8	>45-70	>24-35	441	28.98	53	3.49
9	>70-100	>35-45	109	7.18	7	0.48
		Total:	**1,520.7**	**100.00**	**1,520.7**	**100**

F.4.2 Soil Management

The reclamation material that will be replaced during reclamation will consist of upland surface soil which includes the litter layer (LFH), A horizon, part of or the entire B horizon, and salvaged deep organics where present. The reclamation material will be able to provide:

- adequate moisture retention capability;
- adequate nutrient supply; and
- ability to support an erosion resistant vegetative cover.

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.

The total volume of reclamation material that is available for salvage within the Project footprint is approximately 3.35 million m^3 and the total required for replacement will be approximately 2.9 million m^3 (this is provided in Table F.2.2-2). There is a small surplus estimated, which will get used as appropriate within the reclamation program.

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.

The soil management plan will ensure that unsuitable overburden materials will not be present in the rooting zone. Overburden material samples will be analyzed to determine the suitability of the material. Benga will ensure that 1 m of suitable overburden/reclamation material exists over top of unsuitable material.

F.4.3 Revegetation

Established revegetation procedures will be used for the Project's revegetation program. The objectives of the revegetation program relate to issues of wildlife, erosion, recreation and tourism, ecological succession, diversity, and traditional land use.

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.

The goals of the revegetation program include:

- establishment of an erosion-resistant plant cover on disturbance areas;
- provision of a diverse range of plant species at the start of reclamation to increase the potential of achieving a biodiversity level equivalent to pre-development conditions; and
- establishment of self-sustaining viable plant communities.

Information from the environmental assessment summarized in Section F.2.1.6, was used to select the target plant communities for the various disturbance areas. The revegetation program is expected to, over time, provide the capability to establish ecosite phases. The development of the ecosite phases are determined by the following factors:

- slope and aspect;
- moisture regime;
- soil type (capability class) and drainage conditions; and
- plant succession.

Vegetation communities are expected to evolve into a biologically diverse forest suitable for commercial forest harvesting, traditional land uses, wildlife and recreational uses. Natural processes

and succession will augment the vegetation program and will provide the framework for the revegetated areas to evolve into ecosystems similar to those naturally present in the region.

Slash and deadfall material add value as an amendment to the replaced soils when incorporated into the soil or spread on the soil surface. Woody debris provides habitat for micro and mega fauna by supplying cover, nesting or denning sites. Woody debris also facilitates revegetation as it provides microsites for plant establishment and decomposing wood provides a moist and fertile seedbed.

A comparison of pre-disturbance and post-reclamation ecological unit cover across the Project footprint is provided in Table F.4.3-1. Figure F.3.6-6 and Figure F.3.6-7 depict the distribution of ecological units at mine closure and following closure of the selenium management plan, respectively.

Table F.4.3-1 Comparison of Cover of Pre-Disturbance and Post-Reclamation Ecological Units in Project Footprint

Ecological Unit	Applicable Ecosite Phases	Baseline Cover		Post-Reclamation Cover	
		Area (ha)	Relative Cover (%)	Area (ha)	Relative Cover (%)
CLOSED CONIFER FOREST					
Montane:	b1, c1, c2, d2, d3, e1, e3	874.4	57.5	987.9	65.0
Subalpine:	a1, b1, e1, e2, e3, e4, f1, f2, h1				
GRASSLAND OPEN FOREST					
Montane	a1[1]	160.0	10.5	276.7	18.2
Subalpine	d1				
	HG, SO, SC				
MIXED FOREST					
Montane:	b2, b3, c3, c4, d1, e2, f1, g1, g2	139.7	9.2	141.8	9.3
TREED WETLAND					
Subalpine:	g1[1], h2[1]	0	0	18.2	1.2
	FONG/MONG[1], FONS[1], FTNN[1] & STNN[1]				
OPEN WATER					
	NWF, NWL, NWR [1] (WONN [1])	0.1	0.01	18.4	1.2
BARREN LAND/DAM					
	AIH, AII[1], AIM, ASC, CC, CIP, CIW, CL, CO, CP, NMR	306.8	20.2	38.0	2.5

Table F.4.3-1 Comparison of Cover of Pre-Disturbance and Post-Reclamation Ecological Units in Project Footprint

Ecological Unit	Applicable Ecosite Phases	Baseline Cover		Post-Reclamation Cover	
		Area (ha)	Relative Cover (%)	Area (ha)	Relative Cover (%)
INCIDENTAL PHYSICAL ACTIVITY (GOLF COURSE AND HELIPAD ACCESS)					
		39.7	2.6	39.7	2.6
TOTAL		**1,520.7**		**1,520.7**	**100**

[1] Ecosite Phase or AVI Unit mapped outside of the Project Footprint but within the terrestrial LSA

F.4.4 Water Management

During operations and closure of the Project, the groundwater and surface water will be managed such that water draining from the mine area will meet accepted water quality standards. At closure, a sustainable system of drainage courses, wetlands and an end pit lake will be developed to manage groundwater and surface water. The topographical characteristics of the final closure landscape have been modified by the mine plan and will have similar drainage patterns. Slope angles will be slightly reduced and all slopes will be revegetated which may reduce the runoff coefficients from pre-disturbance conditions. The surface details will be configured to meet the requirements of a sustainable surface water drainage system with flows being directed towards Gold Creek and Blairmore Creek.

F.4.4.1 Sustainable Drainage

As each mining phase is completed, progressive recontouring operations will be undertaken. The pit will be backfilled with rock to create the final rough landscape. These areas will then be contoured and will have reclamation material replaced. Reclamation material will be either directly placed soil from new disturbance areas on the mine or will be hauled from stockpile sources on the mine. Final landforms will consist of micro- and meso-scale topographies that support re-vegetation and valuable wildlife habitat components while maintaining positive drainage across the site.

During operation, landscape features will establish positive surface and subsurface drainage across the site as runoff and rainfall. Water will be managed appropriately for each onsite feature:

- Water collecting in the pit will be directed through a combination of drainage ditches, sumps and pumps to one of the constructed sediment ponds to be sampled (as needed), treated and eventually released into the local drainages (Gold Creek or Blairmore Creek and eventually to the Crowsnest River).

- Water collecting in the rock disposal areas will be sent to the surge ponds and from there will be directed through the saturated backfill areas for circulation and passive treatment as outlined within the Selenium Management Plan and ultimately discharged into Blairmore Creek.

At mine closure, landscape features will continue to provide positive surface and subsurface drainage across the reclaimed landscape and will contain the following features:

- Water collecting on the north side of the mine will drain towards and fill the end pit lake until the lake capacity is achieved. Outflow from the lake will be established through subsurface drainage channels towards Gold Creek.
- Water collecting in the former pit and rock disposal areas will be managed (separated from clean water in the end pit lake) and circulated through the saturated backfill zones (Figure F.4.4-1) until treatment is complete, then it will be released into Blairmore Creek.
- When selenium levels in the mine wastewater and seepage from the rock disposal areas is below release limits, management of the surge ponds will no longer be required. The dams of the surge ponds will be removed, wetlands created and drainage will follow reclaimed patterns to local drainages (Figure F.4.4-2).

The final landscape pattern will result in a self-sustaining drainage scheme that is consistent with surrounding undisturbed terrain, consisting of replaced reclamation material that is stable and will mimic natural soils over time. The quality of reclamation material placed across the mine will maintain equivalent water holding capacity of the soils across the mine and is expected to improve water holding capacity in higher elevation due to incorporation of finer material and organic debris into sandy soil. The slash and woody debris spread with the soil tends to remain on the surface, providing micro-site diversity and additional cover. The resulting micro-relief provides shelter from dry wind, collects and holds snow during chinook wind episodes, and utilizes more snowmelt moisture. The re-established soils and landscape patterns will provide stable substrate, multiple soil nutrient and moisture regimes within variable slope and aspect positions and will support diverse native vegetation communities with equivalent pre-disturbance capability. Multi-layer plant communities will be established based on natural analogues and input provided from public engagement and Indigenous consultation.

The initial reclamation will seek to establish the plant community, including open forest, mixed forest and treed wetland that best fit the final landscape position (slope, slope position, aspect) and expected long-term ecological conditions. The variety of seed mixes and tree species included in the C&R plan are intended to mimic the natural distribution of plant communities from dryer and poor crests and top slope positions to moist and richer lower slope, toe and northern aspect positions.

Diverse and complex landscape features consisting of a variety of multi-layer plant communities with complex understories and remnant forest patches will result in wildlife habitat suitable for key wildlife indicator species of ungulates, carnivores, amphibians, birds, and bats. Creation of early successional plant communities and forests will provide increasing complexity of wildlife habitat as the ecosystems develop over time.

As this system develops and matures the species diversity, community structure, and ecological function will improve and over time will more closely resemble that of the pre-development conditions.

F.4.4.2 Groundwater

The assessment of potential Project effects on groundwater resources considers changes to groundwater levels, flow patterns and quality, including groundwater/surface water interactions. A Hydrogeological Impact Assessment was completed for the Project application.

The development of the Project is expected to change the groundwater drainage characteristics of developed sub-catchments. The natural catchments within the mine footprint tend to have zones of groundwater recharge at higher elevation near the mountain ridges. At lower elevations, mid-slope or near the valley bottom, the groundwater regime transitions to groundwater discharge zones. In groundwater recharge zones, soil and sub-soil moisture is replenished only by precipitation and overland flow. In groundwater discharge zones, soil moisture is also replenished by groundwater.

The waste rock areas within the site footprint are expected to become groundwater recharge zones following development and reclamation. Groundwater infiltration into the waste rock is expected to discharge near the toe or bottom of the waste rock dump, or potentially recharge deeper groundwater aquifers. The reclaimed groundwater drainage characteristics will have no material effect on reclamation as the dominant pine and grassland species to be used are naturally found from crest to lower slope positions and are tolerant of low moisture conditions."

The creation of saturated backfill zones in the operating and reclaimed landscape is required to provide an effective selenium management plan. There is some groundwater that previously reported to Gold Creek that will now report to Blairmore Creek. Blairmore Creek drainage will see slightly higher groundwater flows at closure and Gold Creek might see a slight reduction. This is one of the potential effects of the selenium management program.

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.

F.4.4.3 Surface Water

Throughout mining operations, the sediment ponds and surge ponds actively manage the surface water for the project. At completion of mining, the sediment ponds will be incorporated into the reclaimed landscape as treed wetlands. The surge ponds will remain active, as the selenium management program will continue until water quality is suitable for release. At this point, the selenium management program will be discontinued with the pipelines removed, the dams lowered, and treed wetlands created. Neither the sediment ponds nor surge ponds are expected to require significant reclamation work at closure and are likely to resemble their end land use several years prior to closure.

Mineral wetlands have been strategically planned at major collection points to provide the benefit of water treatment and flow attenuation. The re-constructed watercourses will be developed as riparian areas by maintaining undisturbed areas or redeveloping on reclaimed areas.

The reclaimed wetlands and treed wetlands (swamps) will target the small marsh and subalpine h (horsetail), montane g (horsetail), ecosites common in lower slope and valley bottom positions. Wetlands will be established on wet (Hygric to Hydric) poorly drained soils. These treed wetland communities are characterized by spruce (Engelman, white) trees, poplar trees, and a diverse shrub community including dogwood, alder, rose, dwarf birch and willows. The understory is also diverse with abundant horsetail and sedges (Carex spp.) generally increasing with greater moisture.

Small marsh wetlands dominated by sedges with variable cover of shrubs will also be established on mineral soil where the water is maintained at or above the surface. These marsh communities will be interspersed within the treed wetlands and at the margins of open water within the reclaimed areas. The establishment of treed wetland and shallow marsh will supply suitable habitat for amphibians and other wildlife. This includes western toad and Columbian spotted frogs that require wetlands and fishless aquatic habitats for breeding.

Reclamation of wetlands will progress as suitable saturated soil conditions allow with the planting of trees and shrubs. Water levels will be maintained due to slope position and drainage characteristics of surrounding lands and also by design at final closure with removal of berms and dams to both maintain water stability within the wetlands and also restore natural drainage. Because the tree and shrub species targeted for use in wetland reclamation are adapted to a range of moisture conditions, planting of trees and shrubs will proceed progressively around the margins of ponds and other water control infrastructure. Generally, forbs and grasses adapted to wet conditions are quick to establish naturally from surrounding undisturbed or reclaimed land. Where natural regeneration is not sufficient the proposed seed mix for treed wetlands will be used (Table F.3.6-4). The understory community will change significantly as the planted trees and shrubs mature and increase the amount

of shade and humidity. The cooler and more humid conditions will facilitate natural succession toward the characteristic horsetail dominated forb understory community.

F.4.4.4 Erosion Control

Erosion will occur on the new landscape at the Project. In order to reduce the negative impact of erosion the landscape will be shaped to provide dips and swales that will reduce slope steepness and slope length, thereby reducing surface flow rates and distance. Some erosion of replaced reclamation material is expected to occur on steep slopes and long slopes. The natural process of erosion, sediment transport and re-deposition within the reclaimed landscape may modify the thickness and texture of surface layers. The loss and deposition of soil adds to diversity and develops more natural soil landscapes. As vegetation cover becomes established and provides effective protection, the frequency and magnitude of erosion will decrease.

Drainage courses on the reclaimed landscape will shift over time as erosion occurs. The drainage courses will be designed to accommodate these changes through the use of erosion control systems such as the use of armouring with boulders and the establishment of vegetation. The reclaimed landscape will be monitored for erosion and excessive erosion will be identified and mitigation will be planned as required. To obtain a reclamation certificate, the lands need to be free of erosion, have a self-sustaining vegetative cover and must be safe and stable.

F.4.5 Closure Landscape

The Project development and reclamation process will establish new landforms. These features are common to coalmine developments and form the landscape of the reclaimed mine. These components include:

- reclaimed powerline, access road and conveyor right of way;
- reclaimed coal handling processing plant and associated infrastructure;
- reclaimed temporary construction camp;
- reconstructed sediment ponds, streams and wetlands;
- reclaimed coal load out and railway loop;
- reclaimed pit and rock disposal areas;
- reclaimed end pit lake;
- highwall and escape terrain feature; and
- miscellaneous features such as haul roads, powerlines and other corridors.

Cross sections that show the pre-mining topography and the reclaimed conditions are shown on Figures F.4.1-1 to F.4.1-5. In general, the topography will be less steep and have lesser slope angles,

with the exception of the highwall feature. All new landforms will have an equivalent land capability as the pre-mining conditions.

The closure landforms were designed such that they are integrated with the adjacent undisturbed lands and watershed systems:

- the location of land uses in areas or on landforms provide physical, biological, social and economic value; and
- forest productivity of reclaimed landscape will be equal to or greater than pre-development conditions.

Figure F.3.6-7 shows the proposed closure landscape for the Project. Benga is committed to ensuring that the final reclamation plan for the Project is integrated and compatible with adjacent undisturbed landforms.

F.4.5.1 Reclaimed Access Road/Conveyor Right of Way

At the time of mine closure, the conveyor right of way and the main site access road will be reclaimed. All of the infrastructure will be removed, and the disturbed areas will be recontoured to blend with the adjacent undisturbed lands. Compacted areas will be ripped to relieve compaction. Conserved reclamation material will be replaced, and the disturbed areas will be revegetated.

F.4.5.2 Reclaimed Plant Site

At the time of mine closure, all associated facilities will be reclaimed. The plant building, maintenance shops and the administration building will be dismantled and removed from the site. The building sites, access roads and coal storage areas will be ripped to relieve compaction and recontoured. Conserved reclamation material will be replaced, and the sites will be revegetated.

F.4.5.3 Reclaimed Temporary Construction Camp

The temporary construction camp will be dismantled and removed from the site prior to mine operations. The camp area will have reclamation material replaced, will be decompacted and revegetated following decommissioning.

F.4.5.4 Reconstructed Sediment Ponds, Drainages and Wetlands

During the operations of the mine, there will be four sediment ponds, four surge ponds, and drainage ditches constructed to manage the mine wastewater generated during the development of the mine. During mine closure, the drainage ditches and sediment ponds will be reclaimed. The sediment ponds can be fully decommissioned and reclaimed once they have demonstrated that sedimentation has been reduced to naturally occurring levels. The areas will be recontoured, reclamation material

will be replaced, and the sites will be revegetated to the requirements of the revegetation program. Three surge ponds will remain intact beyond mine closure until the completion of the selenium management requirements, at which point they will also be revegetated to the requirements of the revegetation plan.

The sediment ponds will be removed and replaced with remnant freshwater ponds or wetlands remaining as discussed in Section F.4.4.3. Western toad and Columbian spotted frogs require wetlands and fishless aquatic habitats for breeding, which these features will provide.

Final detailed plans for these activities will be provided during the closure planning phase.

F.4.5.5 Reclaimed Loadout and Rail Loop

The coal conveyor will transport the clean coal to a rail loadout facility that will be constructed adjacent to the town of Blairmore and will consist of a rail loop, track addition, and supporting infrastructure. The track will connect to Canadian Pacific Railway's (CPR) existing rail line along Highway 3.

At mine closure, the rail loop and supporting infrastructure will be fully reclaimed. The track will be dismantled, and all associated infrastructure will be removed. The area will be recontoured to meet the sloping requirements, compaction will be alleviated, and conserved reclamation material will be replaced. The area will be revegetated to integrate with adjacent lands.

F.4.5.6 Reclaimed Pit and Rock Disposal Areas

The rock disposal areas will be progressively recontoured and reclaimed throughout the life of the mine. As each disposal bench is completed, final contouring will be conducted, and reclamation material will be replaced. Revegetation efforts will be conducted as prescribed in the revegetation plan to achieve the ecological units desired for closure.

F.4.5.7 End Pit Lake

An end pit lake will be developed in the northeast portion of the mine development area. The conceptual physical characteristics for the end pit lake are provided in Table F.4.5-1.

Table F.4.5-1 Lake Characteristics	
Water level (m)	1,700
Lake Surface Area (ha)	18.4
Maximum Depth (m)	105
Average Depth (m)	36
Lake Volume (x 1000 m^3)	6,500
Littoral Zone (ha)	1.8
Littoral Zone (%)	10.0
Drainage Area including lake (km^2)	1,032
Mean Annual Outflow (mm/yr)[1]	738

1. No surface outlet, discharge will flow subsurface through saturated backfill zones for treatment and Se removal.

Based on a review of the post mining hydrology, a design water surface elevation of 1,700 m was determined for the end pit lake.

The lake is expected to discharge, east toward Gold Creek (Figure F.4.4-1). Water in the lake should not contain elevated levels of selenium. Selenium enriched water will be captured and passed through the saturated backfill areas. The saturated backfill areas will remove the selenium from the water and will eventually discharge from the saturated backfill zones into Blairmore Creek.

The end pit lake will have a highwall feature on the west side that has slopes of 55˚ to 60˚. The remaining slopes around the lake will have a maximum reclaimed slope angle of 23˚. The lake is planned to be an aesthetic waterbody and not to have a fisheries component.

F.4.5.8 Highwall Escape Terrain Feature

The north end of the pit is the final area of mining completed for the Project and, when completed, there is no opportunity to backfill the remaining mined-out hole resulting in a highwall (Figure F.4.1-6). A portion of the highwall along the north end of the pit will be left standing, shown on cross-section 17, Figure F.4.1-5. The maximum height will be 330 m above the lake level, with an average of 250 m. The length of the highwall will be 2,050 m and the overall area will be 42 ha. A lake will be created at the bottom of the pit and the lake will fill with water to an elevation of 1,700 m.

The highwall will provide some of the steeper terrain in the reclaimed landscape. Much of the existing steep terrain (>45˚) will be reduced to 23˚ after reclamation. The steeper highwall slopes will provide valuable escape terrain for bighorn sheep and mountain goats. It will also provide valuable habitat for various bird species such as peregrine falcon, black swift, cliff swallow, and golden eagle.

F.4.5.9 Reclaimed Linear Corridors

All roads, powerlines and linear corridors will be reclaimed to equivalent capability during the closure of the mine. Access and haul roads will have all the culverts removed, be ripped to relieve compaction and will be recontoured to integrate with the surrounding landscape. With the replacement of reclamation materials, it is anticipated that the roads will become part of the productive land base.

F.4.5.10 Proposed Golf Course Development

The construction of the rail loop and loadout will displace eight of eighteen holes of the existing Crowsnest Pass Golf and Country Club; as a result, a portion of the golf course will be reconstructed to the northwest of its existing location on Benga private land. The construction of the proposed golf course development is an "incidental physical activity" resulting from the mine development. Upon development of the golf course, the end land use will convert to recreational. The construction, operation and closure responsibilities associated with the proposed golf course development are the responsibility of the Crowsnest Pass Golf and Country Club.

F.4.5.11 Proposed Helipad Access

The construction of the helipad access road will provide access to the forestry helipad for fire suppression. As with the proposed golf course development, the helipad access is an "incidental physical activity" and the reclamation responsibilities will reside outside of Benga, with the Department of Agriculture and Forestry.

F.5 RECLAMATION EFFECTIVENESS AND CLIMATE CHANGE

F.5.1 Climate Change Consideration

Guidelines on incorporating the potential effects of climate change on a Project are provided by the Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment in the document *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (2003) which states:

Information collected through the EA process relating to GHG emissions and the impacts of climate change on a project can:

- *help proponents manage or reduce the potential risk posed by the impacts of climate change to their projects and contribute to climate change action;*
- *provide assurance to the public that climate change implications are being appropriately considered in the assessment of proposed projects;*

- *provide environmental managers with information that will assist their broader climate change action; and*
- *help decision makers to address climate change implications in a risk management context.*

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).

The *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (2003) also states:

> *Incorporating climate change considerations in EA can assist proponents in using best practices that adapt to possible climate change impacts, such as changes in the frequency or intensity of extreme weather events, increases in mean temperatures or altered precipitation patterns and amounts.*
>
> *Recommended Procedures: The recommended procedures for addressing impacts considerations are as follows:*
>
> 1. *Preliminary Scoping for Impacts Considerations;*
> 2. *Identify Impacts Considerations: regional considerations and project sensitivity;*
> 3. *Assess Impacts Considerations: impact on project and risks to public and the Environment*
>   - *assess range of possible changes to climatic parameters*
>   - *determine the range and extent of possible impacts on the project*
>   - *assess the potential risks to the public or environment*
>   - *based upon the risks to the public or environment resulting from the effects of climate change on the project, determine whether impact management is required*
> 4. *Impacts Management Plans: project specifics and ongoing data clarification; and,*
> 5. *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.

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).

F.5.2 Effects of Climate Change on Reclamation

Benga conducted the following assessments related to climate change:

- effects of changes in wildfire frequency and severity on valued components, and any changes required to existing mitigation plans (subsection F.5.2.1);
- frequency and severity of natural hazards now and in the future as a result of climate change (subsection F.5.2.2);
- potential future changes in temperature due to climate change (subsection F.5.2.3);
- potential future changes in precipitation extremes due to climate change (subsection F.5.2.4);
- changes in natural hazards over time and associated risks (to the Project, public, and the environment) (subsection F.5.2.5);
- potential effects of climate change on valued components and its effect on planned mitigation (subsection F.5.2.6);
- a discussion on the direct and indirect effects on the survival or recovery of federally listed species (subsection F.5.2.7);
- a discussion on how climate change may affect anticipated reclamation outcomes for rough fescue communities, whitebark pine (WBP), limber pine and vegetation species important for traditional use (subsection F.5.2.8); and
- a discussion on how climate change may affect anticipated reclamation outcomes for wetland reclamation (subsection F.5.2.9).

F.5.2.1 Effects of Changes in Wildfire Frequency and Severity on Valued Components

Wildfires are a complex product of many factors that affect fuel (availability, fuel moisture, and fuel loading), heat, and oxygen supply (*e.g.*, wind regime). All of these factors are affected by climate and a changing climate could affect the frequency and severity of wildfires. In a warmer environment, water is more likely to evaporate from vegetation, increasing fire risk. Rain and snow falling in heavier bursts, but less frequently, with longer periods of dryness in between, also increases fire risk. These changes may affect Valued Components (VCs) directly, but also through changes to insects, disease, habitat loss, and changes in habitat composition, function or structure. Wildfires not only cause direct mortality, but the reduced air quality produces an increase in eye and respiratory illnesses. In Canada, the main economic costs of wildfires include timber losses, property destruction, fire suppression services, and reductions in tourism (Handmer *et al*. 2012). The Project will not affect the frequency or severity of wildfires.

To provide a more detailed review of wildlife impacts to VCs, historical fire data were retrieved from the Canadian Forest Service's (2016) National Fire Database, which includes data from Alberta for 1931-2015. Wildfires within the Mine Permit Boundary (MPB) have been very infrequent in the past (Figure F.5.2-1 and Table A2.6-1 (Appendix 2.6-1a)), with only one recorded fire crossing into the MPB and Wildlife Local Study Area (WLSA) in 1934. An additional six fires were recorded within the Wildlife Regional Study Area (WRSA).

Boulanger *et al*. (2014) used homogenous fire regime (HFR) zones to make model projections of fire occurrence and annual area burned across Canada. For the HFR zone in which the Project is located (*i.e.*, Southern Cordillera), we obtained model projections for the time periods of 2011-2040 and 2041-2070.

1. Relative to the baseline from 1961-1990 (2-5 fires/100,000 km^2/yr), fire occurrence is projected to be reduced by at least 33% in 2011-2040 and by 25% to 33% in 2041-2070. Based on 1961-1990 baseline values, these changes equate to frequencies of less than 1.34/100,000 km^2/yr in 2011-2040 and less than 1.5/100,000 km^2/yr in 2041-2070.
2. Annual area burned is 1.11-1.33 times higher in 2011-2040 and 2-3 times higher in 2041-2070 than during the baseline period (<0.1% annual area burned). Because areal extent of burn is an increasing function of burn severity (Whitman *et al*. 2015), area burned is used here as a surrogate for understanding the potential effects of climate on burn severity.
3. Conclusion: fire frequency is predicted to decrease at least 25% to 33% over the lifetime of the Project, and total burn area (severity) is projected to increase 11% to 33% by 2040 and 200% to 300% by 2070. Generally, this means fewer but larger wildfires.

Based on historical fire occurrences (area-standardized frequency) of 31.8, 20.8, and 11.2 fires/10^5 km^2/year in the MPB, WLSA, and WRSA, respectively, the projected percentage increase

predicted by Boulanger *et al*. (2014) would equate to future fire occurrences of 21.3 – 23.8, 14.0 – 15.6, and 7.5 – 8.4 fires/10^5 km^2/yr in the MPB, WLSA, and WRSA, respectively (Table F.5.2-1). These values are based on the assumption that Boulanger's baseline of 1961-1990 over a larger geographic scale is representative of the 1931-2013 Project baseline at the local scale.

Table F.5.2-1 Projected Changes in Wildfire Regime

Characteristic and Timeframe	Mine Permit Boundary	Wildlife Local Study Area	Wildlife Regional Study Area
Frequency (fires/year)			
Historical 1931-2015	0.01	0.01	0.08
2011-2040	≤ 0.0067	≤ 0.0067	≤ 0.054
2041-2070	0.0067 – 0.0075	0.0067 – 0.0075	0.054 – 0.060
Fire Occurrence (fires/10^5 km^2/yr)			
Historical 1931-2015	31.8	20.8	11.2
2011-2040	≤ 21.3	≤ 14.0	≤ 7.5
2041-2070	21.3 – 23.8	14.0 – 15.6	7.5 – 8.4
Total Area Burned/Year (%/yr)			
Historical 1931-2015	0.02	0.01	0.13
2011-2040	0.022 – 0.027	0.011 – 0.013	0.14 – 0.17
2041-2070	0.06 – 0.08	0.03 – 0.04	0.39 – 0.52
Total Area Burned/Year (ha/yr)			
Historical 1931-2015	0.6	0.6	95.4
2011-2040	0.7 – 0.8	0.7 – 0.8	106 - 127
2041-2070	1.2 – 1.8	1.2 – 1.8	191 - 286

Other literature points to both increased burn area and increased frequency, resulting from a number of factors including climate change. For example, Westerling *et al.* (2006) and Riley and Loehman (2016) examined historical fire events in the western US and found that large wildfire activity increased in the mid-1980s, with higher large-wildfire frequency, longer wildfire durations, and longer wildfire seasons. They noted increased wildfire activity over recent decades reflected sub-regional responses to changes in climate. As virtually all climate-model projections indicate that warmer springs and summers will occur over the region in coming decades, the predictions support

the tendency toward earlier spring snowmelt and longer fire seasons. This could accentuate conditions favorable to the occurrence of more frequent large wildfires.

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.

Table F.5.2-2 Effects of Changes in Wildfire Frequency and Severity on Valued Components

Valued Component	Potential Effect	Effect on Mitigation
Migratory birds	Altered landscape may increase preferred habitat for some species and decrease preferred habitat for others. Direct mortality of nestlings from fire may decrease in frequency but increase in severity.	No changes anticipated from mitigations/monitoring plans identified in the Draft Wildlife Mitigation and Monitoring Plan (JRP IR-5.39, Appendix 5.39-1)
Olive-sided flycatcher	Increase of preferred post-burn habitat for foraging. Direct mortality of nestlings from fire may decrease in frequency but increase in severity.	No changes anticipated from mitigations/monitoring plans identified in the Draft Wildlife Mitigation and Monitoring Plan (JRP IR-5.39, Appendix 5.39-1)
Little brown myotis	Loss of non-critical habitat (*e.g.*, summer roosts, foraging habitat). Direct mortality of young in maternity roosts may decrease in frequency but increase in severity. Creation of snags for roosting.	No changes anticipated from mitigations/monitoring plans identified in the Draft Wildlife Mitigation and Monitoring Plan (JRP IR-5.39, Appendix 5.39-1)
Common nighthawk	Increase (open areas for nesting and foraging) or decrease (shade) of suitable habitat for breeding and foraging. Direct mortality of nestlings may decrease in frequency but increase in severity.	No changes anticipated from mitigations/monitoring plans identified in the Draft Wildlife Mitigation and Monitoring Plan (JRP IR-5.39, Appendix 5.39-1)
Short-eared owl	Open habitats may increase if area burned increases. Due to nomadism, changing fire regime is not anticipated to have any effects on this species' habitat availability. Direct mortality of nestlings may decrease in frequency but increase in severity.	No changes anticipated from mitigations/monitoring plans identified in the Draft Wildlife Mitigation and Monitoring Plan (JRP IR-5.39, Appendix 5.39-1)

Table F.5.2-2 Effects of Changes in Wildfire Frequency and Severity on Valued Components

Valued Component	Potential Effect	Effect on Mitigation
Whitebark pine and limber pine	Direct mortality in burn areas. Opening up of areas for new regeneration. Reduced competition from Engelmann spruce if total burn area increases in size.	No change to proposed mitigations identified in subsection F.2.8.
Westslope cutthroat trout	Potential for increased runoff/sedimentation from larger burns.	No change to proposed Project mitigations identified in updated Appendix 2B (EIA, CEAR #42).
Indigenous health	Reduced air quality during burns will be less frequent. Air quality may be further reduced during larger fires.	No change to proposed Project mitigations identified in the Updated Assessment on the Potential Effects of the Grassy Mountain Project on Indigenous Peoples (JRP IR-4.1, Appendix 4.1-1)
Indigenous socio-economics	Reduced land use opportunities during burn and while landscape recovers.	No change to proposed Project mitigations identified in the Updated Assessment on the Potential Effects of the Grassy Mountain Project on Indigenous Peoples (JRP IR-4.1, Appendix 4.1-1)
Indigenous physical and cultural heritage	No expected change in damage/disturbance of valued sites on land surface by fire.	No change to proposed mitigations identified in the Updated Assessment on the Potential Effects of the Grassy Mountain Project on Indigenous Peoples (JRP IR-4.1, Appendix 4.1-1)
Traditional land use and resource use	Reduced land use for hunting, trapping, gathering, and reduced access to trails and travelways during burn and while landscape recovers – will become less frequent, but over larger areas.	No change to proposed Project mitigations identified in the Updated Assessment on the Potential Effects of the Grassy Mountain Project on Indigenous Peoples (JRP IR-4.1, Appendix 4.1-1)

The area to be reclaimed is located within the Project's MPB. Changes to the historical fire regime, and potential impacts of fire occurrences, within this local area are uncertain (for reasons including the only fire record is not within Boulanger's baseline timeline, and n=1 fire does not allow for statistics/trends for prediction purposes). The fire regime and changing fire conditions will be monitored and adapted to as per Section F.3.9.

Although the project isn't a measurable contributor to wildfire impacts, Benga will consider the risk of fire in management and reclamation plans including the following (*e.g.,* Keane *et al.* 2017), specifically for whitebark pine and limber pine:

- reducing fuel loads in surrounding whitebark pine and limber pine habitat;
- thin forest stand containing whitebark pine and limber pine to reduce competition from other species, reduce fire severity risk, enhance survivorship;
- supporting planting and recovery efforts in burned areas in the area, within and beyond the MPB in the event that a fire does occur or as part of reclamation;
- implement efforts to protect seed and rust resistant trees and otherwise recover seed from cone trees in advance of construction where feasible to support broader conservation efforts; and
- incorporate climate change into reclamation plans to account for shifting conditions, *e.g.,* plant at higher elevations, consider slope and aspect, use suitable seed stock for conditions, *etc.*

During construction and operations appropriate procedures will be implemented to reduce the risk of fire and response plans developed in conjunction with local emergency services in the event that fires occur within the MPB or surrounding area. In addition, our vegetation management and reclamation plans will be developed to align with species recovery strategies and priorities. This may include additional mitigation measures implemented on site to reduce the risk of fire impacts on threatened species.

F.5.2.2 Future Frequency and Severity of Natural Hazards

Future frequency and severity of natural hazards, relative to current frequency and severity, are provided in Table F.5.2-3 and are based on predictions from the CMIP5 ensemble of models for temperature and wind (CCDS 2017), and CMIP5 projections for extreme temperature and precipitation (CCCMA 2017). These projection data are provided in Appendix A2.6-1a, Tables A2.6-2 to A2.6-13.

Table F.5.2-3 Frequency and Severity of Natural Hazards Now and in the Future as a Result of Climate Change

Natural Hazard	Current		Future	
	Frequency	Severity	Frequency	Severity
Extreme Temperature – Frequency / Severity	1986-2005 max daily temperature: 95th percentile and max = 31.1°C and 31.8°C (Table A2.6-2)		Higher frequency of extreme high temperatures (*i.e.*, >31.1°C). (Tables A2.6-1 and A2.6-2)	Higher maximum daily temperatures (Tables A2.6-1 and A2.6-2).
	1986-2005 minimum daily temperature: 5th percentile and min = -42.0°C and -43.4°C (Table A2.6-3)		Lower frequency of extreme low temperatures (*i.e.*, < -42.0°C). (Tables A2.6-1 and A2.6-3)	Higher minimum daily temperatures (Tables A2.6-1 and A2.6-3).
Extreme Precipitation – Frequency / Severity	1986-2005 1-day maximum: 95th percentile and max = 65.7 mm and 70.9 mm (Table A2.6-6) 1986-2005 5-day maximum: 95th percentile and max = 130.3 mm and 137.9 mm (Table A2.6-7) 1986-2005 # days > 20 mm ppt: 95th percentile and max = 7.1 days and 8 days (Table A2.6-9)		11% to 58% higher frequency of historical extreme based on P_{20} analysis (Tables A2.6-4 and A2.6-5) Lower frequency based on CMIP5 precipitation data: 1-day max, 5-day max, and # days > 20 mm ppt (Tables A2.6-6, A2.6-7, and A2.6-9)	-- Lower severity based CMIP5 precipitation data: 1-day 95th percentile (33.9 mm to 57.3 mm), 5-day 95th percentile (81.5 mm to 103.2 mm) (Tables A2.6-6 and A2.6-7)
Streamflow	Base flows, low flows, and peak flows provided in CR #4 Section 3.6, 3.7, and 3.8. Peak flows for return period of 25 years = 543 and 679 l/s/km2 for Blairmore and Gold Creeks, respectively.		With general reductions in total annual precipitation (Table A2.6-8) and # days with >20 mm precipitation (Table A2.6-9), and a tendency towards longer dry periods (Table A2.6-10), streamflow may be reduced, particularly for higher emissions scenarios. Based on P20 analyses, peak flows may become more frequent.	
Groundwater / Soil Moisture	Groundwater conditions are described in CR #3 Section 4.0 (EIA, CEAR #42), and are complex due to the geology and topography. Soils are described in CR #7 Section 4.0. Soil conditions, including soil moisture, are very diverse across the Project.		Unknown. Recharge of shallow aquifers is likely to be more responsive to regional changes in climate than recharge of deep aquifers (Rivera *et al*. 2003, Clifton *et al*. 2010). Note that local conditions for the Project are not necessarily indicative of the regional conditions that affect aquifer recharge. Soil moisture is likely to decrease (Collins *et al*. 2013, Kirtman *et al.* 2013). Projections include 0% to 1% reduction in soil moisture in the near-term (2016-2035) relative to 1986-2005 (Kirtman *et al*. 2013). However, changes are also dependent on soil characteristics, which may themselves be altered by climate change (Kumar 2012).	

Table F.5.2-3 Frequency and Severity of Natural Hazards Now and in the Future as a Result of Climate Change

Natural Hazard	Current		Future	
	Frequency	Severity	Frequency	Severity
Evaporation Rate	Average annual lake evaporation = 738 mm/yr, average annual evapotranspiration = 262 mm/yr (CR #4 Section 2.6)		Likely to increase as a function of annual temperature increases (Collins *et al*. 2013, Kirtman *et al*. 2013). Projections include up to 5% increase in the near-term (2016-2035) relative to 1986-2005 (Kirtman *et al*. 2013).	
Wind	See Appendix A2.6-1a, Tables A2.6-12 and A2.6-13		Median, 95th percentile, maximum monthly wind speeds lower than historical values (Table A2.6-12). Frequencies of gusts of ≥28 km/h, ≥40 km/h, ≥70 km/h, and ≥90 km/h are projected to increase with climate change (Table A2.6-13). Gust severity (*i.e.*, speed) is not anticipated to increase. More frequent periods of light winds.	
Avalanche	--		Potential effects of climate change on avalanche risk, frequency, and severity are uncertain/unknown (Eckert *et al*. 2009, Bellaire *et al*. 2013, Sinickas *et al*. 2015)	
Erosion	--		Reduced total rainfall and 1-day and 5-day maximum rainfalls would result in reduced soil erosion; however, the analysis of P20 would indicate increased soil erosion risk from more frequent extreme rainfall events (Nearing *et al*. 2004). Effects of changes in precipitation on soil erosion are therefore uncertain. Erosion from wind may increase from increased gust frequency.	
Landslide	--		Increased temperature and decreased annual precipitation may lead to drying that increases slope stability and reduces the risk of rockslides and mudslides. If wind gusts become more severe, slopes may destabilize. "*The type, extent, magnitude, and direction of the changes in the stability conditions of the slopes, and on the location, abundance and frequency of the landslides, are not completely clear. The effects of the warming climate on landslide risk, and particularly the risk to the population, also remain difficult to quantify*" (Gariano and Guzzetti 2016). Huggel *et al* (2011) reviewed major landslide events occurring since the 1990s, including three in BC, and proposed a number of mechanisms that could significantly change landslide magnitude and frequency under a warming climate. Riannaa *et al* (2014) modelled changes in slope movement with precipitation amount, and forecasted reduced movement based on reduced predicted climate-induced rainfall.	

Table F.5.2-3 Frequency and Severity of Natural Hazards Now and in the Future as a Result of Climate Change

Natural Hazard	Current		Future	
	Frequency	Severity	Frequency	Severity
			Similarly, Bathurst *et al.* (2005) used scenario runs of the Hadley Center global circulation model HadRM3 for 2070–2099 as input to a physically based model to assess changes in landslide activity at a site in the Italian Alps. They found slightly reduced debris flow activity in a warmer drier climate. Laloui *et al* (2010) expected shallow slips and debris flows will take place more frequently as a consequence of more extreme weather events, using the example of Switzerland, with stable total precipitation but an increased tendency to stormy and intense weather, especially in fall, spring and winter. As a result, they expected more rain at higher altitudes and increased occurrence of shallow landslides in steep mountainous slopes.	
Subsidence	--	--	No anticipated changes in subsidence resulting from climate change during the life of the Project.	
Seismic Events	From 1985-2016, 4 earthquakes within 25 km of Project centre (magnitude 2.1 to 2.5) and 40 within 100 km (magnitude 0.0 to 4.3). Source: Natural Resources Canada 2017.		No anticipated changes in seismicity resulting from climate change during the life of the Project. If climate change affects plate tectonics, this would be over a much longer time scale than that of the Project.	
Wildfire	See subsection F.5.2-1			

F.5.2.3 Potential future changes in temperature

Projected changes in winter (December, January, February), summer (June, July, August), and annual median temperature relative to historical (1986-2005) winter, summer, and annual median temperature for the Project were determined for three time periods (2020-2029, 2035-2044, and 2050-2059) (Table A2.6-2). Historical and projected future temperatures were acquired from CCDS (2017). Ensemble projections were extracted for three future emissions scenarios (RCP2.6 – low emissions, RCP4.5 – intermediate emissions, and RCP8.6 – high emissions) for the location of 49.5°N latitude and 245.5°E longitude, which is the closest available location to the Project and about 20 km SW from the centre of the proposed pit.

On average, median annual temperatures are projected to increase by 1.1°C to 1.6°C over the duration of the Project under mitigated (low) emission conditions, 1.2°C to 2.3°C under intermediate emissions, and 1.3°C to 2.9°C under high emission conditions. Summer temperatures are projected to increase more than winter temperatures during all time periods and emission scenarios.

Extreme maximum and minimum temperature data were obtained from CCCMA (2017) to assess potential changes in severity with climate change (Tables A2.6-3 and A2.6-4). Daily temperature maxima are projected to increase from historical values over the duration of the Project, and extreme temperatures (greater than the 95th percentile of historical values) are more probable at higher emission levels and at later dates (Table A2.6-3). With winters expected to warm, cold temperatures are not projected to be as extreme as historical minimum temperatures (median, 5th percentile, and minimum) (Table F.5.2-4).

F.5.2.4 Potential future changes in precipitation extremes

Potential future changes in precipitation extremes were discerned through two methods:

- Changes in the historical 20-year return period (ΔP20) for annual daily precipitation extremes were calculated to assess potential future changes in precipitation extremes for the duration of the Project and for three emissions scenarios; and
- Climate model precipitation data (CCCMA 2017) (1-day maximum, 5-day maximum, total annual, number of days >20 mm precipitation, maximum number of consecutive dry days) were reviewed.

ΔP20

The sensitivity was calculated of the historic 20-year return period for annual daily precipitation extremes (ΔP20) for the location (49.5°N latitude and 245.5°E longitude), scenarios, and median annual temperatures provided in Table A2.6-2. Percentage changes in P20 were calculated based on Kharin *et al.'s* (2013) estimate of 10% to 20% reduction in P20 per 1°C increase in local annual

temperature for land in the northern hemisphere (Table A2.6-5); return times for equivalent extreme precipitation were subsequently calculated (Table A2.6-6).

From the ΔP20 metrics, it is expected that extreme rainfalls will occur more frequently as time progresses and if emission levels are higher. Under the worst-case scenario included in the Table A25-6, historical P20 precipitation may be experienced every 8.4 years in 2050-2059. If emissions in the future are similar to the mitigated (low) scenario, historical P20 rainfall is projected to occur approximately every 17-18 years (10% reduction scenario) or 13-16 years (20% reduction scenario) for the duration of the Project. It must be noted that Kharin *et al.* (2013) stated that extreme precipitation projections have large uncertainties associated with them (approximately ±20% error in the extratropics).

Precipitation Model Projections

Projections from the CMIP5 ensemble of models were obtained and reviewed for 1-day and 5-day precipitation maxima, total annual precipitation on wet days (days with >1 mm precipitation), number of days with >20 mm precipitation, and consecutive dry days (days with <1 mm precipitation). Data were extracted from historical data and three future emissions scenarios (RCP2.6, RCP4.5, and RCP8.6) from CCCMA (2017) for the available locations of 1) 49.72°N latitude and 244.69°E longitude and 2) 49.72°N latitude and 246.09°E longitude, which are approximately 64 km west (in mountainous terrain) and 39 km east (in prairie landscape) of the Project, respectively. It is anticipated that future precipitation will be more similar to the mountainous Location 1 than to the prairie Location 2, and the discussion therefore focuses on Location 1.

Projected 1-day and 5-day maximum precipitation (Tables A2.6-7 and A2.6-8), total annual precipitation during wet days (Table A2.6-9), number of days with >20 mm precipitation (Table A2.6-10), and consecutive dry days (Table A2.6-11) were determined for three periods (2020-2029, 2035-2044, and 2050-2050) and compared with historical values (1986-2005).

Each of these five metrics are projected to change over time, with trends differing among potential emissions scenarios and timeframes. The model projections indicate:

- 1-day maximum precipitation values in the future are within the range of historical values, and 95th percentiles and maximum values are all lower than the historical maximum at Location 1 (Table A2.6-7);
- 5-day maximum precipitation values in the future are within the range of historical values, and 95th percentiles and maximum values are all lower than the historical values at Location 1 (Table A2.6-8);

- total annual precipitation in the future is within the range of historical annual accumulations, and 95th percentiles and maximum values are all lower than the historical values at Location 1 with the exception of one 95th percentile (rcp26, 2035-2044) (Table A2.6-9);
- number of days annually with more than 20 mm precipitation in the future is within the range of historical values, and 95th percentiles and maximum values are all lower than or the same as the historical values at Location 1 (Table A2.6-10); and
- median maximum number of consecutive days annually with less than 1 mm precipitation is generally within the range of historical values, but 95th percentile values for rcp45 and rcp68 at Location 1 were higher than historical values (Table A2.6-11).

  Overall: total annual and extreme (high) precipitation events are projected to decrease in the future for the Project as a result of climate change and extended dry (or extreme low) precipitation events are likely to be more common.

Conclusion

The analyses of P20 and ΔP20 indicated historical extreme precipitation levels should occur more frequently in the future due to the local increases in annual temperature (Tables A2.6-5 and A2.6-6). However, the precipitation data indicated 1-day and 5-day maximum precipitation extremes were lower than historical values (Tables A2.6-7 and A2.6-8), which contradicts the former conclusion.

Environment Canada (2016) noted climate models are limited when it comes to predicting precipitation extremes due to the spatial resolution of the models. Kharin *et al*. (2013) also indicated a high level of uncertainty in the projections of extreme precipitation achieved with the most current climate models used in Canada.

Due to the magnitude of the discrepancy in conclusions achieved from the analysis of P20 and the analyses of precipitation projections, it is not possible to discern the probable impacts of climate change on precipitation and precipitation extremes for the Project location. Nonetheless, design criteria for the structures sensitive to precipitation amounts are conservative and included as one potential design basis for the maximum probable flood (PMF). The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation and snow melt measurements coupled with the worst flood producing catchment conditions.

F.5.2.5 Changes in Natural Hazards Over Time and Associated Risks

The information in Table F.5.2-4 is based on predictions of the CMIP5 ensemble of models at Location 1 as discussed in subsection F.5.2.4 above. Benga recognizes that use of the P20 return period projections suggests alternative changes in some of the hazards, and other interpretations of risks.

Table F.5.2-4 Changes in Natural Hazards Over Time and Associated Risks

Natural Hazard	Projected to Change	Confidence	Risk to Project	Subsequent Risk of Effects on Project		Additional Mitigations Required
				To Public	To Environment	
Annual Temperature	Yes – increase (Table A2.6-2)	High	Low	Low	Low	None
Extreme Temperature – Frequency / Severity	Yes – increase of hot extremes, decrease of cold extremes (Table A2.6-3, A2.6-4)	High	Low	Low	Low	None
Total Annual Precipitation	Yes – decrease (Table A2.6-9)	High	Low	Low	Low	None
Extreme Precipitation – Frequency / Severity	Uncertain – increase (Table A2.6-6) or decrease (Tables A2.6-7, A2.6-8, A2.6-10) in heavy ppt extremes. Increase in # consecutive dry days (Table A2.6-11).	Low	Drought – Low Flooding - Low	Low	Low	None
Streamflow	Yes- likely to decrease in general, altered flow regimes, droughts, increased frequency of high flow events (Table F.5.2-3).	Moderate	Low	Low	Low	None
Groundwater / Soil Moisture	Uncertain – groundwater levels (Table F.5.2-3) Yes – soil moisture likely to decrease in general (Table F.5.2-3).	Low High	Low Low	Low	Low	None
Evaporation Rate	Yes - likely to increase 0-5% (Table F.5.2-3).	High	Low	Low	Low	None
Wind	Yes – increase in gust frequency (Table A2.6-13).	High	Low	Low	Low	None
Avalanche	Uncertain (Table F.5.2-3).	Low	Low	Low	Low	None
Erosion	Uncertain (Table F.5.2-3).	Low	Low	Low	Low	None
Landslide	Uncertain (Table F.5.2-3).	Low	Low	Low	Low	None
Subsidence	Uncertain – related to groundwater levels, particularly in shallow aquifers. Unlikely during life of Project.	Low	Low	Low	Low	None
Seismic Events	Unlikely in lifetime of Project (Table F.5.2-3).	High	Low	Low	Low	None

Table F.5.2-4 Changes in Natural Hazards Over Time and Associated Risks

Natural Hazard	Projected to Change	Confidence	Risk to Project	Subsequent Risk of Effects on Project		Additional Mitigations Required
				To Public	To Environment	
Wildfire	Yes – decreased frequency, increased severity (Table F.5.2-1).	High	Loss of access to mine site - Low Loss of mine infrastructure - Low Loss of coal resource - Low	Low	Low	None

F.5.2.6 Potential Effects of Climate Change on Valued Components

Based on analyses completed for temperature, precipitation, and projections resulting from climate change (Tables A2.6-2 to A2.6-13), we can be confident that mean annual temperature, hot temperature extreme frequency/severity, and frequency of wind gusts will increase during the lifetime of the Project, and that cold temperature extremes will decrease in severity and frequency. However, due to contradictions in precipitation predictions, we are not confident in concluding whether the Project will experience more or fewer extreme heavy precipitation events, and therefore what the implications would be on VCs.

Potential effects of these climate change conclusions on VCs during the life of the Project are summarized in Table F.5.2-5.

Table F.5.2-5 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
Migratory birds	Increased temperature (up to 4°C increase in annual median temperature by 2050s) • Range shifts northwest up the Rocky Mountains and to higher elevations to marginal habitats, until vegetation responds to climate change; this may reduce reproduction and survival. • Species ranges may shift northwest up the Rocky Mountains and higher in elevation in response to increased temperatures. • Migratory birds, including species at risk, not currently in the WLSA or WRSA may shift into these areas. • Birds may arrive earlier in the spring and nest earlier – if this occurs out of sync with food availability, nestling survival will decrease Sources: King and Finch (2013), Iverson and McKenzie (2014), Nature Canada (2017)	• Annual breeding bird surveys will be conducted for duration of Project to monitor changes in the migratory bird community, including changes in presence and relative abundance of species at risk. • C&R Plan will be adapted accordingly over time to accommodate requirements of shifting migratory bird community.
	Less precipitation and fewer heavy rainfall events • As for increased temperature • Precipitation-sensitive species' ranges may shift with precipitation rather than temperature (*e.g.,* to lower elevation). Or Increased frequency of heavy rainfall events • Precipitation-sensitive species' ranges may shift with precipitation Sources: King and Finch (2013), Nature Canada (2017)	• As for increased temperature
	Reduced median monthly wind speeds • No anticipated effects Increased frequency of hourly wind gusts • No anticipated effects	• None

Table F.5.2-5 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
Olive-sided flycatcher	Increased temperature (up to 4°C increase in annual median temperature by 2050s) – • As for migratory birds • Recovery Strategy (Environment Canada 2015a) indicates habitat shifting and alternation from climate change will have unknown severity of effect and that the causal certainty of any effect is low (*i.e.,* plausible, but not confirmed).	• As for migratory birds • Any additional information made available for this species (*e.g.,* finalized Recovery Strategy, confirmation of sensitivity to climate change) will be reviewed. C&R Plan will be adapted accordingly. • If required, species-specific mitigation, monitoring, and management program will be developed with support from Environment Canada.
	Less precipitation and fewer heavy rainfall events • As for increased temperature • As for migratory birds Or Increased frequency of heavy rainfall events • As for increased temperature	• As for increased temperature • As for migratory birds
	Reduced median monthly wind speeds • No anticipated effects Increased frequency of hourly wind gusts • No anticipated effects	• None

Table F.5.2-5 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
Little brown myotis	Increased temperature (up to 4°C increase in annual median temperature by 2050s) • Recovery Strategy (Environment Canada 2015b) indicates unknown severity and low causal certainty for effects of climate change on this species. • As for fire (Table F.5.2-2)	• Any additional information made available for this species (*e.g.*, finalized Recovery Strategy, confirmation of sensitivity to climate change) will be reviewed. C&R Plan will be adapted accordingly. • If required, species-specific mitigation, monitoring, and management program will be developed with support from Environment Canada
	Less precipitation and fewer heavy rainfall events • Recovery Strategy (Environment Canada 2015b) indicates unknown severity and low causal certainty for effects of climate change on this species. • As for fire (Table F.5.2-2) Or Increased frequency of heavy rainfall events • Recovery Strategy (Environment Canada 2015b) indicates unknown severity and low causal certainty for effects of climate change on this species.	• As for increased temperature
	Reduced median monthly wind speeds • May overall increase abundance of flying insect prey and suitable foraging time Increased frequency of hourly wind gusts • Temporary reductions in prey availability and suitable foraging time if more frequent during peak foraging periods.	• As for increased temperature

Table F.5.2-5 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
Common nighthawk	Increased temperature (up to 4°C increase in annual median temperature by 2050s) • Recovery Strategy (Environment Canada 2015c) indicates moderate severity and medium causal certainty for effects of temperature extremes related to climate change on this species. o These effects are described for cold wet weather during breeding and tropical storms during fall migration, neither of which are applicable to the Project. Therefore, climate change projected for the WLSA and WRSA would have unknown severity and low causal certainty for this species. • Recovery Strategy (Environment Canada 2015c) indicates unknown severity and low causal certainty for effects of habitat shifting related to climate change on this species. • As for migratory birds • As for fire (Table F.5.2-2)	• Any additional information made available for this species (*e.g.*, finalized Recovery Strategy, confirmation of sensitivity to climate change) will be reviewed. C&R Plan will be adapted accordingly. • If required, species-specific mitigation, monitoring, and management program will be developed with support from Environment Canada
	Less precipitation and fewer heavy rainfall events • As for increased temperature Or Increased frequency of heavy rainfall events • If heavy rainfall events occur during nesting season, reproductive success may decrease, especially if accompanied by cold temperatures (Environment Canada 2015c).	• As for increased temperature
	Reduced median monthly wind speeds • No anticipated effects Increased frequency of hourly wind gusts • No anticipated effects	• None
	Increased temperature (up to 4°C increase in annual median temperature by 2050s) –	• None

Table F.5.2-5 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
Short-eared owl	• Management Plan (Environment Canada 2016b) indicates negligible severity with high and medium causal certainty for habitat shifting/alternation and severe weather resulting from climate change (*i.e.,* climate change is not anticipated to have any effects on this species).	
	Less precipitation and fewer heavy rainfall events • As for increased temperature Or Increased frequency of heavy rainfall events • As for increased temperature	• None
	Reduced median monthly wind speeds • As for increased temperature Increased frequency of hourly wind gusts • As for increased temperature	• None
Whitebark pine and limber pine	Increased temperature (up to 4°C increase in annual median temperature by 2050s) • increased survival spread of mountain pine beetle leading to increased mortality • reduced suitable and available habitat • increased competition from species better adapted to warmer temperatures (*e.g.,* subalpine fir, lodgepole pine) • shift in range northwards through Rocky Mountains Source: AWLPRT (2014a, 2014b).	• Any additional information made available for this species (*e.g.,* federal Recovery Strategy) will be reviewed. C&R Plan will be adapted accordingly.
	Less precipitation and fewer heavy rainfall events • may increase wildfire severity, which has unknown effects on the population of whitebark pine and limber pine at the Project (would be beneficial in terms of eliminating competing species, opening up	• As for increased temperature

Table F.5.2-5 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
	regeneration sites, and reducing susceptibility to mountain pine beetle; would be detrimental in terms of high-intensity fires killing mature trees) Source: AWLPRT (2014a, 2014b). Or Increased frequency of heavy rainfall events • no anticipated effect	
	Reduced median monthly wind speeds • No anticipated effects Increased frequency of hourly wind gusts • No anticipated effects	• None
Westslope cutthroat trout	Increased temperature (up to 4°C increase in annual median temperature by 2050s) • Medium to High severity with Low mitigation potential resulting from increased air/water temperature, shortened winters, higher evapotranspiration, reduced runoff, reduced summer streamflows, increased fire intensity (AWCTRT 2013). o Reduced suitable habitat availability, survival, and reproduction	• None
	Less precipitation and fewer heavy rainfall events • As for increased temperature Or Increased frequency of heavy rainfall events • Increased streamflow and increased runoff may reduce some of the effects of increased temperature	• None
	Reduced median monthly wind speeds • No anticipated effects Increased frequency of hourly wind gusts • No anticipated effects	• None

Table F.5.2-5 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
Indigenous health	Increased temperature (up to 4°C increase in annual median temperature by 2050s) • no anticipated effects assuming people self-mitigate appropriately (*e.g.*, stay indoors during extreme heat, air conditioning, staying hydrated)	• None
	Less precipitation and fewer heavy rainfall events • No anticipated effects Or Increased frequency of heavy rainfall events • No anticipated effects assuming people self-mitigate appropriately (*e.g.*, stay away from streams during/after high rainfall events, follow public warnings or evacuation notices)	• None
	Reduced median monthly wind speeds • No anticipated effects Increased frequency of hourly wind gusts • No anticipated effects	• None

Table F.5.2-5 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
Indigeous socio-economics	Increased temperature (up to 4°C increase in annual median temperature by 2050s) • As for fire (Table F.5.2-2)	• None
	Less precipitation and fewer heavy rainfall events • As for fire (Table F.5.2-2) Or Increased frequency of heavy rainfall events • No anticipated effects unless washouts/flooding prevent workers from attending workplace.	• None
	Reduced median monthly wind speeds • No anticipated effects Increased frequency of hourly wind gusts • No anticipated effects	• None
Indigenous physical and cultural heritage	Increased temperature (up to 4°C increase in annual median temperature by 2050s) • No anticipated effects	• None
	Less precipitation and fewer heavy rainfall events • No anticipated effects Or Increased frequency of heavy rainfall events • No anticipated effects	• None
	Reduced median monthly wind speeds • No anticipated effects Increased frequency of hourly wind gusts • No anticipated effects	• None

Table F.5.2-5 Potential Effects of Climate Change on Valued Components

Valued Component	Potential Effect	Effect on Mitigations[1]
Traditional land use and resource use	Increased temperature (up to 4°C increase in annual median temperature by 2050s) • As for fire (Table F.5.2-2)	• None
	Less precipitation and fewer heavy rainfall events • as for fire (Table F.5.2-2) Or Increased frequency of heavy rainfall events – • reduced use of flooded areas during and while landscape recovers • reduced use if access roads/bridges wash out from flooding	• None
	Reduced median monthly wind speeds • No anticipated effects Increased frequency of hourly wind gusts • No anticipated effects	• None

[1] Mitigations in addition to those provided in the EIA (CEAR #42), and Appendix A-3, Addendum 6 (CEAR #70)

F.5.2.7 Direct and Indirect Effects on the Survival or Recovery of Federally Listed Species

Westslope Cutthroat Trout

AWCTRT (2013) concluded that climate change would result in impacts to westslope cutthroat trout with medium to high severity and with low mitigation potential, due to reduced habitat suitability and availability, increased air/water temperature, shortened winters, higher evapotranspiration, reduced runoff, reduced summer streamflows, and increased fire intensity resulting in erosion. Reduced habitat suitability may subsequently result in a competitive advantage to other fish species.

With limited mitigation potential based on current knowledge of this species and the restricted available habitat for this species, recovery from climate change may be limited.

Whitebark Pine and Limber Pine

Currently, potential effects of climate change on whitebark pine are not understood. Because this species already occurs at the northern limits of its range and at treeline, there is little to no room to expand its range northwards or up in elevation (AWLPRT 2014a). It is likely that its range will shrink. It is also likely that threats from mountain pine beetle will increase due to increased winter survival of this beetle as temperatures increase. Effects of a changing fire regime are not known – may be negative or positive, depending on, for example, the amount of direct mortality, the resulting landcover, changes in competition from other tree species, and change in risk from white pine blister rust.

Limber could respond to increasing temperatures by shifting its range northward or up in elevation (AWLPRT 2014b). Similar to whitebark pine, limber pine is expected to have increased risk from mountain pine beetle as temperatures increase, and unknown effects from a changing wildfire regime. Limber pine may also become more susceptible to limber pine dwarf mistletoe during drought conditions.

Both of these species are expected to exhibit long lag times (>1,000 years to respond to changing climate, during which physiological stress may lead to reduce survival of these species (AWLPRT 2014b).

Due to limber pine currently having more geographical flexibility in where it can shift its range, it is likely to adapt to climate change better than whitebark pine. Should whitebark suffer large losses in suitable habitat, extreme physiological stress during its lag in adapting, and higher risks from white pine blister rust and mountain pine beetle, climate change will have a detrimental effect on its survival and recovery.

Olive-sided Flycatcher

Currently, there is no understanding of potential impacts of climate change on olive-sided flycatcher (Environment Canada 2015a). Similarly, little is known about impacts of other potential threats to this species in its breeding range. It is thought that the greatest threat to this species is loss and degradation of wintering habitat in South America. Should climate change adversely affect this species' wintering habitat by contributing to further habitat loss and degradation, survival of this species may be reduced.

If climate change does negatively impact this species' breeding range due to increasing temperatures, including within the Project location, it is expected that this species will move northward or to higher altitudes to suitable coniferous or mixedwood habitats. It is also possible that this species may experience an overall benefit from a changing fire regime within its breeding range. Until more is known about the potential effects of climate change on this species, and whether it is sensitive to climate change, it is not possible to assess impacts of climate change on survival and recovery.

Little Brown Myotis

Currently, there is no understanding of potential impacts of climate change on little brown myotis (Environment Canada 2015b). Increasing temperatures may be detrimental (*i.e.,* increased evaporative water loss) or beneficial (*i.e.,* increased suitable locations for hibernating), as may be a changing wildlife regime. Reduced precipitation may alter the available insect prey community, thereby indirectly affecting growth and survival.

Until more is known about the potential effects of climate change on this species, and whether it is sensitive to climate change, it is not possible to assess impacts of climate change on survival and recovery.

Common Nighthawk

There is little known about effects of climate change on this species (Environment Canada 2015c). Currently, the most probable effect of climate change on this species is the indirect affect related to reduced insect prey abundance, particularly if unusually cold and wet weather occurs during the breeding season (Environment Canada 2015c).

If climate change does negatively impact this species' breeding range due to increasing temperatures, including within the Project location, it is expected that this species will move northward or to higher altitudes. Until more is known about the potential effects of climate change on this species, and whether it is sensitive to climate change, it is not possible to assess impacts of climate change on survival and recovery.

Short-eared Owl

Based on Environment Canada's (2016) Management Plan for this species, climate change is expected to have a negligible effect on this species within its breeding range. Therefore, climate change is not expected to affect this species' survival or recovery. Should information about potential effects of climate change on this species change in the future, this can be re-evaluated.

F.5.2.8 Climate Change Effects on Anticipated Reclamation Outcomes

Table F.5.2-6 provides an abbreviated summary of climate parameters based on future high and low carbon predictions. The amount of change estimated is not beyond the range of tolerance for critical life history traits for most species present in the Montane and Subalpine regions of Alberta and is within the range of occurrence for the plant communities that are the target of the Projects reclamation plan.

Table F.5.2-6 Projected Climate Parameters near Pincher Greek based on the Average of 12 GCMs (PCC 2016)

Parameter	Baseline Value (1961 – 1990)	High Carbon Prediction, 2050s	Low Carbon Prediction, 2050s
Number of Days above 30 °C	7.6	17.2	15.2
Number of Days below -30 °C	3.0	0.6	0.9
Precipitation (mm)	474.7	487.0	489.2
Total Winter	76.6	79.4	82.2
Total Spring	134.8	151.3	150.8
Total Summer	175.4	164.1	165.5
Total Fall	87.9	92.2	90.7
Frost Free Days	114.3	133.2	129.9

Species response to climate change will not be uniform with some benefitting, some potentially impacted, and others reduced in number or abundance. The reduction in a number or abundance of individual species within their communities may also occur indirectly; as changes to climate can result in changes in relative competitiveness of species within communities. For WBP and limber pine, it is expected that across their range more habitat will become available at higher elevations as habitat at lower elevations becomes less suitable (Hamann and Wang 2006) due to expansion of lower elevation communities (*i.e.*, competition). The process of habitat shifting will occur slowly and long after the Project has been reclaimed.

Reclamation outcomes are driven by both opportunity (*e.g.*, suitable soil volume, nutrient and moisture conditions, propagules) and stochastic (*e.g.*, drought, fire, disease) conditions. Reclamation plans are typically updated every five years to reflect new, site specific knowledge and prediction of

the opportunities that will be present at the time of execution. The amount of time from disturbance (mine advancement) to reclamation is too short for significantly altering reclamation plans as the target plant communities identified today will not change over such a short period. In ecological terms, the time from the initial project disturbance to reclamation is within one rotation (renewal to maturity) for the lodgepole pine forests that are the dominant plant community. In addition, species such as WBP are slow maturing and long lived (500 years or more), such that once established they will effectively resist change due to climate if the climate remains within the tolerable range for the species, and stochastic factors do not occur that are beyond the individual's ability to endure. Thus, the expected direct impact on individual species due to changes in climate parameters would be negligible.

As it relates to indirect effects, the most likely impact on both individual plant species and on reclaimed plant communities may be caused by change in the fire regime (Flannigan *et al.* 2005). Though fire is largely a stochastic process, the modeled changes in climate parameters are expected to increase the area burned each year and in many cases the frequency of fire as well. Where fire adapted species dominate, such as the pine forests in the Project area, it is expected that changes in the fire regime may act to maintain much of the forested areas in younger age classes with less area reaching old age. Because both limber pine and WBP are not well adapted to fire and are slow to mature compared to other pine species, the indirect effect of climate change on the fire regime may over time reduce their numbers – particularly where they occur in mixed species stands. The total absence of fire is also a threat to limber pine and WBP as suitable regeneration space is not opened and competition prevents establishment from seed (Alberta Whitebark and Limber Pine Recovery Team 2014a, 2014b, ECCC 2017).

The draft federal recovery strategy for WBP (ECCC 2017) describes the effects of climate as follows;

> *"Climatically suitable habitat for Whitebark Pine is projected to shift under climate change scenarios, with negligible predicted net change in climatically suitable habitat as habitat lost is replaced by new habitat at higher elevations and higher latitudes (Hamann and Wang 2006). However, the ability of Whitebark Pine to respond to climate change through species migration or in-situ genotypic adaptation will lag behind the rate at which the climate is anticipated to change, owing to its requirement for suitable microsites for establishment, and slow growth rate to maturity. Recovery needs of Whitebark Pine will require that potentially suitable habitat for growth is identified within predicted suitable climate envelopes, to facilitate assisted migration trials or operational migration plantings where appropriate. All restoration activities must address how natural or planted Whitebark Pine will survive under the constant threat of White Pine Blister Rust. "*

Rough fescue has a complex response to fire and may be reduced where fire is excluded allowing fuel to build up resulting in increased fire severity and the spread of competing woody species (Fleenor

2011, Bailey and Anderson 1978). Rough fescue is tolerant of fire during the dormant season and an alteration of the fire regime due to climate change will favor the open forest grassland communities where rough fescue is found. However, fire may not result in an increase in in rough fescue if the occurrence of fire during the growing season increases.

For species listed as important for traditional use, abundance post reclamation is dependent on successful establishment of the communities in which they occur. Again, a change in climatic parameters due to climate change is not anticipated to result in wholesale changes in plant communities, particularly since the natural communities already present are driven largely by terrain (slope and aspect) and occur across naturally steep gradients in local and micro climate. As described for WBP, limber pine and rough fescue it is the anticipated indirect effect of climate change on the fire regime that may have the largest impact on individual species abundance. Since there is no suit of exotic replacement species waiting to invade, the effects of climate change will be manifest as changes in relative species abundance within communities, and over time as changes in relative abundance of communities across the landscape.

F.5.2.9 Climate change and reclaimed wetlands

The predicted changes in the amount of precipitation are provided in Table F.5.2-6. The total amount of precipitation is expected to increase with more precipitation in the spring and less in the summer. Less precipitation in the summer may lead to increased moisture loss late in the season and stress on wetland communities. The reclaimed wetlands planned for the Project are in low receiving landscape positions and intended as treed wetlands (initial target is swamp). Once established swamps are the least sensitive to reduced water levels during late summer. Swamps are typically flooded in the spring and without surface water for significant periods during the growing season (ESRD 2015). Tree growth within swamps is generally improved when the rooting zone is not saturated during the summer.

F.5.3 Strategies to Manage Risks Associated with Reclamation Uncertainty and Climate Change

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.

F.5.3.1 Confidence in Reclamation Mitigation

The initial reclamation will seek to establish the plant community, including open forest, mixed forest and treed wetland that best fit the final landscape position (slope, slope position, aspect) and expected long-term ecological conditions. The variety of seed mixes and tree species included in the C&R Plan are intended to mimic the natural distribution of plant communities from dryer and poor crests and top slope positions to moist and richer lower slope, toe and northern aspect positions.

Diverse and complex landscape features consisting of a variety of multi-layer plant communities with complex understories and remnant forest patches will result in wildlife habitat suitable for key wildlife indicator species of ungulates, carnivores, amphibians, birds, and bats. The reclaimed lands will feature regionally compatible landforms and vegetation patterns that are ecologically functional and successional. The goal of the reclamation plan is to develop lands that are maintenance-free and self-sustaining. Due to progressive reclamation, there is ample opportunity to incorporate adaptive management practices and modify specific reclamation prescriptions to accommodate a gradually changing environment.

The mine reclamation program will include the following major activities:

- final grading and recontouring;
- reclamation material replacement;
- revegetation; and
- reforestation.

Table F.2.8-1 details the reclamation mitigation that is planned for the Project. The confidence in the ability to implement each mitigation measure can be assessed to determine if it changes with future climate change predictions and uncertainty. For most reclamation mitigation, confidence for reclamation success remains the same as originally anticipated in the EIA and is not changed due to the climate change uncertainty.

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).

Terrain and Soils:

- Benga is confident that the mitigation for Terrain and Soils can be implemented as planned, and the confidence generally does not change due to climate change uncertainty. Mitigation

(*i.e.*, final grading, soil stockpiling and reclamation material placement, erosion control, site re-contouring, and reseeding of stockpiles) should proceed with the same level of confidence as originally predicted in the EIA (CEAR #42) regardless of climate change predictions.

Vegetation and Wetlands:

- Species response to climate change will not be uniform with some benefitting, some potentially impacted, and others reduced in number or abundance. As outlined in section F.5.2.8, it is the anticipated indirect effect of climate change on the fire regime that may have the largest impact on individual species abundance. As such, there is moderately reduced confidence in reclamation mitigation involving specific species reestablishment. Therefore, Benga is confident that the mitigation for terrestrial vegetation (*i.e.*, replacing ecological units, tree and shrub plantings, preservation of adjacent vegetation communities, use of coarse woody debris, incorporating traditionally used plants, and establishing multiple layers of vegetation) should proceed with the same level of confidence as originally predicted in the EIA (CEAR #42). As well, mitigation for the reestadblishment of forested landscapes, biodiversity, and traditional use plants remains confident as these involve multiple species and communities. Confidence in wetland reclamation, as described in section F.5.2.9, does not change due to climate change uncertainty.
- There is a moderate reduction in level of confidence in the reestablishment of whitebark pine and rough fescue due the uncertainty in the future forest fire regime associated with climate change (as described in sections F.5.2.7 and F.5.2.8).
- The confidence in the revegetation techniques used for reclamation is expected to remain high. Natural recovery, seeding, fertilization, tree and shrub plantings, and transplantation should be carried out as expected.
- Potential impacts on vegetation that may occur as a result of future climate change, would occur with or without the Project.

Wildlife:

- In general, with the establishment of a diverse and varied landscape, wildlife habitat restoration and recovery of wildlife species is expected to proceed as originally anticipated in the EIA (CEAR #42).
- As discussed in section F.5.2.7, there is currently no understanding of potential impacts of climate change on olive-sided flycatcher, little brown myotis, or common nighthawk. As such, it is not possible to assess impacts of climate change on survival and recovery, and the confidence in its successful recovery is moderately reduced.
- Potential impacts on wildlife that may occur as a result of future climate change, would occur with or without the Project.

Fish:

- Benga is not directly impacting fish and fish habitat within the mainstems of Blairmore or Gold Creek. Potential impacts on fisheries resources that may occur as a result of future climate change, would occur with or without the Project. Through the Project's Fish Offsetting Plan, and supporting Fish Offset Plan Effectiveness Monitoring Plan, Benga will be implementing offsetting measures that intended to have an overall net benefit to fish and fish habitat.

F.5.3.2 Managing Risks

By utilizing the guidance document: *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (2003), Benga will incorporate the following measures to help minimize risks associated with the uncertainty in reclamation mitigation, as mentioned in Section F.5.3.1:

- incorporation of mitigation measures to reduce project vulnerability;
- incorporate adaptive management to reduce risks associated with climate change; and
- incorporate ongoing information gathering and risk assessment.

Benga has incorporated these strategies into Reclamation planning through:

- Advanced planning:
  - Additional planning for reclamation attributes that may be more vulnerable to climate change (*e.g.*, native rough fescue and whitebark pine reclamation);
- 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);
- Precautionary principal and conservative planning:
  - Benga has incorporated the precautionary principal in its Reclamation planning to accommodate uncertainty. For instance, the number of whitebark pine seedlings that will be planted is 63,000 and is three times the conservative pre-disturbance number to account for planting and natural mortality, reclamation of historical mine areas, and future losses;
- Consultation with Indigenous groups and Regulatory Agencies:
  - Benga has committed to ongoing consultation with Indigenous groups on the reclamation plan and monitoring program. This will enable the incorporation of future understanding

of climate change effects and any potential changes to TEK vegetation prescriptions to accommodate changing site conditions.

  - Consultation with Regulators will be ongoing throughout the life of the mine. It is anticipated that a condition in the EPEA approval will require update, review, and approval of the reclamation plan every 3-5 years. This allows the opportunity for continuous improvement and updates to the C&R Plan.

- Ongoing monitoring and review of monitoring findings:
  - 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.
- Continued progression of knowledge in the scientific community and updated versions of Recovery Plans:
  - As the science and knowledge of the effects of climate change on VCs within the Project area increases, and Recovery Strategies are updated, there will be opportunities to incorporate this new knowledge into future updates of the C&R Plan and adaptively manage as appropriate.
- Progressive reclamation:
  - 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.

F.6 REPORTING

It is anticipated that under the Project's EPEA approval there will be conditions outlining the requirements for reclamation planning and monitoring. Benga expects a requirement for an updated Conservation and Reclamation Plan to be submitted to the regulator for review and discussion every three to five years. As such, this document is evergreen, with the next update expected prior to operations, upon the receipt of an EPEA approval. It is also anticipated that an annual Conservation and Reclamation Monitoring Report will be required that outlines the results of the Reclamation Monitoring Program.

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.

F.7 FINANCIAL SECURITY

The Mine Security Financial Program (MSFP) and the associated Mine Financial Security Program Standard (AER 2014) and Guide to the Mine Financial Security Program (AER February 2017) have been reviewed and will be complied with by Benga. Upon completion of the EA Review process, Benga will make the appropriate submission to MFSPSubmissions@aer.ca with the requisite information.

As the Project is as yet not approved and development has not commenced, Benga believes that the MFSP submission will be as outlined below.

According to the MFSP four types of financial security deposits, focusing on various potential risks in the lifecycle of a mine, are contemplated:

- **Base Security Deposit (BSD)**: existing and new projects will be required to provide a base 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 company takes over or the site is closed.
- **Operating Life Deposit (OLD)** addresses the risks at the end of mine life. A company 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 (ASFD)** addresses the risks if a company's cash flow falls below a level deemed adequate to ensure that all MFSP liabilities can be fully funded. The company 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 (ORD)** addresses the risks posed by a company deferring reclamation. The company posts security when they do not reduce liability according to a reclamation schedule approved by the Alberta Energy Regulator.

Benga understands from the MFSP that overall liability is calculated as:

> MFSP Liability ($)=ARO Liability[2] ($) + Other Liability ($). Schedule-MFSP 003-March 2014

[2] ARO liability – The undiscounted and unescalated estimated cost required to settle the suspension, abandonment, remediation and reclamation obligation for the MFSP site (Guide to the Mine Financial Security Program (AER February 2017))

Benga also understands that operators under the MFSP can elect to provide full financial security under the Program and that amount is equal to the MFSP Liability as calculated above. Further, as the Project is a new mine, the direction provided in the MFSP Guide (*Guide to the Mine Financial Security Program, AER March 2014 p.16)* is that the cost of reclamation of the new mine is to be forecast to December 31 of the reporting year.

Benga will follow the MSFP process. As the timing of the mine approval is uncertain, Benga proposes to submit the MFSP report, as outlined above, a minimum of 90 days prior to the expected approval issuance. At this point, the calculation the assets associated with the Project, the deemed netback proposal to the AER and the offsetting environmental liability is impractical. The amount of security is therefore uncertain but will be no less than the BSD amount for new export coal mines of $7,000,000. This security and the manner of calculating the liability to asset relationship will be reviewed annually as required under the MFSP.

F.8 CONCLUSIONS

The reclamation plan for the Project outlines the vision, goals, approach and detailed plans for reclaiming all areas disturbed through the life of this Project. The primary reclamation goal of the Project is to return the lands to a capability that is equivalent to predevelopment conditions and consistent with end land use objectives.

The key components of the reclamation plan that will ensure these goals are met include:

- the Project has sufficient reclamation material to achieve equivalent land capability;
- the closure plan generally results in a reduction of maximum slopes due to the engineering requirements;
- implementing direct reclamation material replacement is an important aspect of maintaining ecological diversity on reclaimed landscape;
- re-established vegetation patterns will be similar to what existed prior to development with early seral stages that are capable of ecological succession;
- progressive reclamation allows for approximately two-thirds of disturbance area to be reclaimed by the time of mine closure;
- incorporate the input of the local and Indigenous stakeholders into the reclamation and closure plans; and
- incorporate adaptive management strategy into all development activities.

F.9 REFERENCES

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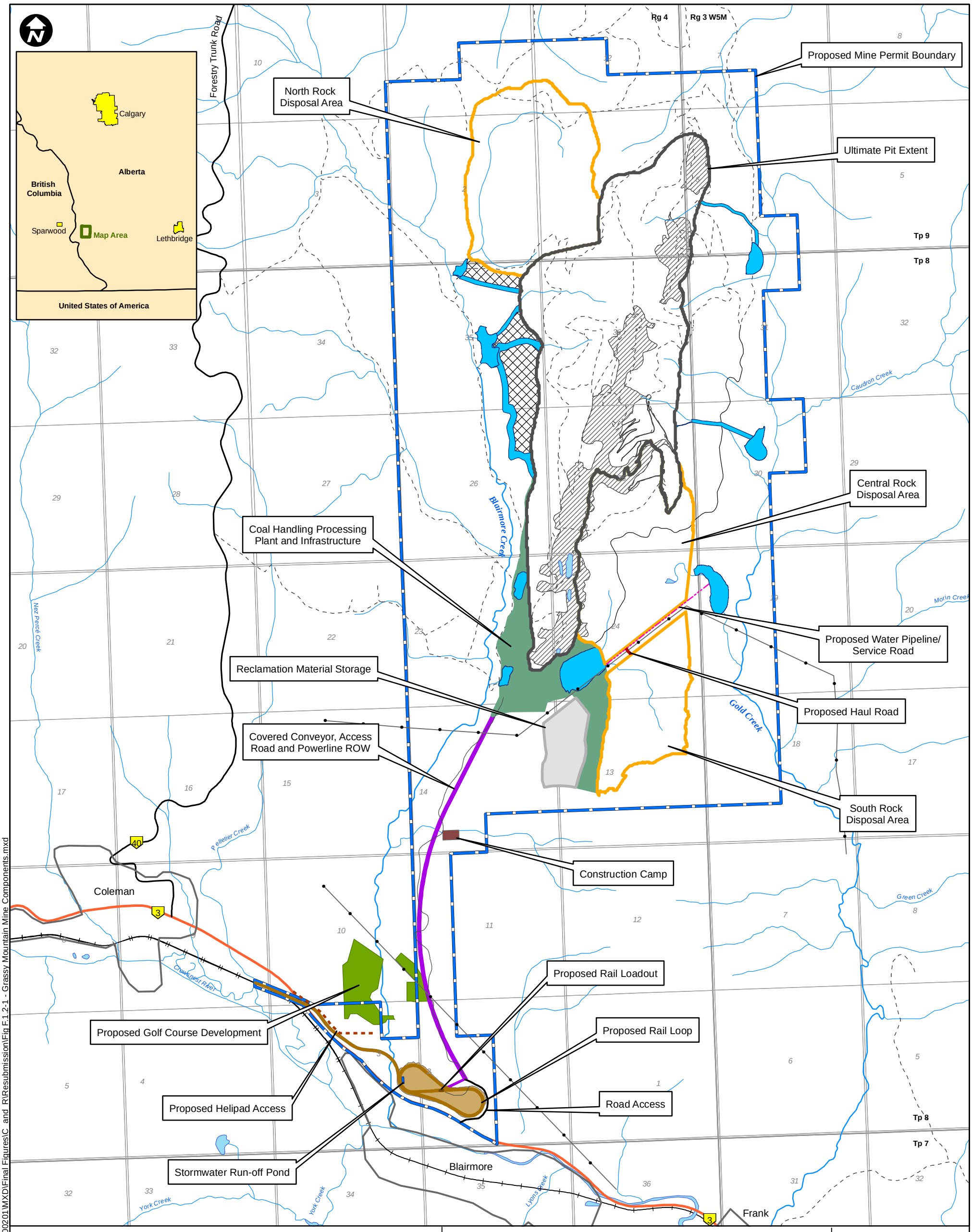
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FIGURES



LEGEND

- Primary Highway
- Secondary Highway
- Existing Trails
- Existing Railway
- Existing Access Road
- Existing Powerline
- Proposed Water Pipeline/ Service Road
- Proposed Helipad Access
- Surface Water Drainage
- Waterbody
- Proposed Mine Permit Boundary
- Ultimate Pit Extent
- Ultimate Rock Disposal Extent
- Reclamation Material Storage
- Construction Camp
- Ponds and Ditches
- Coal Handling Processing Plant and Infrastructure
- Covered Conveyor, Access Road and Powerline ROW
- Railway Loop
- Stormwater Run-off Pond
- Proposed Golf Course Development
- Undisturbed Area
- Legacy Mine Disturbance

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

GRASSY MOUNTAIN MINE COMPONENTS

NOTES

AltaLIS, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

0 0.75 1.5 3
Kilometres

PROJECT: 14-00201-01
DRAWN BY: SL/JL
CHECKED BY: DM
DATE: JULY 8, 2016

FIGURE

F.1.2-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\Resubmission\Fig F.1.2-1 - Grassy Mountain Mine Components.mxd

Freehold = 25.7 ha

Freehold = 8.3 ha

Proposed Golf Course Maintenance Facility Area

Crown = 4.1 ha

Proposed Club House and Parking Area

Proposed Golf Course Crossing

Proposed Helipad Access

Proposed Covered Conveyor, Access Road and Powerline ROW

Existing Helipad Access

Existing Club House

Proposed Rail Loop

Proposed Creek Crossing

Proposed Rail Loadout

Golf Course and Mine Access

Blairmore

10 8-4 W5M

11 8-4 W5M

3 8-4 W5M

2 8-4 W5M

35 7-4 W5M

Blairmore Creek

Crowsnest River

York Creek

Incidental Physical Activity	Hectares
Proposed Golf Course East Area	8.27
Proposed Golf Course West Area	29.80
Proposed Helipad Access	1.65
Total:	**39.72**

LEGEND

- Helipad
- Primary Highway
- Existing Railway
- Main Access Road
- Existing Powerline
- Existing Helipad Access
- Proposed Helipad Access
- Covered Conveyor, Access Road and Powerline ROW
- Railway Loop
- Proposed Mine Permit Boundary
- Stormwater Run-off Pond
- Proposed Golf Course Development
- Existing Golf Course Area
- Proposed Rail Layout (Proposed Cut Area)
- Proposed Rail Layout (Proposed Fill Area)

Golf Course Features

- Cartpath
- Water
- Fairway
- Building

Land Ownership

- Freehold - Benga
- Freehold - Benga 50%, CNP Golf & Country Club 50%
- Freehold - Other
- Registered Roadway

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

INCIDENTAL PHYSICAL ACTIVITIES: PROPOSED GOLF COURSE DEVELOPMENT AND HELIPAD ACCESS AREAS

NOTES

AltaLIS, 2015; DialecticResearch, 2015; Geobase 2015; NRCAN, 2015; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL/JL
CHECKED BY:	DM
DATE:	JULY 8, 2016

0 125 250 500
Metres

FIGURE

F.1.3-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\ResubmissionFig F.1.3-1 - Incidental Physical Activities.mxd



Photo 1: Looking north/northeast at area impacted by legacy mining (July 2014).



Photo 2: Looking south along legacy mine cut (July 2014).



Photo 3: Northward view of approximately 70 cm DBH Whitebark pine on historical mining activity waste rock, located on Grassy Mountain (April 2016).

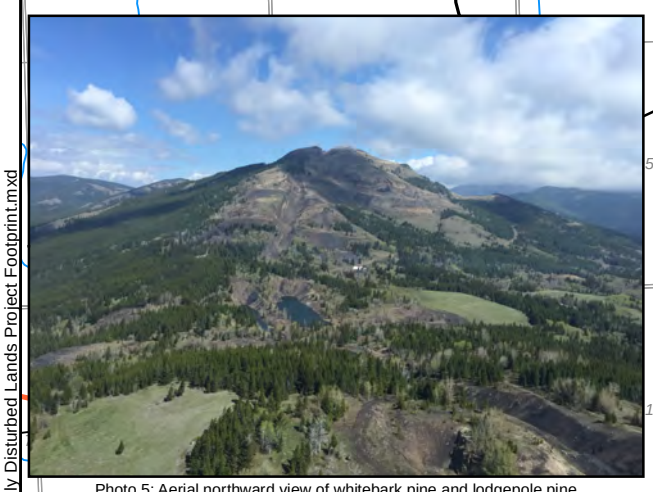


Photo 5: Aerial northward view of whitebark pine and lodgepole pine on a south facing slope on Grassy Mountain. Example of historical mining activity disturbance in background (April 2016).



Photo 10: Looking west at legacy mining disturbance on north edge of project Footprint (July 2014).



Photo 9: Looking south at degrading surface conditions in legacy mining area (July 2014).



Photo 8: Southward view of grassland with scattered pine species adjacent to historical mine waste rock on Grassy Mountain (April 2016).



Photo 6: Aerial northward view of sparse grassland and pine species along a legacy mine disturbance on Grassy Mountain (April 2016).

Photo 8 P
Photo 7 P
Photo 1 P
Photo 6 P
Photo 2 P
Photo 3 P
P
Photo 5
Photo 4 P

Rg 4 Rg 3 W5M
Daisy Creek
Blairmore Creek
Gold Creek
Green Creek
York Creek
Lyons Creek
Blairmore
Frank
3

LEGEND

- Photo Location
- Surface Water Drainage
- Primary Highway
- Secondary Highway
- Road Access
- Existing Trails
- Existing Railway
- Proposed Mine Permit Boundary
- Proposed Mine Permit Boundary Addition
- Project Footprint
- Undisturbed Area
- Legacy Mine Disturbance

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

PREVIOUSLY DISTURBED LANDS ON THE PROJECT FOOTPRINT

NOTES

AltaLIS, 2016; Geobase, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL/JDC
CHECKED BY:	DM
DATE:	JUNE 10, 2016

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Kilometres

FIGURE

F.2.1-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\ResubmissionIFig F.2.1-1 - Previously Disturbed Lands Project Footprint.mxd

Forestry Trunk Road

Rg 4 Rg 3 W5M

Tp 9

Tp 8

Photo 1, 2

Photo 3

Photo 8

Photo 4

Photo 7

Photo 6

Photo 5

Coleman

Blairmore

Frank

Crowsnest River

Lyons Creek

Blairmore Creek

Gold Creek

Green Creek



Photo 1: Example of recreational vehicle use occuring around Blairmore Creek and Gold Creek. Image taken by Wildlife Camera (GM06) located on main trail running parallel to Blairmore Creek. This trail crosses the creek multiple times (March 2016).



Photo 2: Example of livestock grazing that occurs near Blairmore Creek and Gold Creek. Image captured on Wildlife Camera GM06 (June 2014).



Photo 8: View of the landscape degradation along Gold Creek resulting from Legacy mining activity (July 2014).



Photo 7: Example of ATV/Vehicle crossing that occur on both Gold Creek and Blairmore Creek. This specific crossing is located on Gold Creek.



Photo 6: Coal fine deposits and legacy infrastructure along the mainstem of Gold Creek.



Photo 3: Looking north east from the west shore of a legacy pit lake on the lower portion of the mine. Note the legacy mining disturbance on the mountain in the background (July 2014).



Photo 4: Coal fine deposits acting as streambanks on the mainstem of Gold Creek.



Photo 5: View looking downstream past old water supply dam that defines the downstream end of that part of Gold Creek designated in the Recovery Plan as critical habitat for west slope cutthroat trout.

LEGEND

- Photo Location
- Surface Water Drainage
- Primary Highway
- Secondary Highway
- Road Access
- Existing Trails
- Existing Railway
- Proposed Mine Permit Boundary
- Proposed Mine Permit Boundary Addition
- Project Footprint
- Undisturbed Area
- Legacy Mine Disturbance

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

EXISTING DISTURBANCE OCCURING ON THE BLAIRMORE CREEK AND GOLD CREEK

NOTES

AltaLIS, 2016; Geobase, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL/JL
CHECKED BY:	DM
DATE:	JULY 8, 2016

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Kilometres

FIGURE

F.2.1-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\Resubmission\Fig F.2.1-2 - Existing Disturbance on Blairmore and Gold Creek.mxd

Northern

Central

Southern

Rg 4

Rg 3 W5M

Tp 9

Tp 8

Tp 7

Caudron Creek

Blairmore Creek

Gold Creek

Morin Creek

York Creek

Lyons Creek

Blairmore

3

LEGEND

- Surface Water Drainage
- Primary Highway
- Secondary Highway
- Existing Railway
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Steep Slope (>27 degrees)
- Previously Disturbed Lands
- Soil Salvage Area

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

SOIL SALVAGE AREA ON THE PROJECT FOOTPRINT

NOTES

AltaLIS, 2016; Geobase, 2016 MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL/JDC
CHECKED BY:	JH
DATE:	JUNE 10, 2016

0 0.75 1.5 3
Kilometres

FIGURE

F.2.1-3

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\Resubmission\Fig F.2.1-3 - Soil Salvage Area Project Footprint.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Tp 8
Tp 7
Forestry Trunk Road
Nez Percé Creek
Pelletier Creek
Crowsnest River
York Creek
Blairmore Creek
Gold Creek
Caudron Creek
Morin Creek
Green Creek
Lyons Creek
Coleman
Blairmore
40
3

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Existing Trails
- Surface Water Drainage
- Waterbody
- Soils Regional Study Area
- Soils Local Study Area
- Undisturbed Area

Reclamation Suitability (A and B Horizons)

- Good - Fair
- Good - Poor
- Fair
- Fair - Poor
- Poor
- Unsuitable
- Not Rated

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAMATION SUITABILITY RATINGS

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

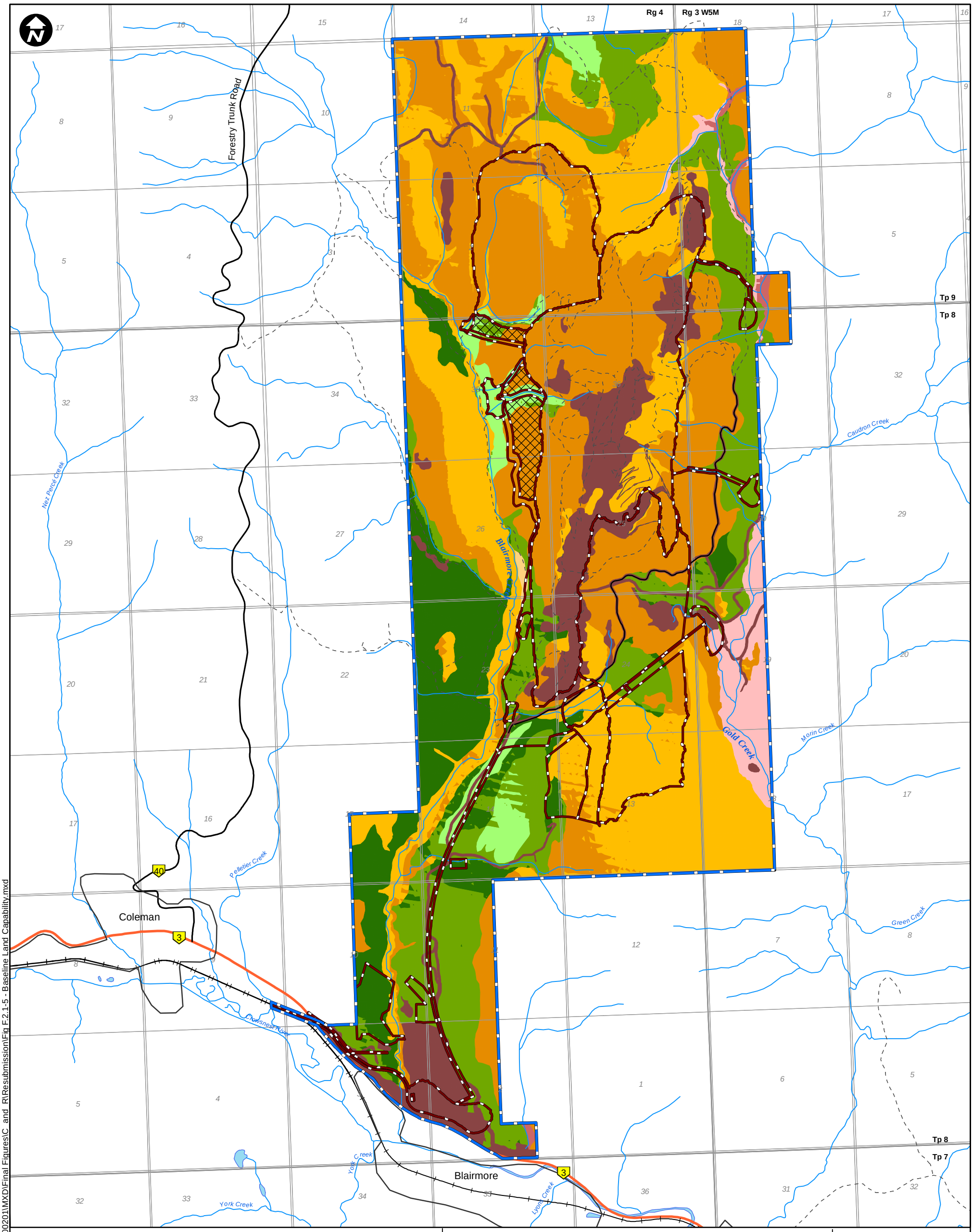
PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JUNE 10, 2016

0 0.75 1.5 3
Kilometres

FIGURE

F.2.1-4

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\Resubmission\Fig F.2.1-4 - Reclamation Suitability Ratings.mxd



LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Existing Trails
- Surface Water Drainage
- Waterbody
- Soils Regional Study Area
- Soils Local Study Area
- Undisturbed Area

Baseline LCC Class

- 4
- 4-5
- 4-6
- 5
- 5-6
- 5-7
- 6
- 6-7
- 7
- NA

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

BASELINE LAND CAPABILITY

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	VL
DATE:	JUNE 10, 2016

0 0.75 1.5 3
Kilometres

FIGURE
F.2.1-5

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\IC and R\Resubmission\Fig F.2.1-5 - Baseline Land Capability.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Tp 7
Forestry Trunk Road
Nez Percé Creek
Blairmore Creek
Caudron Creek
Gold Creek
Morin Creek
Pelletier Creek
Green Creek
Crowsnest River
York Creek
Lyons Creek
Coleman
Blairmore
40
3

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Existing Trails
- Surface Water Drainage
- Waterbody
- Soils Regional Study Area
- Soils Local Study Area
- Undisturbed Area

Reclaimed LCC Class

- 4
- 4-5
- 4-6
- 5
- 5-6
- 7
- NA

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAIMED LAND CAPABILITY

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	VL
DATE:	JUNE 10, 2016

0 0.75 1.5 3
Kilometres

FIGURE

F.2.1-6

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\Resubmission\Fig F.2.1-6 - Reclaimed Land Capability.mxd

Label ID	Scientific Name	Common Name
1	Crepis Atribarba	Slender Hawk's-Beard
2	Angelica Dawsonii	Yellow Angelica
3	Eucephalus Engelmannii	Elegant Aster
4	Piperia Unalascensis	Alaska Bog Orchid
5	Cladonia Symphycarpia	Split-Peg Lichen
6	Pinus Flexilis	Limber Pine
7	Piperia Unalascensis	Alaska Bog Orchid
8	Streptopus Roseus	Rose Mandarin
9	Angelica Dawsonii	Yellow Angelica
10	Angelica Dawsonii	Yellow Angelica
11	Piperia Unalascensis	Alaska Bog Orchid
12	Nodobryoria Abbreviata	Tufted Foxtail Lichen
13	Angelica Dawsonii	Yellow Angelica
14	Hypogymnia Enteromorpha	Budding Tube Lichen
15	Angelica Dawsonii	Yellow Angelica
16	Buxbaumia Aphylla	Bug On A Stick Moss
17	Nodobryoria Abbreviata	Tufted Foxtail Lichen
18	Hypogymnia Rugose	Wrinkled Tube Lichen
19	Eriogonum Cernuum	Nodding Umbrella-Plant
20	Phacelia Hastate	Silver-Leaved Scorpionweed
21	Phacelia Hastate	Silver-Leaved Scorpionweed
22	Phacelia Hastate	Silver-Leaved Scorpionweed
23	Piperia Unalascensis	Alaska Bog Orchid
24	Dicranum Tauricum	Broken-Leaf Moss
25	Angelica Dawsonii	Yellow Angelica
26	Anastrophyllum Helleranum	Heller's Notchwort
27	Peltigera Cinnamomea	Cinnamon Dog Pelt Lichen
28	Streptopus Roseus	Rose Mandarin
29	Conocephalum Salebrosum	Liverwort
30	Dicranum Tauricum	Broken-Leaf Moss
31	Piperia Unalascensis	Alaska Bog Orchid
32	Cladonia Symphycarpia	Split-Peg Lichen
33	Lophozia Ascendens	Liverwort
34	Vulpicida Canadensis	Brown-Eyed Sunshine Lichen
35	Pinus Albicaulis	Whitebark Pine
36	Schistidium Tenerum	Thread Bloom Moss
37	Umbilicaria Americana	American Rock Trip Lichen
38	Pinus Albicaulis	Whitebark Pine
39	Pinus Albicaulis	Whitebark Pine
40	Dicranella Crispa	Curl-Leaved Fork Moss
41	Rhytidiopsis Robusta	Pipecleaner Moss
42	Chiloscyphus Polyanthos	Liverwort
43	Pellia Neesiana	Liverwort
44	Pinus Albicaulis	Whitebark Pine
45	Angelica Dawsonii	Yellow Angelica
46	Lophozia Longidens	Liverwort
47	Lophozia Wenzelii	Liverwort
48	Vulpicida Canadensis	Brown-Eyed Sunshine Lichen
49	Streptopus Roseus	Rose Mandarin
50	Tellima Grandiflora	Fringe-Cups
51	Chiloscyphus Polyanthos	Liverwort
52	Jungermannia Exsertifolia	Liverwort
53	Pellia Endiviifolia	Liverwort
54	Cladonia Symphycarpia	Split-Peg Lichen
55	Cladonia Umbricola	Shaded Cladonia
56	Racomitrium Aciculare	Moss
57	Cladonia Ochrochlora	Smooth-Footed Powderhorn
58	Nodobryoria Abbreviata	Tufted Foxtail Lichen
59	Dicranum Tauricum	Broken-Leaf Moss
60	Xylographa Parallela	Black Woodscript Lichen
61	Nodobryoria Abbreviata	Tufted Foxtail Lichen
62	Carex Petasata	Pasture Sedge
63	Pinus Albicaulis	Whitebark Pine
64	Pinus Albicaulis	Whitebark Pine
65	Dicranum Tauricum	Broken-Leaf Moss
66	Hypogymnia Rugose	Wrinkled Tube Lichen
67	Nodobryoria Abbreviata	Tufted Foxtail Lichen
68	Angelica Dawsonii	Yellow Angelica
69	Dicranum Tauricum	Broken-Leaf Moss
70	Angelica Dawsonii	Yellow Angelica
71	Racomitrium Aciculare	Moss
72	Carex Petasata	Pasture Sedge
73	Phacelia Hastate	Silver-Leaved Scorpionweed
74	Pinus Albicaulis	Whitebark Pine
75	Pinus Albicaulis	Whitebark Pine
76	Pinus Albicaulis	Whitebark Pine
77	Pinus Flexilis	Limber Pine
78	Angelica Dawsonii	Yellow Angelica
79	Aulacomnium Androgynum	Little Groove Moss
80	Streptopus Streptopoides	Twisted-Stalk
81	Aulacomnium Androgynum	Little Groove Moss
82	Dicranum Tauricum	Broken-Leaf Moss
83	Carex Petasata	Pasture Sedge
84	Caloplaca Sinapisperma	Firedot Licken
85	Pellia Neesiana	Liverwort
86	Berberis Repens	Creeping Mahonia
87	Phacelia Hastate	Silver-Leaved Scorpionweed
88	Peltigera Cinnamomea	Cinnamon Dog Pelt Lichen
89	Angelica Dawsonii	Yellow Angelica
90	Bromus Vulgaris	Woodland Brome
91	Peltigera Cinnamomea	Cinnamon Dog Pelt Lichen
92	Pinus Albicaulis	Whitebark Pine
93	Pinus Flexilis	Limber Pine
94	Pinus Flexilis	Limber Pine

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Tp 7
Blairmore
Gold Creek
John Creek
Green Creek
York Creek
Evans Creek
Cadman Creek

LEGEND

- Location of Rare Species
- Primary Highway
- Secondary Highway
- Existing Railway
- Existing Access Road
- Existing Powerline
- CHPP Facilities
- Proposed Water Pipeline/ Service Road
- Railway Loop
- Proposed Helipad Access
- Surface Water Drainage
- Waterbody
- Vegetation Local Study Area
- Ultimate Pit Extent
- Ultimate Rock Disposal Area Extent
- Reclamation Material Storage
- Construction Camp
- Ponds and Ditches
- Coal Handling Processing Plant and Infrastructure
- Covered Conveyor, Access Road and Powerline ROW
- Proposed Golf Course Development
- Undisturbed Area

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RARE PLANT OCCURRENCES IN THE LSA AND FOOTPRINT

NOTES

AltaLIS, 2016; Geobase, 2016; Golder, 2016; MEMS, 2016; RapidEye, 2015 (Image Date: Jul 26/13); Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

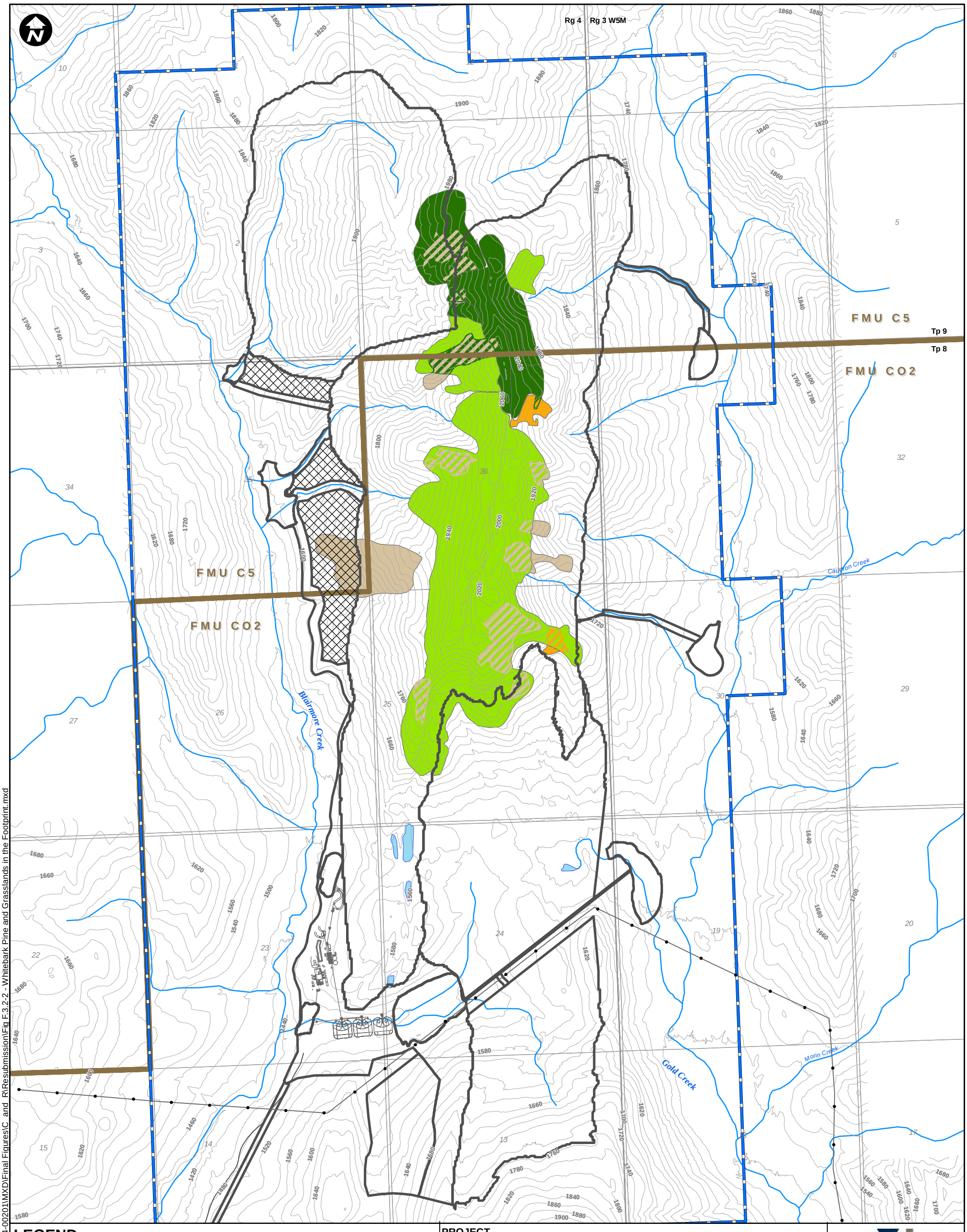
PROJECT:	14-00201-01
DRAWN BY:	SL/JL
CHECKED BY:	DM
DATE:	JULY 11, 2016

0 0.75 1.5 3
Kilometres

FIGURE

F.3.2-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\Resubmission\Fig F.3.2-1 - Rare Plant Occurrences LSA.mxd



LEGEND

- Existing Powerline
- Existing Access Road
- CHPP Facilities
- Topographic Contour (20m interval)
- Watercourse
- Waterbody
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- FMU Boundary

Whitebark Pine/Fescue/Grassland

- Whitebark
- Whitebark Sparse
- Fescue
- Grassland Sparse

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

WHITEBARK PINE AND GRASSLANDS DISTRIBUTION IN THE FOOTPRINT

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
DRAWN BY:	SL/JDC
CHECKED BY:	KK
DATE:	JUNE 7, 2016

0 0.5 1 2
Kilometres

FIGURE

F.3.2-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\Resubmission\Fig F.3.2-2 - Whitebark Pine and Grasslands in the Footprint.mxd

Rg 4 Rg 3 W5M

Tp 9

Tp 8

Tp 7

FMU C5

FMU CO2

FMU CO1

Daisy Creek

Forestry Trunk Road

Nez Percé Creek

Blairmore Creek

Gold Creek

MorinCreek

Caudron Creek

Green Creek

Pelletier Creek

Crowsnest River

Lille

40

3

Land Ownership in Project Footprint	Hectares	% of Footprint
Crown	713.60	46.9
Freehold - Benga	774.93	51.0
Freehold - Benga 50%	2.55	0.2
Freehold - Other	26.53	1.7
Registered Roadway	3.12	0.2
Total:	**1520.74**	**100.0**

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Surface Water Drainage
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- FMU Boundary

Land Ownership

- Freehold - Benga
- Freehold - Benga 50%, CNP Golf & Country Club 50%
- Freehold - Other
- Registered Roadway

Note: Accuracy of land ownership is not guaranteed.

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

TIMBER DISTRIBUTION BY OWNERSHIP

NOTES

AltaLIS, 2016; DialecticResearch, 2015; GeoBase, 2011; NRCAN, 2015; Riversdale, 2015
Datum/Projection: UTM NAD 83 Zone 11

0 1 2 4
Kilometres

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JUNE 10, 2016

FIGURE

F.3.3-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\IC and R\ResubmissionIFi

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Tp 7
Forestry Trunk Road
Nez Percé Creek
Caudron Creek
Blairmore Creek
Gold Creek
Morin Creek
Green Creek
P elletier Creek
Chinook Run
York Creek
Lyons Creek
Coleman
Blairmore
40
3
Y01
Y02
Y03
Y04
Y05

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Haul Road
- Surface Water Drainage
- Waterbody
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Reclaimed Area (Labelled with Year of Reclamation)
- Active Rock Disposal Area
- Active Pit
- Soil Stripping
- Coal Handling Processing Plant and Infrastructure
- Golf Course

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAMATION PROGRESSION YEAR 1-5

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JUNE 10, 2016

0 0.75 1.5 3
Kilometres

FIGURE
F.3.6-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\Resubmission\Fig F.3.6-1 - Reclamation Progression Year 1-5.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Tp 7
Forestry Trunk Road
Nez Percé Creek
Blairmore Creek
Caudron Creek
Gold Creek
Morin Creek
Green Creek
Pelletier Creek
York Creek
Lyon Creek
Chinook Run
Coleman
Blairmore
40
3
Y06
Y07
Y08
Y09
Y10

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Haul Road
- Water Pipeline/Service Road
- Helipad Access
- Surface Water Drainage
- Waterbody
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Reclaimed Area (Labelled with Year of Reclamation)
- Previously Reclaimed
- Soil Stripping
- Active Rock Disposal Area
- Active Pit
- Coal Handling Processing Plant and Infrastructure
- Reclamation Material Storage
- Water Management
- Covered Conveyor, Access Road and Powerline ROW
- Railway Loop
- Golf Course

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAMATION PROGRESSION YEAR 6-10

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL/JL
CHECKED BY: DM
DATE: JULY 12, 2016

0 0.75 1.5 3
Kilometres

FIGURE
F.3.6-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C_and_R\Resubmission\Fig F.3.6-2 - Reclamation Progression Year 6-10.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Tp 7
Forestry Trunk Road
Nez Percé Creek
Pelletier Creek
Blairmore Creek
Caudron Creek
Gold Creek
Morin Creek
Green Creek
York Creek
Lyon Creek
Chorlton Run
Coleman
Blairmore
40
3
Y11
Y12
Y13
Y14
Y15

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Haul Road
- Water Pipeline/Service Road
- Helipad Access
- Surface Water Drainage
- Waterbody
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Reclaimed Area (Labelled with Year of Reclamation)
- Previously Reclaimed
- Active Rock Disposal Area
- Active Pit
- Soil Stripping
- Coal Handling Processing Plant and Infrastructure
- Reclamation Material Storage
- Water Management
- Covered Conveyor, Access Road and Powerline ROW
- Railway Loop
- Golf Course

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAMATION PROGRESSION YEAR 11-15

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

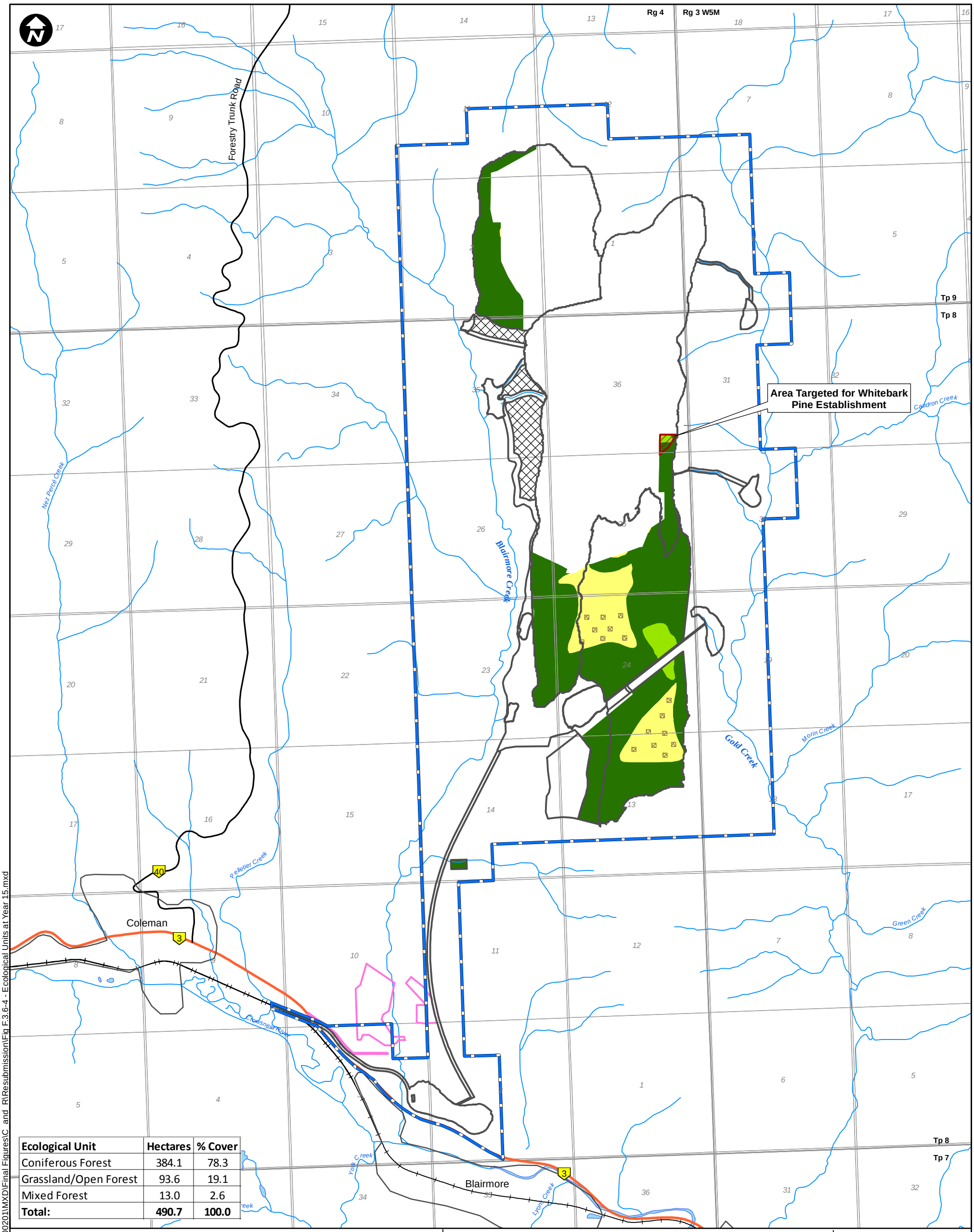
PROJECT: 14-00201-01
DRAWN BY: SL/JL
CHECKED BY: DM
DATE: JULY 11, 2016

0 0.75 1.5 3
Kilometres

FIGURE

F.3.6-3

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C_and_R\Resubmission\Fig F.3.6-3 - Reclamation Progression Year 11-15.mxd



Ecological Unit	Hectares	% Cover
Coniferous Forest	384.1	78.3
Grassland/Open Forest	93.6	19.1
Mixed Forest	13.0	2.6
Total:	**490.7**	**100.0**

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Surface Water Drainage
- Waterbody
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area

Ecological Unit

- Coniferous Forest
- Grassland/Open Forest
- Mixed Forest
- Golf Course
- Area Targeted for Foothill Rough Fescue Establishment
- Area Targeted for Whitebark Pine Establishment

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ECOLOGICAL UNITS AT YEAR 15

NOTES

AltaLIS, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

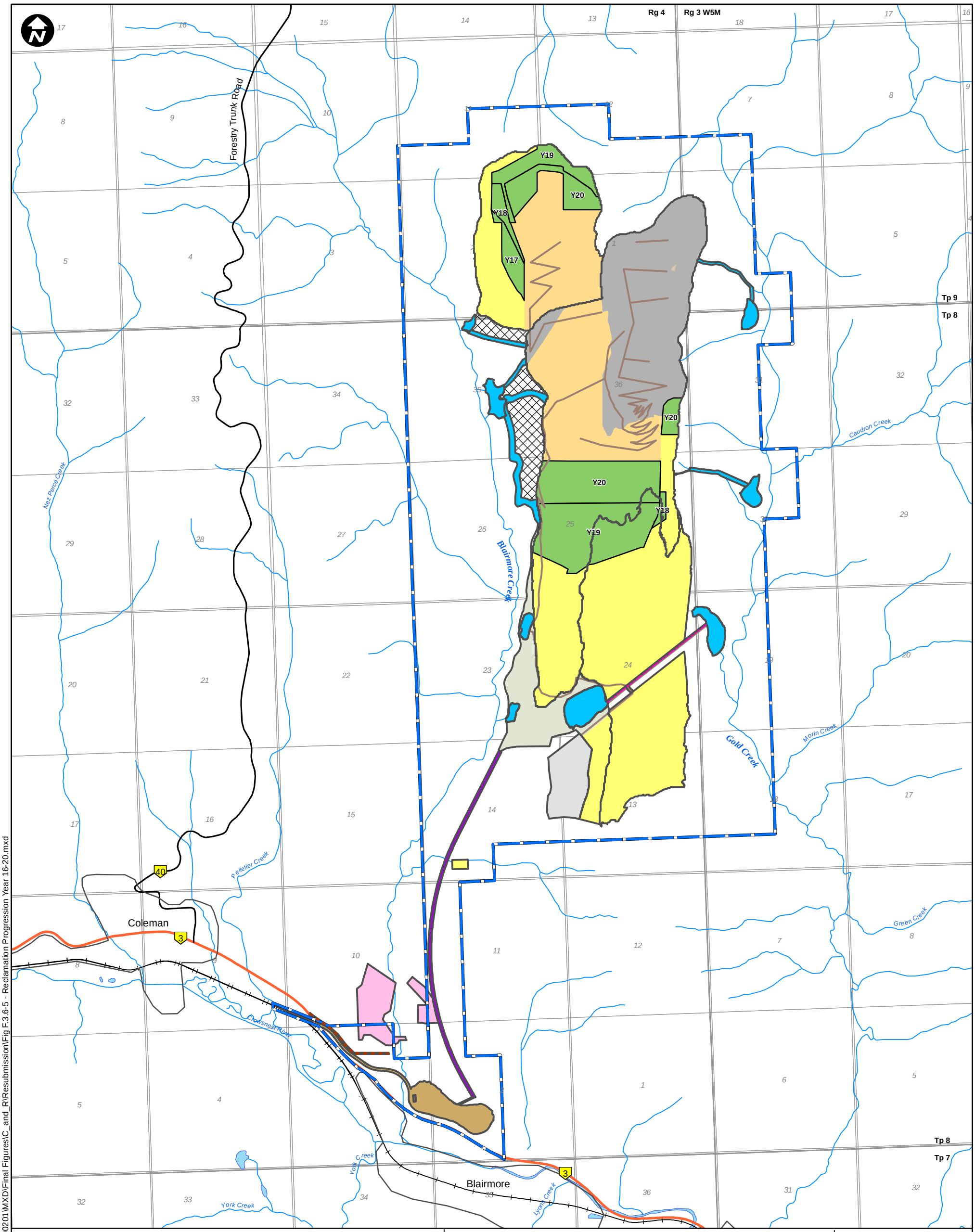
PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: DM
DATE: JUNE 10, 2016

0 0.75 1.5 3
Kilometres

FIGURE

F.3.6-4

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C and R\Resubmission\Fig F.3.6-4 - Ecological Units at Year 15.mxd



Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C_and_R\Resubmission\Fig F.3.6-5 - Reclamation Progression Year 16-20.mxd

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Water Pipeline/Service Road
- Helipad Access
- Haul Road
- Surface Water Drainage
- Waterbody
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Reclaimed Area (Labelled with Year of Reclamation)
- Previously Reclaimed
- Active Rock Disposal Area
- Active Pit
- Soil Stripping
- Coal Handling Processing Plant and Infrastructure
- Reclamation Material Storage
- Water Management
- Covered Conveyor, Access Road and Powerline ROW
- Railway Loop
- Golf Course

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAMATION PROGRESSION YEAR 16-20

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT:	14-00201-01
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CHECKED BY:	DM
DATE:	JULY 12, 2016

0 0.75 1.5 3
Kilometres

FIGURE

F.3.6-5

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Tp 7
Forestry Trunk Road
Nez Percé Creek
Blairmore Creek
Caudron Creek
Gold Creek
Morin Creek
Green Creek
Pelletier Creek
Chinook Creek
York Creek
Lyon Creek
Coleman
Blairmore
40
3
Y21
Y22
Y23
Y24
Y25
Y27
EOR

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Surface Water Drainage
- Waterbody
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Reclaimed Area (Labelled with Year of Reclamation)
- Previously Reclaimed
- Active Rock Disposal Area
- Active Pit
- Soil Stripping
- End-Pit Lake
- Golf Course

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAMATION PROGRESSION YEAR 21 TO END OF RECLAMATION (EOR)

NOTES

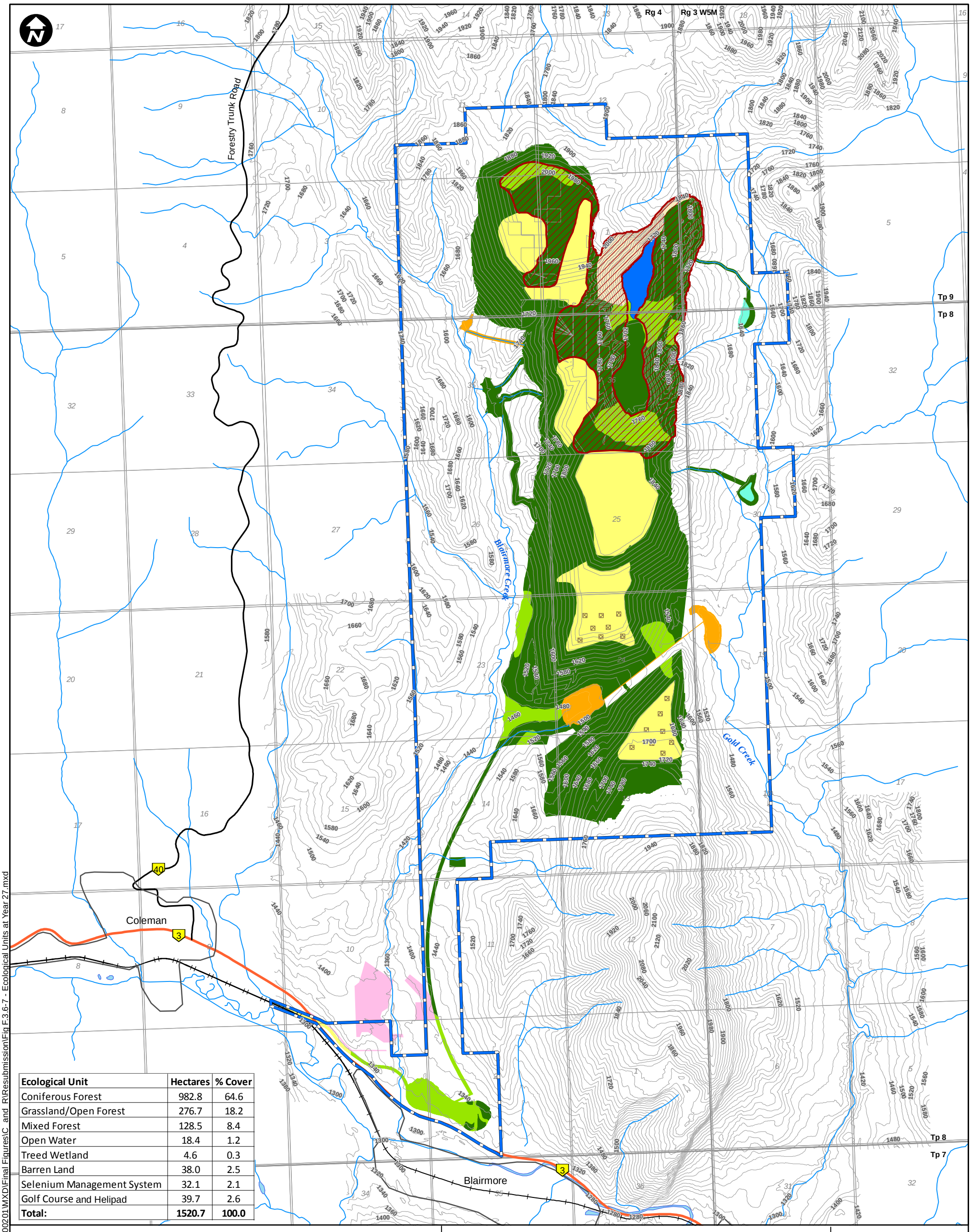
AltaLIS, 2016; Deswik, 2016; Geobase, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL/JL
CHECKED BY: DM
DATE: JULY 12, 2016

0 0.75 1.5 3
Kilometres

FIGURE
F.3.6-6

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C_and_R\Resubmission\Fig F.3.6-6 - Reclamation Progression Year 21-EOM.mxd



Ecological Unit	Hectares	% Cover
Coniferous Forest	982.8	64.6
Grassland/Open Forest	276.7	18.2
Mixed Forest	128.5	8.4
Open Water	18.4	1.2
Treed Wetland	4.6	0.3
Barren Land	38.0	2.5
Selenium Management System	32.1	2.1
Golf Course and Helipad	39.7	2.6
Total:	**1520.7**	**100.0**

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Reclaimed Topographic Contour (20m interval)
- Surface Water Drainage
- Waterbody
- Proposed Mine Permit Boundary

Ecological Unit

- Coniferous Forest
- Grassland/Open Forest
- Mixed Forest
- Open Water
- Treed Wetland
- Barren Land
- Selenium Management System
- Golf Course and Helipad
- Area Targeted for Foothill Rough Fescue Establishment
- Area Targeted for Whitebark Pine Establishment

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ECOLOGICAL UNITS AT YEAR 27

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL/JL
CHECKED BY: DM
DATE: JULY 11, 2016

FIGURE

F.3.6-7

0 0.75 1.5 3
Kilometres

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\WXD\Final Figures\IC and R\Resubmission\Fig F.3.6-7 - Ecological Units at Year 27.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Tp 7
Forestry Trunk Road
Blairmore Creek
Gold Creek
Coleman
Blairmore
40
3

Ecological Unit	Hectares	% Cover
Coniferous Forest	987.9	65.0
Grassland/Open Forest	276.7	18.2
Mixed Forest	141.8	9.3
Open Water	18.4	1.2
Treed Wetland	18.2	1.2
Barren Land	38.0	2.5
Golf Course and Helipad	39.7	2.6
Total:	**1520.7**	**100.0**

LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Reclaimed Topographic Contour (20m interval)
- Surface Water Drainage
- Waterbody
- Proposed Mine Permit Boundary

Ecological Unit

- Coniferous Forest
- Grassland/Open Forest
- Mixed Forest
- Open Water
- Treed Wetland
- Barren Land
- Golf Course and Helipad
- Area Targeted for Foothill Rough Fescue Establishment
- Area Targeted for Whitebark Pine Establishment

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

ECOLOGICAL UNITS AT COMPLETION OF SELENIUM MANAGEMENT PLAN - CLOSURE

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL/JL
CHECKED BY: DM
DATE: JULY 11, 2016

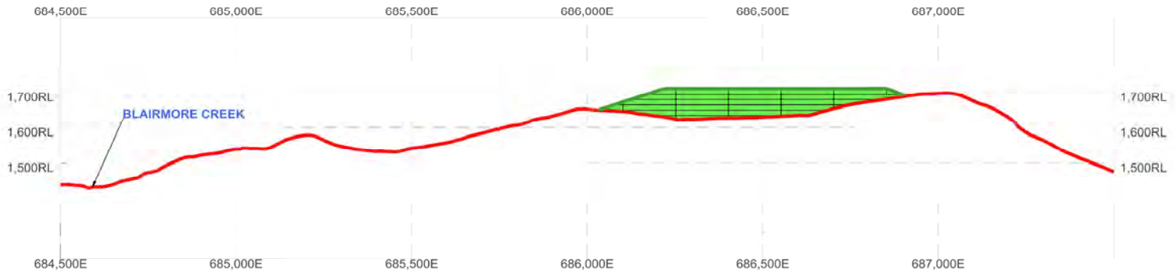
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Kilometres

FIGURE

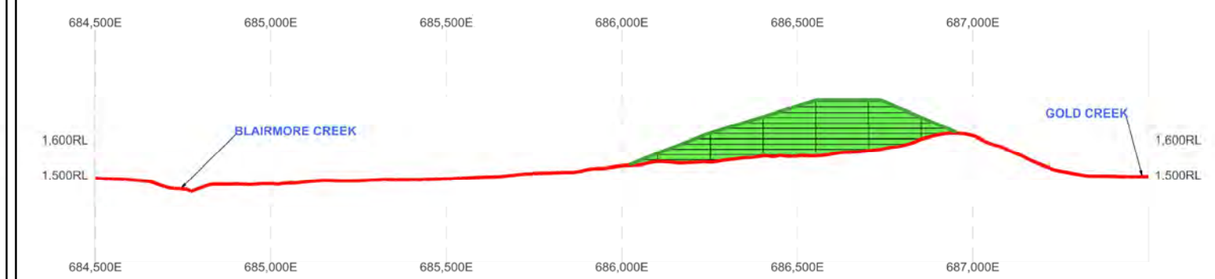
F.3.6-8

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\WXD\Final Figures\C and R\Resubmission\Fig F.3.6-8 - Ecological Units at Completion of Selenium Management Plan.mxd

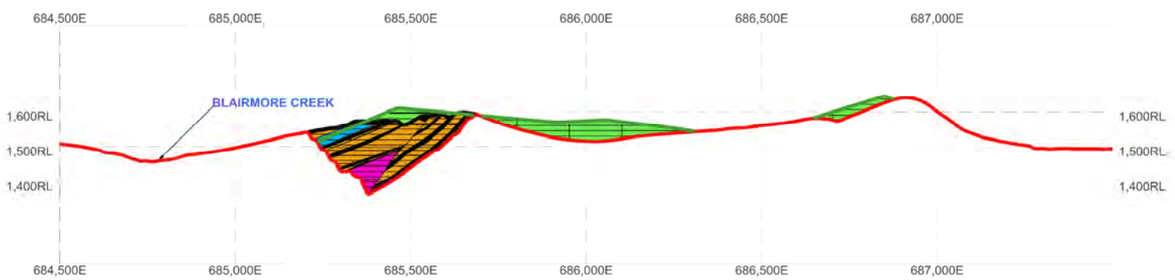
WEST-EAST CROSS-SECTION 1



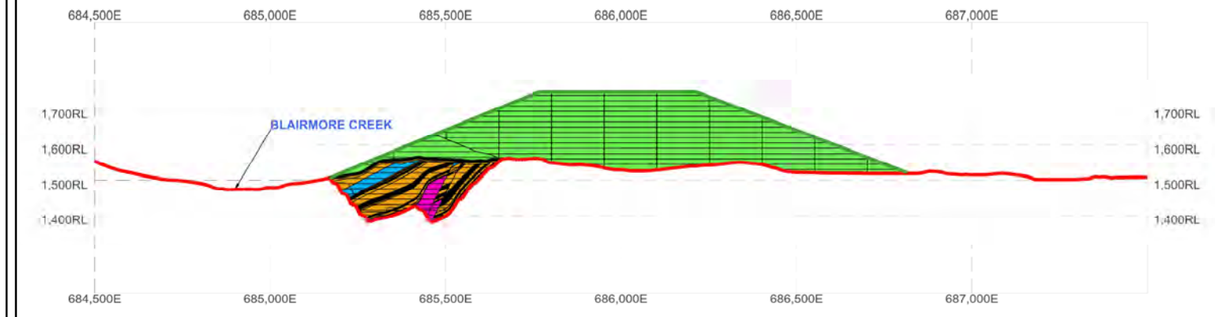
WEST-EAST CROSS-SECTION 2

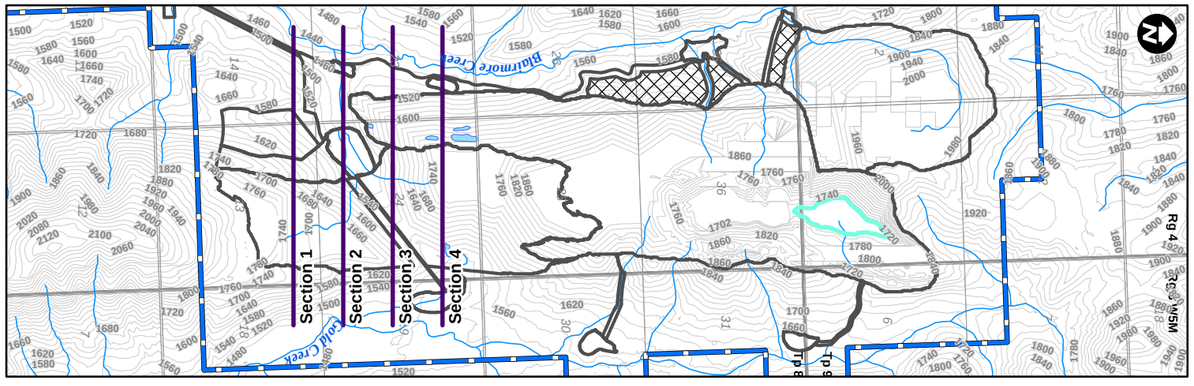


WEST-EAST CROSS-SECTION 3



WEST-EAST CROSS-SECTION 4





LEGEND

- Original Topography
- Final Pit Profile
- Reclaimed Disposal Profile
- Reclaimed Disposal Area
- Coal Seam
- Overburden
- Underburden
- Conglomerate
- Cross-Section Location
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- End-Pit Lake
- Reclaimed Topographic Contour (20m interval)

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAMATION CROSS-SECTIONS 1-4

PROJECT: 14-00201
DRAWN BY: DESWIK/SL
CHECKED BY: DM
DATE: JUNE 8, 2016

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

CROSS-SECTION SCALE

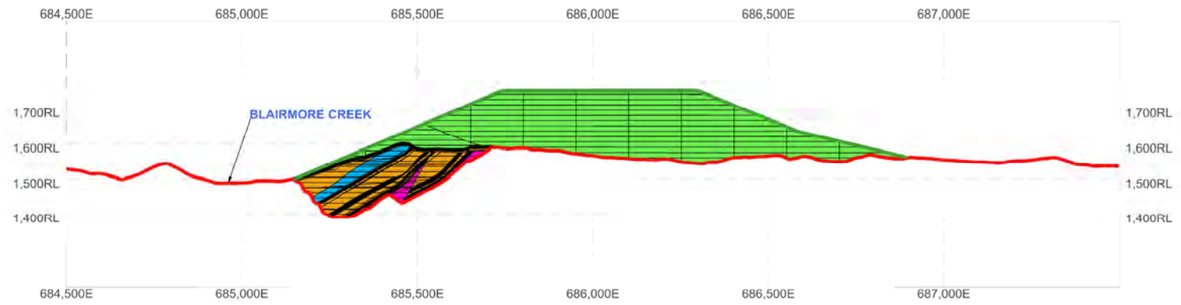
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Metres

FIGURE

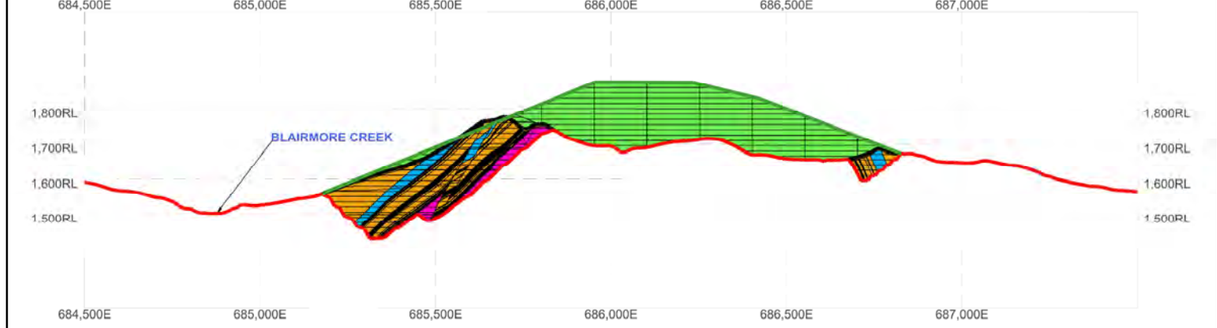
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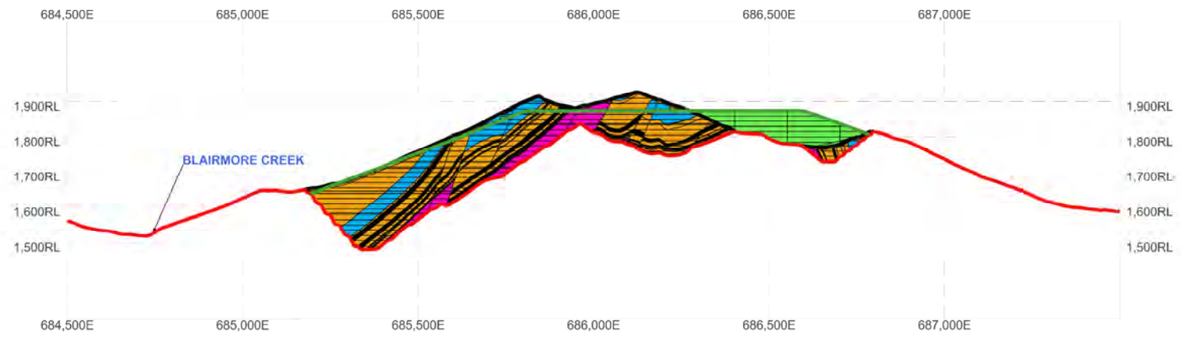
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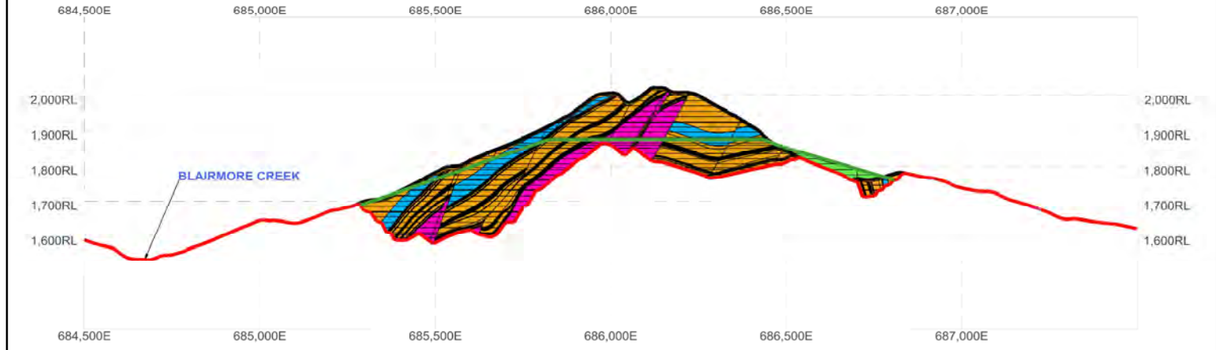
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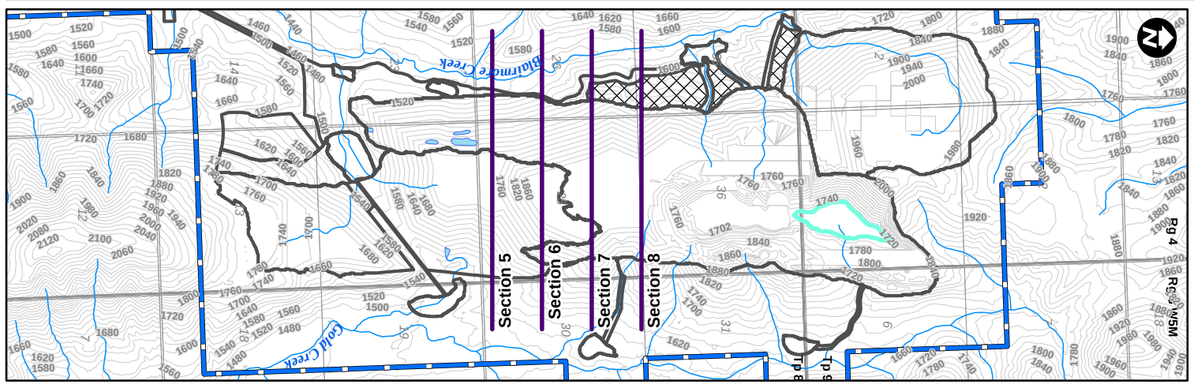


WEST-EAST CROSS-SECTION 7



WEST-EAST CROSS-SECTION 8





LEGEND

- Original Topography
- Final Pit Profile
- Reclaimed Disposal Profile
- Reclaimed Disposal Area
- Coal Seam
- Overburden
- Underburden
- Conglomerate
- Cross-Section Location
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- End-Pit Lake
- Reclaimed Topographic Contour (20m interval)

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

RECLAMATION CROSS-SECTIONS 5-8

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

CROSS-SECTION SCALE

0 250 500 1,000
Metres

MILLENNIUM EMS Solutions Ltd.

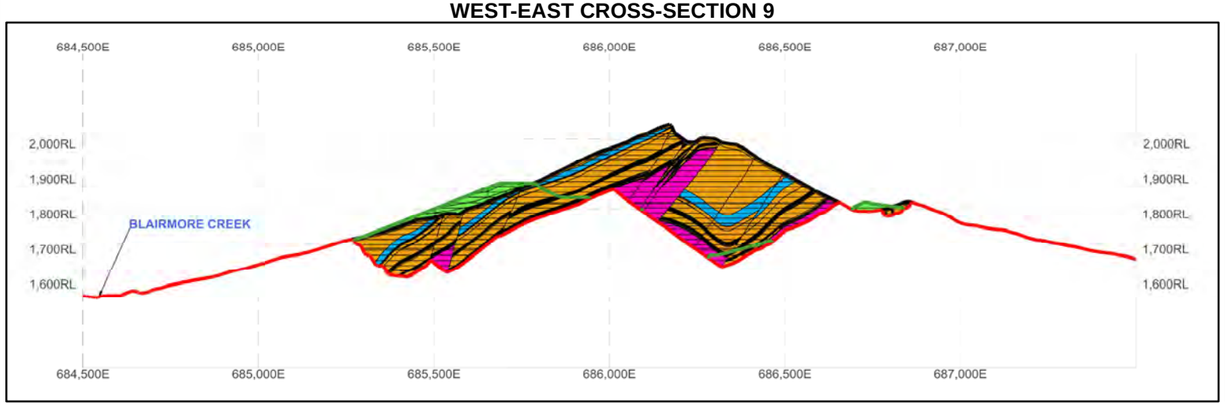
PROJECT: 14-00201
DRAWN BY: DESWIK/SL
CHECKED BY: DM
DATE: JUNE 8, 2016

FIGURE

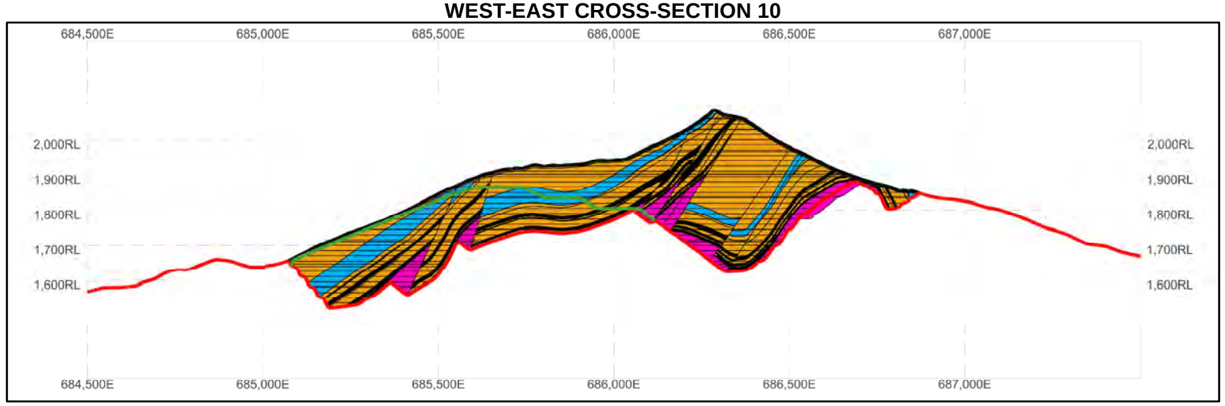
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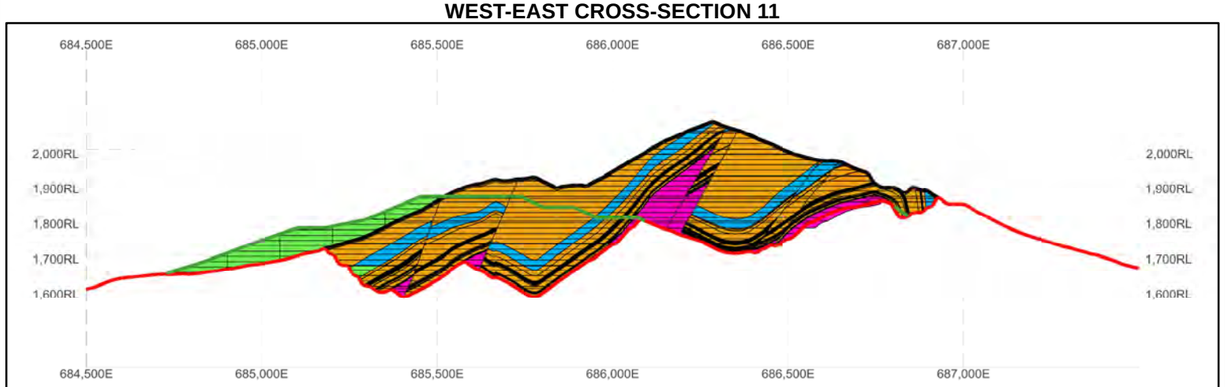
WEST-EAST CROSS-SECTION 9



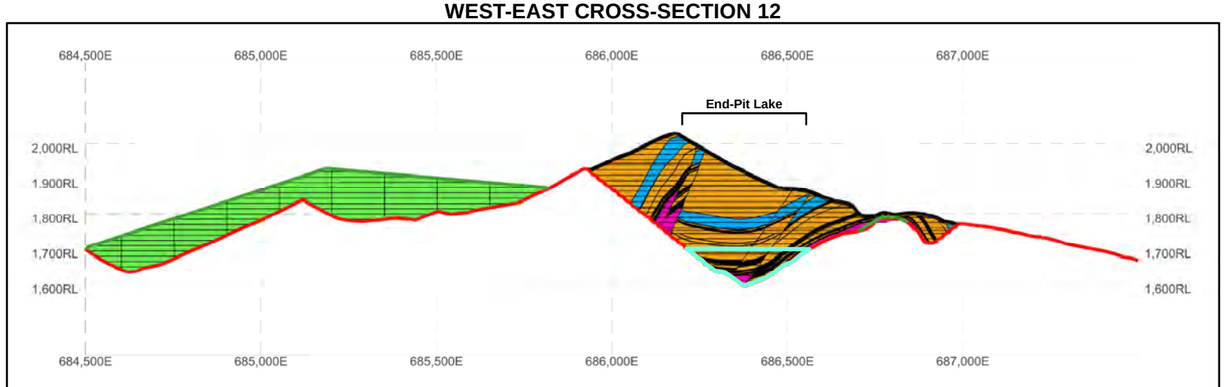
WEST-EAST CROSS-SECTION 10

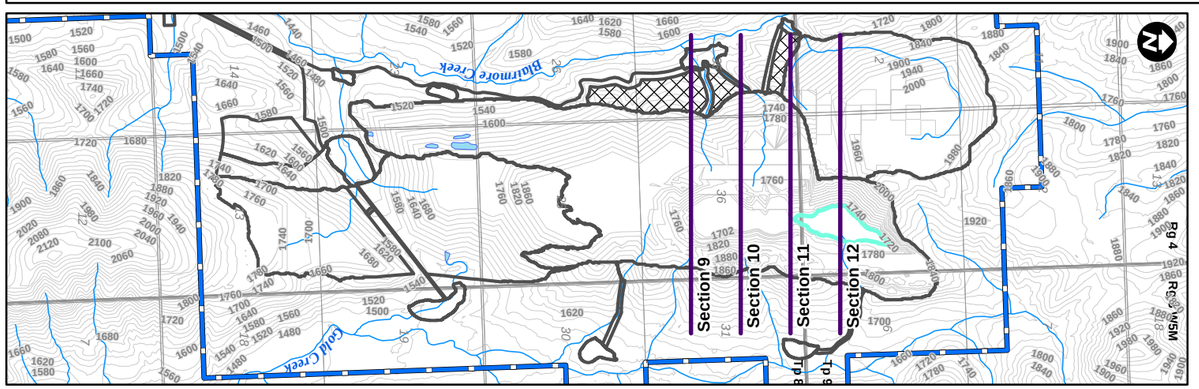


WEST-EAST CROSS-SECTION 11



WEST-EAST CROSS-SECTION 12





LEGEND

- Original Topography
- Final Pit Profile
- Reclaimed Disposal Profile
- Reclaimed Disposal Area
- Coal Seam
- Overburden
- Underburden
- Conglomerate
- Cross-Section Location
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- End-Pit Lake
- Reclaimed Topographic Contour (20m interval)

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

RECLAMATION CROSS-SECTIONS 9-12

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

CROSS-SECTION SCALE

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Metres

MILLENNIUM EMS Solutions Ltd.

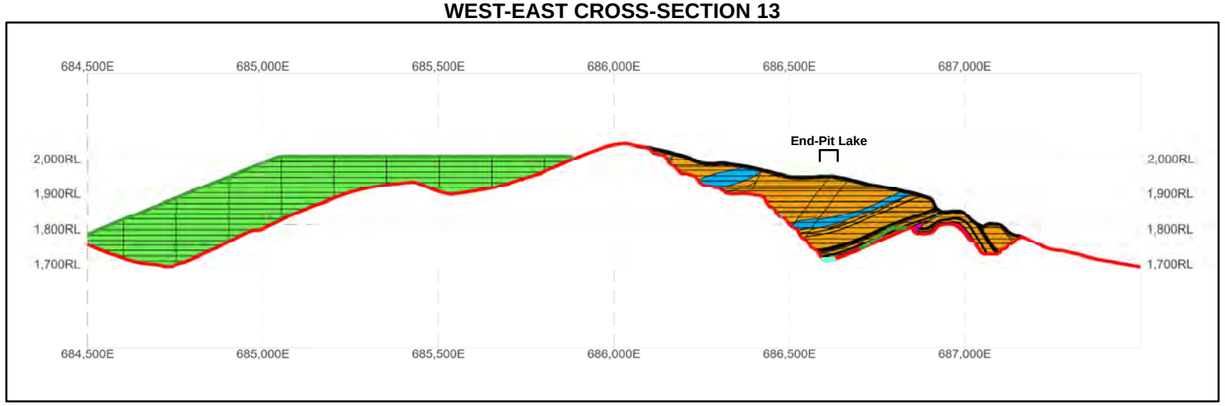
PROJECT: 14-00201
DRAWN BY: DESWIK/SL
CHECKED BY: DM
DATE: JUNE 8, 2016

FIGURE

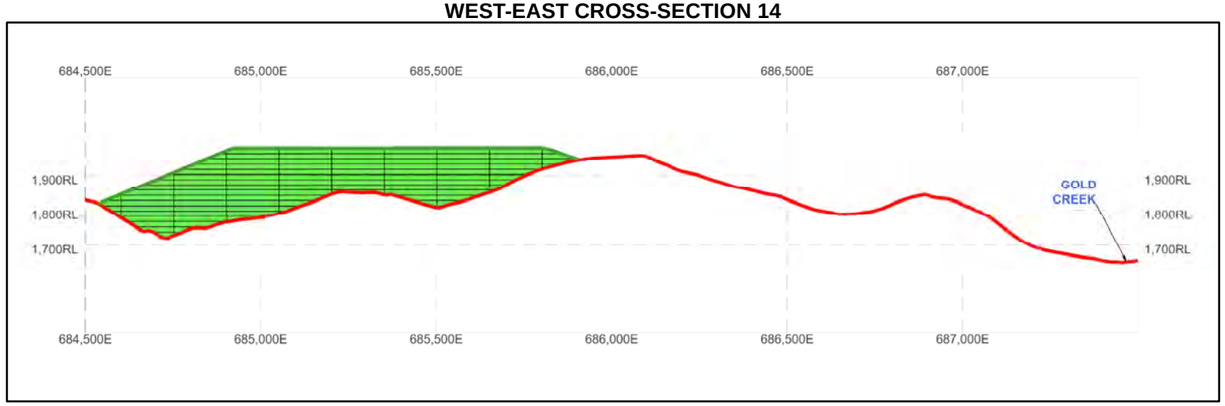
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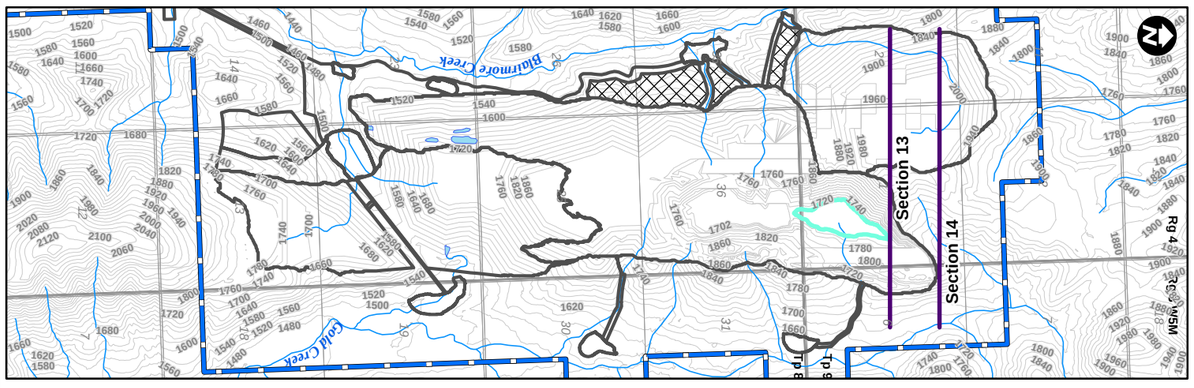
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WEST-EAST CROSS-SECTION 13



WEST-EAST CROSS-SECTION 14





LEGEND

- Original Topography
- Final Pit Profile
- Reclaimed Disposal Profile
- Reclaimed Disposal Area
- Coal Seam
- Overburden
- Underburden
- Conglomerate
- Cross-Section Location
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- End-Pit Lake
- Reclaimed Topographic Contour (20m interval)

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

RECLAMATION CROSS-SECTIONS 13-14

PROJECT: 14-00201
DRAWN BY: DESWIK/SL
CHECKED BY: DM
DATE: JUNE 8, 2016

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

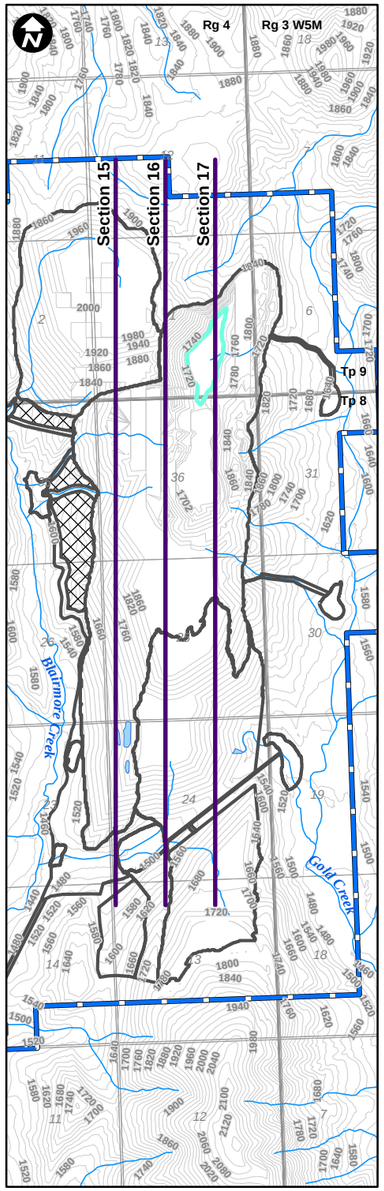
CROSS-SECTION SCALE

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Metres

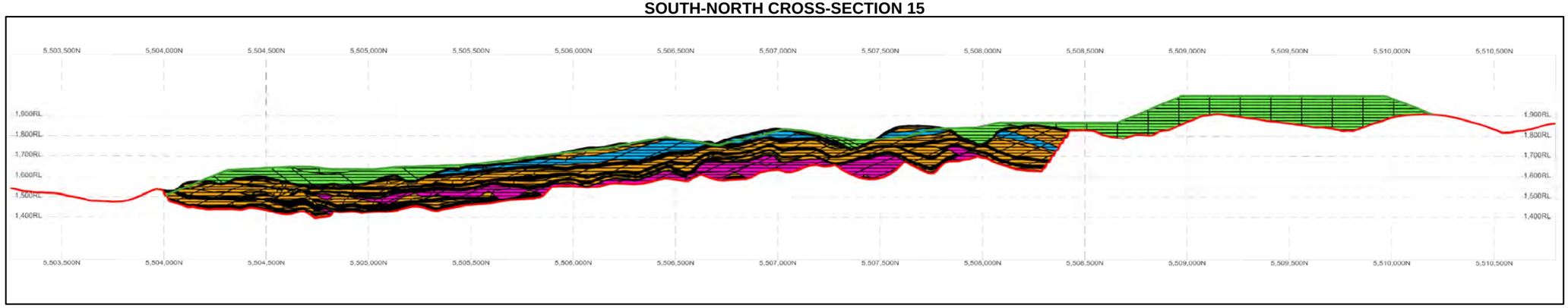
FIGURE

F.4.1-4

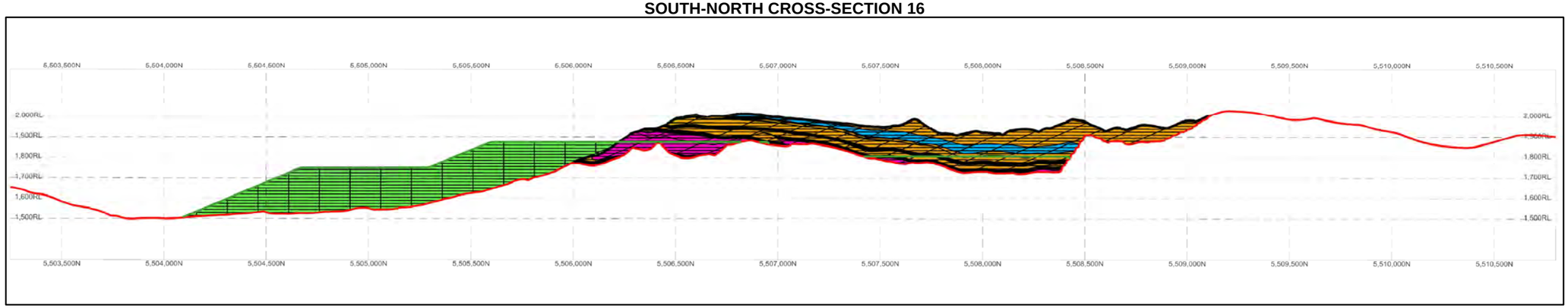
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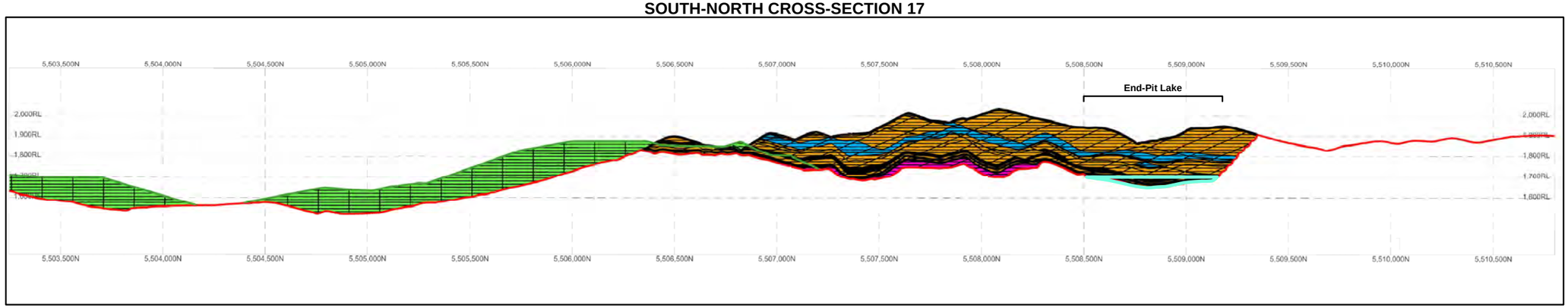
SOUTH-NORTH CROSS-SECTION 15



SOUTH-NORTH CROSS-SECTION 16



SOUTH-NORTH CROSS-SECTION 17



LEGEND

- Original Topography
- Final Pit Profile
- Reclaimed Disposal Profile
- Reclaimed Disposal Area
- Coal Seam
- Overburden
- Underburden
- Conglomerate
- Cross-Section Location
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- End-Pit Lake
- Reclaimed Topographic Contour (20m interval)

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

TITLE

RECLAMATION CROSS-SECTIONS 15-17

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2015; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

CROSS-SECTION SCALE

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Metres

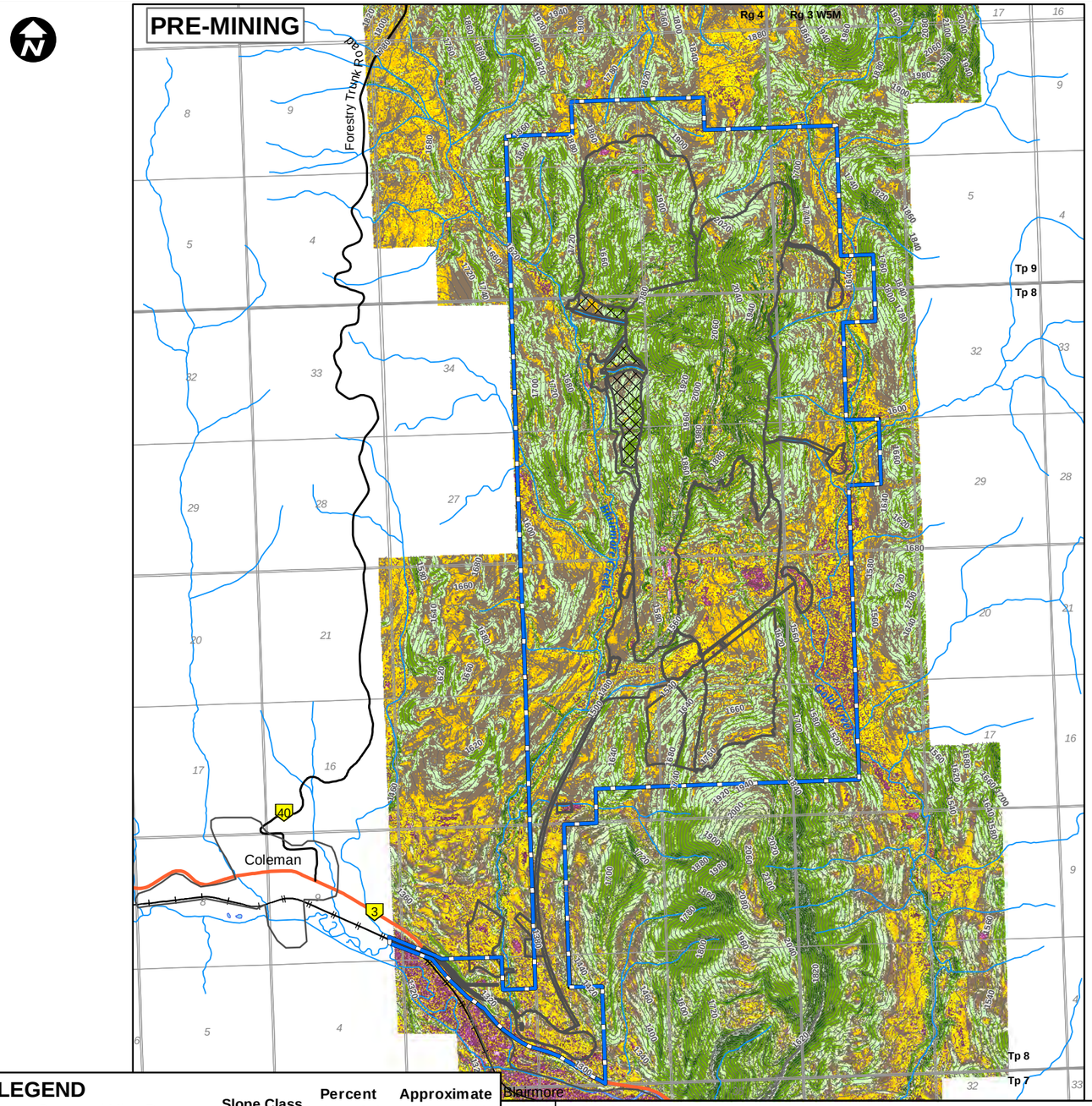
MILLENNIUM EMS Solutions Ltd.

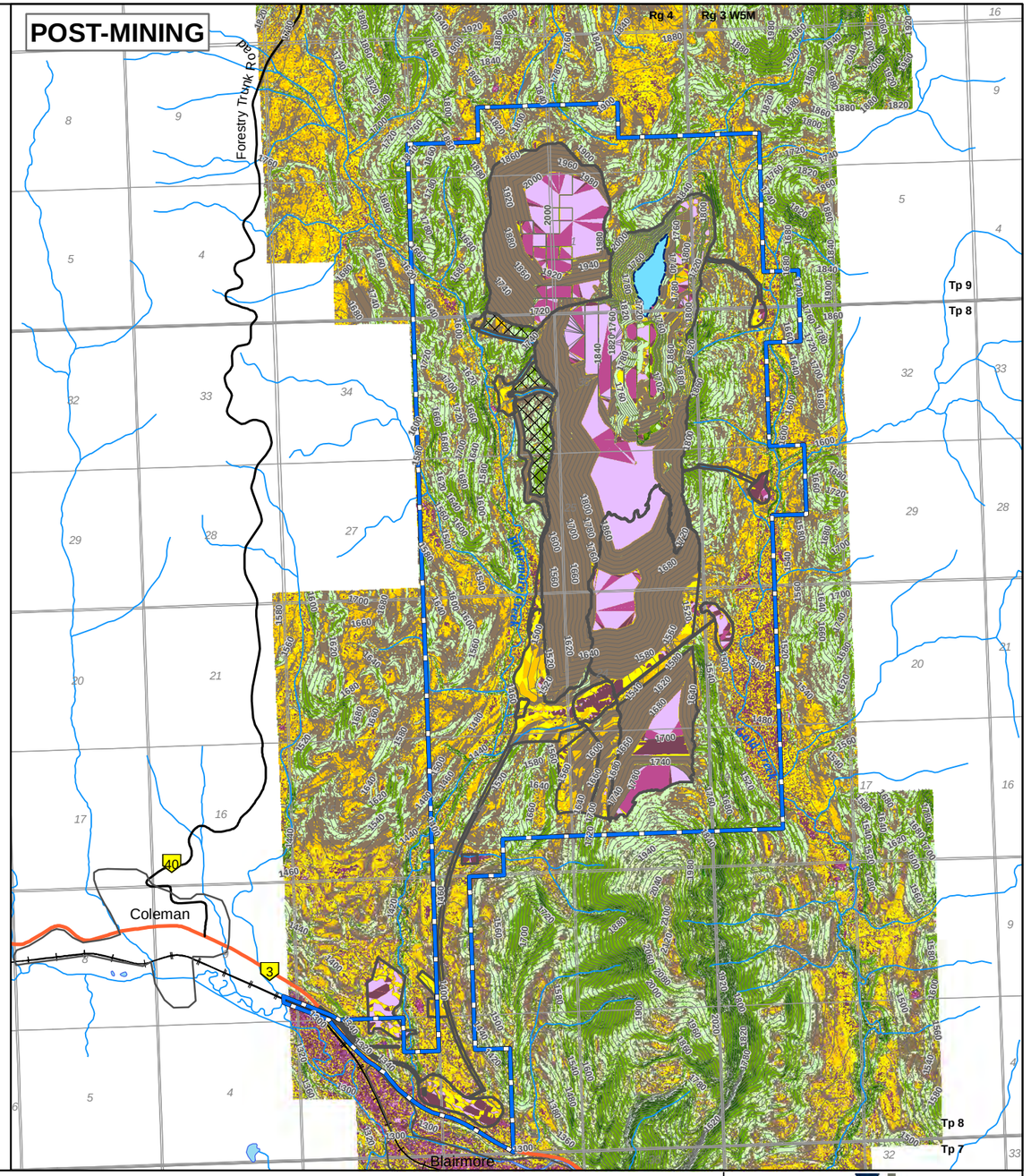
PROJECT: 14-00201
DRAWN BY: DESWIK/SL
CHECKED BY: DM
DATE: JUNE 8, 2016

FIGURE

F.4.1-5

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C_and_R\Reissued_May2016\Fig F.4.1-5 - Cross-sections 15-17.mxd





LEGEND

- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Primary Highway
- Secondary Highway
- Existing Railway
- Surface Water Drainage
- Waterbody
- Topographic Contour (20m interval)

Slope Class	Percent slope (%)	Approximate degrees (°)
1	0-0.5	0
2	>0.5-2	0.3-1.1
3	>2-5	>1.1-3
4	>5-10	>3-5
5	>10-15	>5-8.5
6	>15-30	>8.5-16.5
7	>30-45	>16.5-24
8	>45-70	>24-35
9	>70-100	>35-45

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

PRE AND POST MINING TOPOGRAPHY

PROJECT: 14-00201
DRAWN BY: SL
CHECKED BY: DM
DATE: JUNE 10, 2016

NOTES
AltaLIS, 2015; Deswik, 2016; Geobase, 2015; Golder, 2015; MEMS, 2015; Riversdale, 2015
Datum/Projection: UTM NAD 83 Zone 11

0 1 2 4
Kilometres

FIGURE
F.4.1-6

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\C_and_R\Resubmission\Fig F-4.1-6 - Pre and Post Mining Topography.mxd

Rg 4
Rg 3 W5M
Tp 9
Tp 8
Elev. 2000m
Elev. 1840m
Elev. 1860m
Elev. 1740m
Elev. 1680m
Elev. 1780m
NWSP
NESP
WSP
ESP
SWSP
SESP
PSSP
RWP
Blairmore Creek
Gold Creek
Caudron Creek
Morin Creek
Greenhill Underground Mine
Bear Valley Underground Mine

LEGEND

- Release Point
- Haul Road
- Reclaimed Topographic Contour (20m interval)
- Subsurface Direction of Flow (Selenium Attenuated Water)
- Subsurface Lake Discharge
- Water Transfer Pipeline
- Surface Water Drainage
- End-Pit Lake
- Dam
- Release Pond
- Surface Pond (No Release)
- Saturated Zone
- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Previously Reclaimed
- Reclamation Material Storage
- Coal Handling Processing Plant and Infrastructure
- Underground Mine

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

END OF MINE SURFACE AND SUBSURFACE DRAINAGE

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

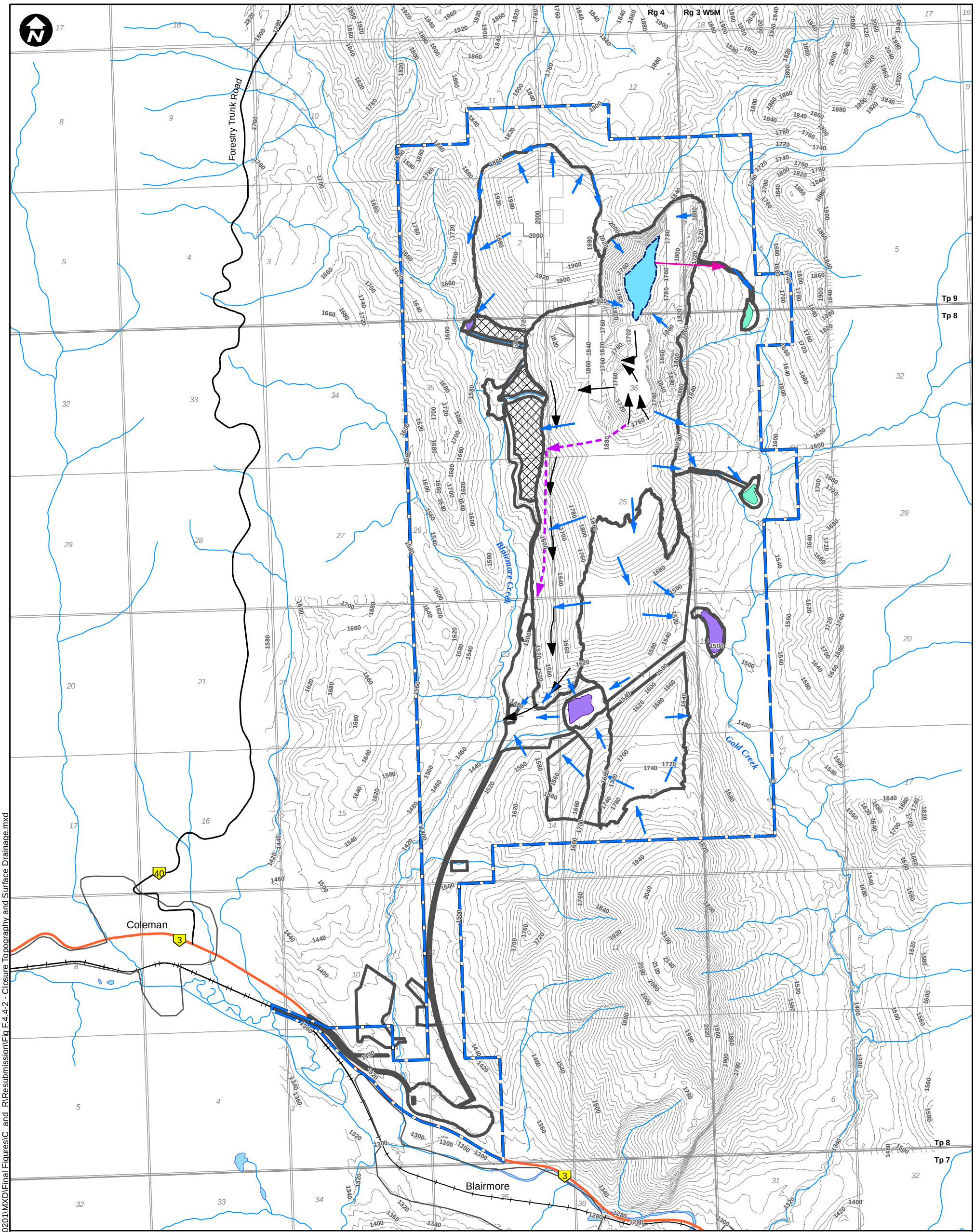
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DRAWN BY:	JDC/JL
CHECKED BY:	DM
DATE:	JULY 11, 2016

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Kilometres

FIGURE

F.4.4-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\IC and R\Resubmission\Fig F.4.4-1 - End of Mine Surface and Subsurface Drainage.mxd



LEGEND

- Proposed Mine Permit Boundary
- Project Footprint
- Undisturbed Area
- Primary Highway
- Secondary Highway
- Existing Railway
- Reclaimed Topographic Contour (20m interval)
- Subsurface Direction of Flow (Selenium Attenuated Water)
- Subsurface Lake Discharge
- Subsurface Drainage
- Drainage Direction
- Surface Water Drainage
- Existing Waterbody
- End-Pit Lake
- Wetland
- Constructed Wetland

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

CLOSURE RECLAMATION LANDSCAPES WITH SURFACE DRAINAGE

NOTES

AltaLIS, 2016; Deswik, 2016; Geobase, 2015; Golder, 2016; MEMS, 2016; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

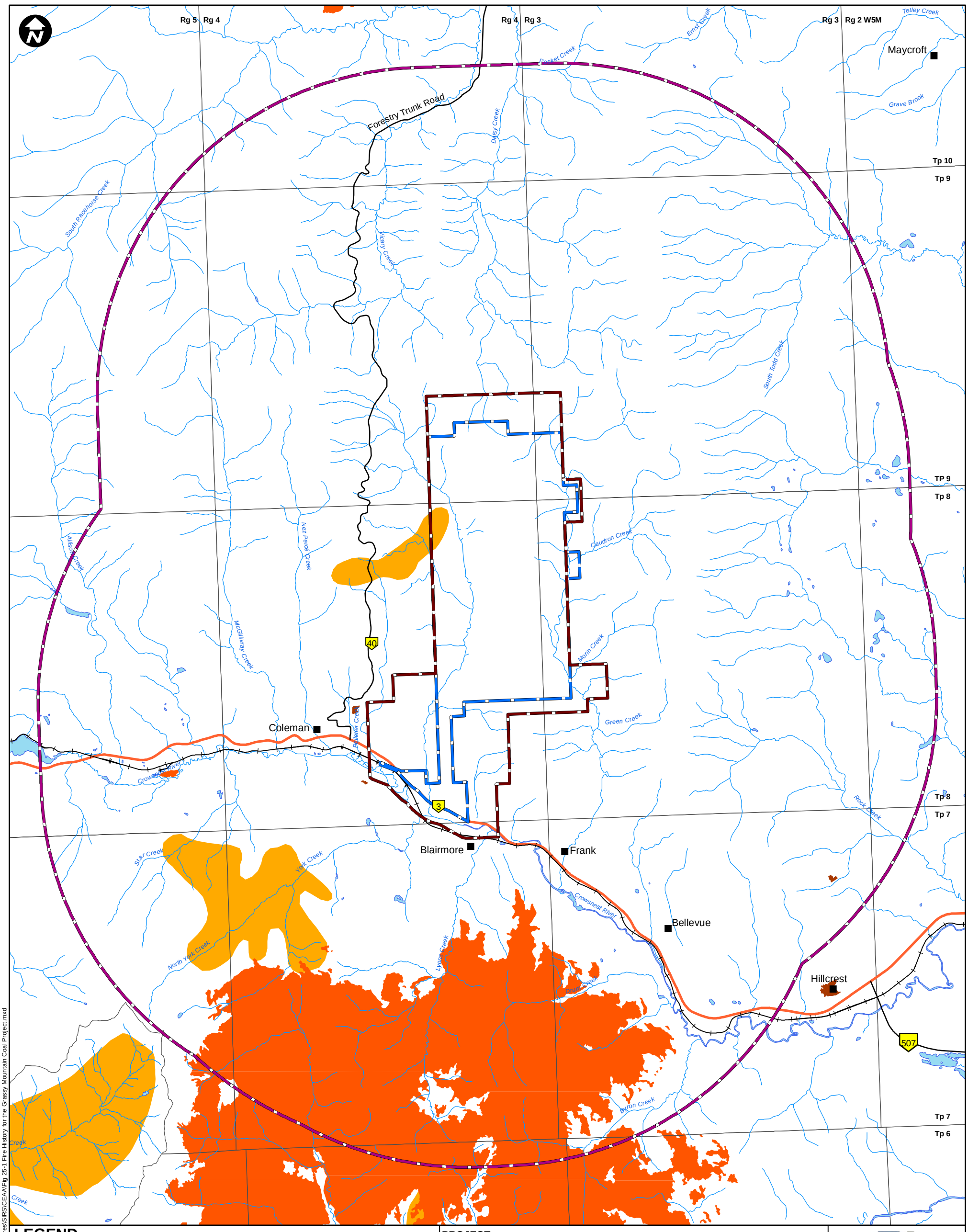
PROJECT:	14-00201-01
DRAWN BY:	SL
CHECKED BY:	DM
DATE:	JUNE 10, 2016

0 0.75 1.5 3
Kilometres

FIGURE

F.4.4-2

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\IC and RI\Resubmission\Fig F.4.4-2 - Closure Topography and Surface Drainage.mxd



LEGEND

- Primary Highway
- Secondary Highway
- Existing Railway
- Surface Water Drainage
- Waterbody
- Wildlife Regional Study Area
- Wildlife Local Study Area
- Proposed Mine Permit Boundary

Fire History

- 1930-1939
- 2000-2009
- 2010-2019

PROJECT

RIVERSDALE RESOURCES

GRASSY MOUNTAIN COAL PROJECT

MILLENNIUM EMS Solutions Ltd.

TITLE

FIRE HISTORY FOR THE GRASSY MOUNTAIN COAL PROJECT

NOTES

AltaLIS, 2017; Geobase, 2015; MEMS, 2016;
Natural Resources Canada, 2015; Riversdale, 2016
Datum/Projection: UTM NAD 83 Zone 11

PROJECT: 14-00201-01
DRAWN BY: SL
CHECKED BY: RM
DATE: MAY 4, 2017

0 2 4 8
Kilometres

FIGURE

F.5.2-1

Document Path: K:\Active Projects 2014\AP 14-00201 to 14-00250\14-00201\MXD\Final Figures\SIR\SVCEAA\Fig 25-1 Fire History for the Grassy Mountain Coal Project.mxd

APPENDIX 2.6-1A: CLIMATE CHANGE TABLES

APPENDIX 2.6-1a: Climate change tables

Source: Addendum 4, Attachment 2, CEAA Registry #55, IR 25, Tables A25-1 to A25-13

Table A2.6-1 Wildfire History for the Project (1931-2015)

Year	Total Area Burned (ha)		
	Mine Permit Boundary	Wildlife Local Study Area	Wildlife Regional Study Area
1931	--	--	1,256
1934	54	54	310
2003	--	--	6,528
2008	--	--	7.2
2010	--	--	2.6
2012	--	--	2.9
2013	--	--	0.7
Total Area Burned (ha)	54	54	8,107
Total Area Burned (%)	1.5	1.0	11.0
Total Area Burned/Year (ha/yr)	0.6	0.6	95.4
Total Area Burned/Year (%/yr)	0.02	0.01	0.13
Frequency (fires/year)	0.01	0.01	0.08
Fire Occurrence (fires/10^5 km^2/yr)	31.8	20.8	11.2

Table A2.6-2 Summary of Change in Projected Temperature (°C Change from 1986-2005) for Winter (December-February), Summer (June-August), and Annual for Three Time Periods for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	RCP2.6			RCP4.5			RCP8.5		
Future Time	**2020-2029**	**2035-2044**	**2050-2059**	**2020-2029**	**2035-2044**	**2050-2059**	**2020-2029**	**2035-2044**	**2050-2059**
Winter[2]									
Median	0.90	1.10	1.35	1.10	1.57	2.15	1.25	2.05	2.78
25th[3]	0.47	0.70	0.86	0.59	1.10	2.00	0.55	1.80	2.27
75th[3]	1.44	1.46	2.05	1.30	1.80	2.80	1.55	2.35	3.19
Summer[2]									
Median	1.10	1.45	1.65	1.15	1.75	2.35	1.40	2.10	3.40
25th[3]	0.95	1.35	1.55	0.95	1.55	2.15	1.25	1.78	2.88
75th[3]	1.05	1.45	1.65	1.15	1.75	2.35	1.35	2.05	3.35
Annual									
Median	1.13	1.41	1.62	1.16	1.67	2.27	1.29	2.00	2.91
25th[3]	0.95	1.31	1.54	1.06	1.58	2.07	1.12	1.86	2.76
75th[3]	1.24	1.46	1.77	1.18	1.78	2.34	1.46	2.16	3.15

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5). Data are for 49.5°N latitude and 245.5°E longitude.

[2] Winter: December, January, February. Summer: June, July, August.

[3] 25th and 75th percentiles

Data Source: CCDS (2017)

Table A2.6-3 Summary of Maximum Daily Temperature for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	25.3	**27.2**	**28.7**	**29.8**	**27.4**	**26.3**	**28.8**	**27.8**	**29.0**	**29.9**
95th[2]	31.1	28.8	**31.4**	**34.0**	28.9	30.9	**32.3**	**31.6**	**31.6**	**33.3**
Maximum	31.8	29.0	31.6	**34.9**	29.0	**32.2**	**32.4**	31.7	**32.2**	**33.3**
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	30.1	**32.6**	**33.1**	**33.8**	**32.7**	**31.2**	**33.2**	**32.3**	**34.1**	**34.1**
95th[2]	35.2	32.9	34.9	**38.4**	34.3	35.2	**36.2**	**36.1**	**36.0**	**36.6**
Maximum	35.9	32.9	35.0	**39.1**	35.1	**36.4**	**36.5**	**36.3**	**36.6**	**37.0**

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).
2 95th percentiles
Data Source: CCCMA (2017)

Table A2.6-4 Summary of Minimum Daily Temperature for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	-33.3	-29.1	-28.8	-26.3	-32.3	-29.6	-27.9	-30.9	-31.8	-29.7
5th[2]	-42.0	-39.2	-36.1	-38.3	-39.1	-34.4	-39.4	-39.8	-36.7	-34.6
Minimum	-43.4	-41.7	-37.3	-40.5	-42.2	-36.0	**-44.1**	-43.1	-37.1	-34.6
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	-34.4	-30.7	-29.3	-31.0	-32.2	-29.5	-29.2	-32.9	-33.2	-29.0
5th[2]	-42.0	-41.1	-36.0	-40.0	-41.8	-36.6	-40.9	-41.7	-37.5	-34.7
Minimum	-44.8	-42.5	-36.1	-40.7	-44.4	-37.9	**-46.2**	**-45.1**	-37.9	-35.1

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

[2] 5th percentile

Data Source: CCCMA (2017)

Table A2.6-5 Summary of Reduction in Projected 20-year Return Period for Annual Daily Precipitation Extremes (% Reduction from 1986-2005) for Three Time Periods for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	RCP2.6			RCP4.5			RCP8.5		
Future Time	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
10% Reduction in P_{20} per 1°C Local Warming									
Median	11.3	14.1	16.2	11.6	16.7	22.7	12.9	20.0	29.1
5th[3]	7.7	11.9	13.4	8.5	14.2	19.6	8.4	16.0	24.8
95th[3]	18.8	15.1	18.6	12.9	19.1	25.4	15.9	22.8	33.1
20% Reduction in P_{20} per 1°C Local Warming									
Median	22.6	28.3	32.4	23.1	33.4	45.3	25.9	39.9	58.2
5th[3]	15.4	23.8	26.7	17.1	28.4	39.2	16.8	32.0	49.5
95th[3]	37.7	30.3	37.3	25.8	38.3	50.7	31.7	45.6	66.2

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5). Data are for 49.5°N latitude and 245.5°E longitude.

[2] Median (50th percentile) % reduction in return period for the equivalent extreme precipitation in historic ΔP_{20} in each year within the time period.

[3] 5th and 95th percentiles

Table A2.6-6 Projected Return Period (Years) for Annual Daily Precipitation Extremes Equivalent to Historic (1986-2005) 20-year Return Period for Three Time Periods for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	RCP2.6			RCP4.5			RCP8.5		
Future Time	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
Return Period for 10% Reduction in ΔP_{20} per 1°C Local Warming									
Median	17.7	17.2	16.8	17.7	16.7	15.5	17.4	16.0	14.2
5th[3]	16.2	17.0	16.3	17.4	16.2	14.9	16.8	15.4	13.4
95th[3]	18.5	17.6	17.3	18.3	17.2	16.1	18.3	16.8	15.0
Return Period for 20% Reduction in ΔP_{20} per 1°C Local Warming									
Median	15.5	14.3	13.5	15.4	13.3	10.9	14.8	12.0	8.4
5th[3]	12.5	13.9	12.5	14.8	12.3	9.9	13.7	10.9	6.8
95th[3]	16.9	15.2	14.7	16.6	14.3	12.2	16.6	13.6	10.1

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5). Data are for 49.5°N latitude and 245.5°E longitude.

[2] Median (50th percentile) projected return period for the equivalent extreme precipitation in historic ΔP_{20} in each year within the time period.

[3] 5th and 95th percentiles

Table A2.6-7 Summary of 1-Day Maximum Precipitation (mm) for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	35.6	38.2	33.9	29.3	35.8	28.9	34.1	30.1	35.4	39.1
5th[2]	24.1	24.5	18.9	19.8	27.6	20.6	24.2	21.1	25.6	19.8
95th[2]	65.7	43.7	50.9	48.2	57.3	42.3	48.7	33.9	52.8	47.5
Maximum	70.9	44.1	51.4	53.6	70.4	43.7	55.5	35.1	55.0	51.4
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	29.2	29.1	26.1	25.9	31.4	25.8	22.9	25.3	32.0	26.3
5th[2]	14.9	21.5	12.3	11.4	19.1	15.0	19.7	17.3	18.9	15.6
95th[2]	59.9	44.8	43.8	53.1	43.3	47.4	31.8	32.7	48.2	43.6
Maximum	61.7	45.7	47.7	59.5	47.8	52.9	33.1	33.1	51.1	47.5

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).
[2] 5th and 95th percentiles
Data Source: CCCMA (2017)

Table A2.6-8 Summary of 5-Day Maximum Precipitation (mm) for the Grassy Mountain Coal Project

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	68.1	71.3	67.9	60.9	75.9	63.4	72.9	74.0	71.7	68.7
5th[2]	51.8	51.7	45.4	45.6	51.9	47.5	60.0	51.7	56.3	49.4
95th[2]	130.3	101.8	89.7	86.3	87.6	81.5	83.7	99.8	103.2	96.8
Maximum	137.9	109.8	91.5	89.9	88.4	82.4	85.0	101.6	112.7	98.4
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	59.8	56.8	55.5	49.2	57.5	57.3	44.5	62.8	57.7	49.0
5th[2]	35.2	43.6	29.8	28.0	33.8	40.4	36.3	38.7	36.7	34.7
95th[2]	103.2	87.1	89.3	97.4	74.7	71.5	64.2	75.6	100.3	78.2
Maximum	109.7	92.7	93.0	97.6	80.6	72.2	64.9	75.9	**113.2**	81.1

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

[2] 5th and 95th percentiles

Data Source: CCCMA (2017)

Table A2.6-9 Summary of Total Annual Precipitation on Wet Days (mm) for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	1,050.2	1,033.2	1,030.6	1,002.5	1,091.4	1,019.0	1,041.1	1,002.5	981.9	1,041.1
5th[2]	889.9	881.3	863.2	818.3	808.5	927.6	944.5	893.4	836.1	840.4
95th[2]	1,221.2	1,189.1	**1,228.2**	1,113.8	1,176.8	1,079.2	1,135.7	1,139.9	1,122.2	1,190.8
Maximum	1,387.5	1,254.7	1,248.9	1,122.4	1,201.7	1,116.8	1,151.0	1,146.6	1,136.7	1,225.1
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	592.4	570.0	545.4	502.5	607.5	583.5	572.9	568.8	533.6	515.8
5th[2]	440.6	493.5	456.7	413.4	440.4	505.6	488.8	464.3	432.4	418.3
95th[2]	735.5	677.8	640.5	700.6	652.0	660.2	716.9	655.0	685.5	680.7
Maximum	747.9	689.2	643.7	736.9	657.7	695.5	**770.2**	683.9	695.6	703.0

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

[2] 5th and 95th percentiles

Data Source: CCCMA (2017)

Table A2.6-10 Summary of Number Days with >20 mm Precipitation for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	3	4	2.5	2	3.5	3	3.5	3	3	3
5th[2]	1	1	0	0.5	1	0.5	1	0.9	1	0.5
95th[2]	7.1	5.6	6.6	3.6	6	5	6	6.1	6.6	7.1
Maximum	8	6	7	4	6	5	6	7	7	8
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	2	1.5	1	1	2	1	1	1	1.5	1.5
5th[2]	0	0.5	0	0	0	0	0.5	0	0	0
95th[2]	4.1	**5.1**	**4.6**	2.6	3.6	3	3.6	4	4	3.1
Maximum	5	**6**	5	3	4	3	4	4	4	4

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

[2] 5th and 95th percentiles

Data Source: CCCMA (2017)

Table A2.6-11 Summary of Maximum Consecutive Dry Days for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.72°N latitude and 244.69°E longitude (60 km west of Project)										
Median	12.5	12	10	12.5	14	12	15.5	12.5	15.5	11.5
5th[2]	8.9	8.5	7.5	9.5	9.4	9.0	10.3	8.9	11.5	8.4
95th[2]	18.3	16.1	18.1	18.2	**23.6**	**19.1**	**18.7**	**20.1**	**22.6**	16.6
Maximum	24	17	19	20	24	20	20	21	23	17
49.72°N latitude and 246.09°E longitude (39 km east of Project)										
Median	17.5	15.5	20	16.5	23	19.5	17	17	21	18.5
5th[2]	12.9	11.5	13.5	13.9	13.9	13.3	11.4	11.5	14.4	11.5
95th[2]	27.3	**29.1**	23.7	20.6	**28.1**	**33.6**	**31.5**	**35.4**	**31.0**	**33.6**
Maximum	32	**34**	25	21	29	**34**	**36**	**43**	31	**34**

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

[2] 5th and 95th percentiles

Data Source: CCCMA (2017)

Table A2.6-12 Summary of Monthly Wind Speed (m/s) for the Grassy Mountain Coal Project.

CMIP5 Scenario[1]	Historical (1986-2005)	RCP2.6			RCP4.5			RCP8.5		
		2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059	2020-2029	2035-2044	2050-2059
49.5°N latitude and 245.5°E longitude										
Median	2.77	2.64	2.66	2.64	2.59	2.56	2.53	2.76	2.72	2.70
95th[2]	3.48	3.41	3.33	3.43	3.35	3.30	3.34	3.45	3.53	3.37
Maximum	3.92	3.60	3.52	3.74	3.72	3.42	3.52	3.63	3.81	3.52

[1] CMIP5: Coupled Model Intercomparison Project Phase 5. Results are provided for three emission scenarios based on Representative Concentration Pathways (RCPs) for low emissions resulting from mitigation (RCP2.6), intermediate emissions (RCP4.5), and high emissions (RCP8.5).

[2] 95th percentile

Data Source: CCCMA (2017)

Table A2.6-13 Change in Hourly Gust Frequency

	Wind Gust (km/h)			
	≥ 28	≥ 40	≥ 70	≥ 90
1994-2009 – Frequency of Gusts (# hours or days/yr)				
Hourly (# hours)	616	257	6	0.3
Daily	129	81	6	0.6
2046-2065 – % Change from 1994-2009 Hourly Gust Frequency				
Low Emissions	0	3	20	200
High Emissions	5	11	30	220

Source: Cheng *et al.* 2014. Project is located within Region W3.